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The impact of interest rates on bond yields: the case of Banking Tunisia

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Abstract:

The aim of this paper is to study the effects of changes in interest rates on the performance of bonds issued by the Tunisian banking knowing that it is a significant component of financing. So, the bond issue is an essential link of investments. The studying of yield bond is an important first step. For many types of financial research. To date, this research has focused on the bond yield for banks. There regression models are tested by different methods. The first model is based only on relationship between Actuarial Rate of Return, maturity and coupon. The other models are prominent in the published literature on the bond yield.

Key words: Interest rates, bonds yield, coupon, maturity, actuarial rate of return, institution banking

Classification JEL: G11, G12, G21, G23

I. Introduction

In recent years, that banks in Tunisia become more autonomous in setting rates. Caused by gradual liberalization financial. But, Fluctuation rates are a source of banking risk that must be managed to take advantage of market opportunities and avoid capital losses. Such management requires two prerequisites: The definition of a rate interest structure and the measurement of its risk. In fact, interest rate risk represents a market risk, which has a very significant impact on the returns of the various financial assets (variable-rate bonds, indices, etc.). Diversifying sources of internal and external bank financing are about ensuring stable, low-cost financing. The aim of diversifying bank financial sources is to attract investors. So, financial institutions are mainly interested in external financing such as bond borrowing in order among the methods of ensuring the liquidity of banking institutions. Thus, several institutions resort to bond loans to diversify bank products more and more, since bond borrowing is also a component of net banking income, it is a securities transaction. The nature of the bond activity is part of the banking policy aimed at coping with the increase in its commitments and reaching the target market shares by moving towards the mobilization of stable resources in the medium and long term. As such, the bank plans to mobilize, on a recurring basis, the resources needed to finance its assistance to the economy.

While the need for the bond issue is aimed at consolidating long-term resources in order to preserve its balance in terms of the adequacy of jobs and resources, to ensure better financing of medium and long-term loans, to diversify increasingly the products of financial and banking institutions.

II. Literature Review

The interest rate refers to differ only in the timing of interest payments (coupon) and depends maturity. Many consider these definitions to be -synonymous with each other; most testing of term structure theory has been in a relationship between the actuarial rate of return (ARR), coupon and maturity developed from yield bonds. Several authors have pointed out that because of a coupon effect, maturity is equivalent to Actuarial rate of return only under certain restrictive conditions. Many researchers have particularly focused on the relationship between the interest rate and bond yield. For example, we mention explanatory theories of the term structure of interest rates. The purpose of studying the forward structure of interest rates is to explain the differences between short-term and long-term rates, i.e. the explanation of changes in interest rates by term has a certain anticipatory content.

To analyze this structure, the investor needs the explanatory theories namely: the theory of pure expectations, the theory of preferred habitat, the theory of preference for liquidity and the theory of market segmentation.

Since 1930, J. Ficher has highlighted the role of expectations in setting the level of the nominal interest rate. The Ficher effect (1930) is defined as the increase in the nominal interest rate resulting from the effects of these expectations.

The theory of anticipation was formulated first in certain future by F. Hurtz (1940) who required Ficher's notion of anticipation, then in uncertain future with Meiselman (1962). It regards agents as speculators indifferent to capital risk.

Modigliani and Sutch (1966) analyze as an extension of the two previous theories. Intermediaries do not naturally prefer a short horizon for lenders and a long horizon for issuers, but they define a horizon that determines the preferred habitat of each operator they want to fully protect against the risk of the interest rate by adopting as the only investment rule the equalization of the duration of instruments extended to their investment horizon. This horizon depends essentially on the structure of their resources.

Thus, each term of the structure interest curve can be analyzed separately: The premium with a particular deadline is the price to pay for any stakeholder to agree to abandon their preferred habitat. It therefore appears as a premium for imbalance in the rate interest structure. It can be positive or negative. On the other, the theory of preference for liquidity by bonds, if the issuers of securities have different preferences than investors, for example, if issuers prefer long-term securities while investors prefer short-term securities, then issuers will have to offer a premium for the investors to renounce their initial choice. This bonus is called the liquidity premium. It is then considered that this situation is the most frequent, the longer a bond, the higher the no liquidity premium. This approach to the rate interest structure was developed by Culbertson (1957) who emphasizes the fact that investors have preferences for certain maturities. So, researchers have been trying to determine the mechanisms affecting the shape and evolution of the structure interest rate. Various models have been proposed to describe the term structure of interest rates. Besides, the equilibrium model and the econometric are presented and used to describe the relationship between the rate and its term.

In this respect, researchers and, generally, all financial market practitioners are interested in understanding the techniques for plotting the interest rate curve. Much of the financial literature has been devoted to the study of the term structure of the interest rate. The purpose of the equilibrium model is to determine the term structure of interest rates. This type of model is based on a single variable. The models of this theory are equilibrium models such as the Vasicek (1977) models, Cox, Ingersoll and Ross (1985) are two models with a single variable that determines the evolution of the interest rate. Next, the approach Salomon brothers developed an option pricing model for callable bonds. It based on the volatility of interest rates, as their volatility will affect the possibility of the bonds.The volatility-dependent these assumptions that the entire structure per term at any time can be expressed in terms of the returns of the instruments without defects of the longest and shortest maturity.

In this context, there are some models Econometric is based on actuarial rates of return. The basic idea is to find a relationship that explains the rate of return of a security according to its maturity and coupon level, the relationship is written as follows:

$$\mathbf{Y = f (m, c)}$$

With:

- Y= This is the actuarial rate of return on the bond
- m= it's maturity

and

- C= Coupon that implicitly reflects the change in the interest rate

We can cite, as an example, the model of Salomon Brothers tested for the first time in 1976 on a bond portfolio, this model relates the actuarial yield, the maturity and the coupon.

-The model Salomon Brothers:

- $Y = a_0 + a_1 . \log(m) + a_2 \frac{1}{m} + a_3 . C$

with: a_0, a_1, a_2, a_3: are estimated by the method of least squares OLS and Perform FE-RE-model.

-The model Salomon Brothers modify:

- $Y = a_0 + a_1 . \log(m) + a_2 . C$

In the context of this paper, we attempt to econometrically analyze the relationship between the of actuarial rate of return, maturity and coupon in the case of Tunisia by three models.

III. Research Methodology

The concept of bond issues often aims to achieve its investissement objectives. It is today associated with all financial fragile as a means of offering liquidity and investment. In concrete terms, these bonds have created more liquidity. For this purpose, the yield bond is based on a number of variables that are used in the measurement, in order to facilitate understanding. Indeed, the analysis of the variables makes it possible to measure the actuarial rate of return, maturity and coupon. These indicators are analytical tools and financial interpretations, or the most relevant of them have been chosen. The independent variables (the factors below) represent the actuarial rate of return and dependent variable maturity, coupon. Our model is as follows:

Actuarial rate of return = F (maturity, coupon)

t: the number of years between 2010 and 2022

1. Objectives of the research

This article aims to link the actuarial rate of return, maturity and coupon. Our goal is to study the concept of this relationship. A general objective and other specific objectives were selected for this study, namely:

* Analyze the concept of bond yield and interest rate and cite their measurement indicators.

* Identify the nature of the relationship between the actuarial rate of return and maturity, coupon.

We will use the Stata test for data processing. On the one hand, this test will be applied to the correlation analysis to verify the relationship between the of actuarial rate of return, maturity, coupon by the correlation matrix. On the other hand, we will study the influence of of actuarial rate of return on maturity, coupon by model estimation through the ordinary least squares (OLS), Perform FE- and RE-model methods and the hypothesis.

IV. RESULTS and Discussion

4.1. Data and Sources of Data

In this paper, we analyze different variables, Actuarial rate of return, maturity, coupon. More precisely, we examine the dynamic relationship between these variables during the period from January 1, 2010 until December 31, 2022 on annual frequencies. In our study, the choice of starting date of January 1, 2010 is to better identify and understand the investor sentiment.

Our sample is composed of Tunisia. The choice of Tunisia is due to a fragile financial situation based on bond issues. In addition, central bank financial data containing annual data from the year 2010 to 2022 on all financial information relating to bond issues of banking institutions (ATB[1], AB[2], Attijari Bank, BH[3], BTE[4], BTK[5], STB[6], UIB[7]). In this framework, we tried to analyze the relationship between the actuarial rate of return, maturity and coupon.

4.2. Results of Descriptive Statics of Study Variables

Before presenting our results, we present the descriptive statistics of the endogenous variables and the explanatory variables which appear in the following table:

Table 4.1: Descriptive Statics

	TMM[8]	TI[9]	ARR[10]	M[11]	C[12]	1/M	Log(M)	Log(C)	Log(ARR)
Mean	5. 308	5.21	0.056	5.75	3.83	0.288	0 .668	0.547	-0.97
Std.dev	1.33	2.29	0.013	3.24	1.68	0.265	0 .313	0.17	0.77
Min	4.02	0.047	0.036	1	1.89	0 .07	0	0.93	-1.43
Max	7.74	8.74	0.087	13	8.54	1	1.11	0 .93	1.08
Skewness	0.28	0.0006	0.002	0.24	0.0002	0.000	0.005	0.062	0.000
Kurtosis	0.147	0.12	0.788	0.03	0.22	0.003	0.73	0.055	0.0009
p-value	0.15	0.002	0.015	0.05	0.000	0.000	0.02	0.03	0.000

All the considered variables are collected on annual frequencies. From the beginning, we convert all the series into Log values (L variables). **Table4.1**, Actuarial rate of return (Log (ARR)= -0.97) whereas the lower. Besides, the variable ARR is less risky whereas other variable to have a high standard deviation (Maturity (M)=3.24). The asymmetry between different variables in terms of skewness and kurtosis are well documented, implying they are normally distributed.

4.3. Results of Correlation matrix of Study Variables

Table4.3.Correlation matrix

	TMM	TI	ARR	Maturity	C	1/M	Log(M)	Log(C)	Log(ARR)
TMM	1								
TI	1	1							
ARR	1	1	1						
Maturity	0.99	0.99	0.82	1					
Coupon	1	1	1	0.828	1				
1/M	-0.5	-0.5	-0.5	-0.77	-0.5	1			
Log(M)	0.7	0.71	0.71	0.943	0.71	-0.93	1		
Log(C)	0.99	0.99	0.99	0.843	0.99	-0.51	0.727	1	
Log(ARR)	0.99	0.99	0.99	0.843	0.99	-0.51	0.727	1	1

Based on the result of the correlation matrix, the relationship between the actuarial rate of return and maturity, coupon, interest rate is a positive relationship.

[1] ATB: Arab Tunisia Bank
[2] AB: Amen Bank
[3] BH: Bank Habitat
[4] BTE: Bank Tunisia Emarat
[5] BTK: Bank Tunisia Bank
[6] STB: Society Tunisia Bank
[7] UIB: Union Tunisia Bank
[8] **TMM:** Money market rate

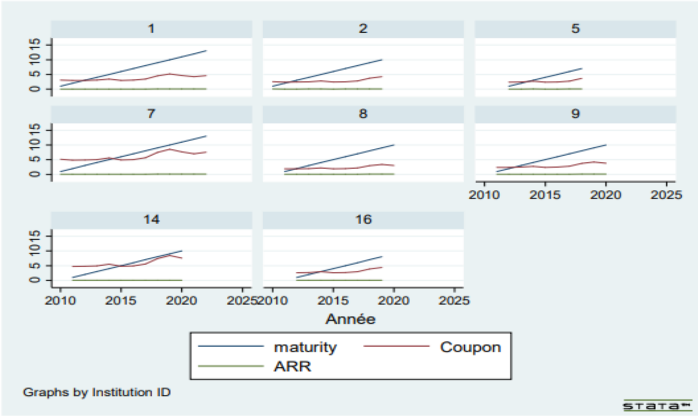
[9]**TI:** Interest rate
[10] **ARR:** Actuarial Rate of Return
[11] **M:** Maturity

[12] **C:**Coupon

4.4. Analysis Graphic

From the estimation result by different graphics, we show that the different relationships ARR, Maturity and Coupon. So, the relationship as showed in the following impulse response functions.

4.4.FigureN°1 of relationship ARR,Maturity and Coupon



It can say, the Variable ARR relate to two variables maturity and coupon. Through this **Figure N°1** the variable ARR represented in parallel with Coupon and Interest rate. But, we compare difference lower between ARR, coupon and maturity. This relationship between ARR and Maturity are starting from the same position, but the curve of maturity increases remarkably on the other hand the curve of ARR remains constant. It gives figure triangle. Besides, the curve of coupon is parallel with ARR, but there is an intersection the curve of maturity and interest rate.

4.5. Results of Analysis Variance-Covariance

Table4.4. Analysis Variance-Covariance

Variables	TMM	TI	Maturity	Log(M)	1/M	Coupon	Log(C)
ARR	0	3.15e-06	1.26e-33	5.03e-33	6.10e-33	0	2.39e-32

Then, we examine the linear relationships between these variables using the variance-covariance matrix. In this regard, it is important to analyse the potential associations between different variables based on the variance-covariance matrix. **Table4.4**, illustrates the variance-covariance matrix. Needless to say, the diagonal elements of the matrix correspond to the variances of the variables (in bold) whereas the off-diagonal elements are the covariance between all possible pairs of variables. Firstly, some asymmetries between different variables are quite pronounced. There is a positive link between the actuarial rate of return «ARR» and coupon (C). Rather, there is positive relationship between the actuarial rate of return «ARR» and maturity (M), interest rate.

V. Empirical validation

5.1. Results from unit root test

Table 5.1.Unit root test of Study Variables

TypeTest					Fisher-type Test				
Variable	**TMM**	**TI**	**ARR**	**Log(ARR)**	**Coupon**	**Log(C)**	**M**	**Log(M)**	**1/M**
P	0.821	1	1	1	1	1	1	0.00	0.00
Z	0.821	1	1	1	1	1	*	0.00	0.00
L*	0.803	1	1	1	1	0.99	*	0.00	0.00
Critical value of 5%	0.788	0.99	0.99	0.99	0.99	0.99	0.99	0.00	0.00

We first examine the issue of stationarity for different variables using two classical unit root tests: Fisher-type test. I'm performing several tests on panel data. From Table4, the optimal number of lags that whitens residuals of each variable is greater than1. Hence, we apply a unit root test with different test such as the augmented “Fisher-Type test”. These variables are not stationary in level, variables become stationary given that the statistics are lower than the critical values of “Fisher-Type test”. We can accept the hypothesis (H1) is said different variables (TMM, TI, ARR, Log(ARR), Coupon, Log(coupon) and Maturity) to be no stationary and statistical not significance. But, the variable «Log(maturity) and 1/M» is tested by Fisher-type unit root test:

Ho: All panels contain unit roots
Ha: At least one panel is stationary

If you look at your tests P,Z,L* and Pm, the null hypothesis of this test is that all panels contain a unit root. Given your results we reject hypothesis null. If you look at your tests P, Z, L* and Pm, you get a value for these test statistics of variable Log(Maturity) and 1/M are (576.6985; -22.9835; -56.8714 and 99.1184) with p-value=0.000. One on the other hand, we used Logarithmic of variable Maturity for change result by test Fisher unit root. This new result shows that variable become stationary. We can reject the null hypothesis at the 1% level of statistical significance.

5.2. Estimation results using different methods

Then, our estimates are through the application of Stata econometric software to a sample of 8 institutions banking Tunisia over a period of 13 years (from the year 2010 to 2022). Most of the results obtained show the existence of a relationship between the actuarial rate of return and maturity, coupon.

Table5.2.Estimation of Study Variables

		Model 0		**Model 1**			**Model 2**	
		Maturity	**Coupon**	**Log(M)**	**1/M**	**Coupon**	**Log(M)**	**Coupon**
Methode: OLS	**coeff**	0.0021	0 .0019	0.049	0.03	0 .0019	0.0184	0.0027
	Std.d	0.00038	0 .0007	0.011	0.01	0.0007	0.0039	0.0007
	P> t	0.000	0.009	0.000	0.003	0.010	0.000	0.000
	F	37.87		26.02			31.18	
	P>F	0.000		0.000			0.000	
	R^2	0.49		0.5			0.44	
Methodes :*Perform FE-*	**coeff**	0.0006	0.0113	0.013	0.009	0.011	0.004	0.0119
	Std.d	0.000244	0.0008	0.006	0.006	0.0008	0.002	0.0007
	P> t	0.013		0.036	0.139	0.000	0.02	0.00
	F	300.43		200.71			294.82	
	P>F	0.000		0.000			0.000	
RE-model	**coeff**	0.00122	0.0083	0.03	0.022	0.0078	0.008	0.009
	Std.d	0.00028	0.0009	0.007	0.008	0.0009	0.0025	0 .0008
	P> t	0.000		0.000			0.00	
	chi2	336.2		314.84			312.54	
	P>chi 2	0.000		0.000			0.00	

We use a double step method to estimate the long a term relationship between different variables. Given some drawbacks of using such method, one might use the «OLS» and «Perform FE- and RE-model». From Table, the estimation of this long-term relationship by the method of Engle and Granger (1987) is based on the ordinary least squares (OLS). We are testing these relationships by method OLS:

- **Model0:** Y=f (m, c)

Such relationship accepted under the stationary in the level of the residuals of long term relationship, we show this variable maturity has to impact positively on the ARR whereas coupon does influence, this indicates that it is statistically significant p=0.00<0.05.

- **Model1 "Salomon Brothers":** $Y = a_0 + a_1 . \log(m) + a_2 \frac{1}{m} + a_3 . C$

From the estimation result, we notice that this model is significant (p>F =0.000. We used logarithmic of maturity affected (Log(Maturity)) positively and significantly influences the ARR. Besides, Inverse Maturity has an impact positively on the ARR. But, whereas coupon does influence it.

- **Model 2 "Salomon brothers modify":** $Y = a_0 + a_1.\log(m) + a_2 . C$

From the estimation result, we notice that this model is significant (p>F=0.00). We used logarithmic of maturity, and coupon variable does influence a variable ARR.

➢ In this regard, we find that use other methods for estimating the relationship by " **Perform FE (Unbalanced)- and RE-model (balanced)".**

- **Model0:** Y=f(m,c)

Such relationship accepted under the stationary in the level of the residuals of long term relationship, we show this variable maturity (p=0.00>0.05 has to impact positively on the ARR whereas coupon does influence, which indicates that it is statistically significant p=0.00>0.05.

Model1: " Salomon brothers ": $Y= a_0 + a_1.\log(m) + a_2\frac{1}{m} + a_3.C$

From the estimation result by" Perform FE (Unbalanced)- and RE-model (balanced)" , we notice that this model is significant (p>F=0.000). We used logarithmic of maturity affected (Log(Maturity)) positively and significantly influences the ARR. Besides, Inverse Maturity has an impact positively on the ARR. On the other hand, the variable coupon gives the same result does influence it.

- **Model 2: "Salomon brothers modify" :** $Y= a_0 + a_1.\log(m) + a_2.C$

From the estimation result by" Perform FE (Unbalanced)-and RE-model (balanced)", we notice that this model is significant (p>F=0.000). We used logarithmic of maturity and coupon variable does influence an ARR variable.

VI. Conclusion

In this paper, we attempt to investigate the association between ARR, maturity and coupon over the period 01/01/2010-31/12/2022. In this regard, the result of studying yield bonds of corporate data suggests that there are some problems in developing a data set that is somewhat homogeneous. Nevertheless, the empirical models tested in this paper performed of these models, proves to provide a high level of explained variation in the yields observed in the Tunisian bond market. In the first step, we used descriptive statistics, the correlation and variance-covariance matrix to study existence the relationship between different variables in a first step. Afterwards, we studied the impact of the interest rate on actuarial rate of return by an econometric model in a second step.

The models that are reported in the yield bonds literature as being good explanatory models were run with corporates. These three Models are not significant with an average R^2 of 0.44 and 0.5 by methods "OLS". But,it's according to the methods "Perform FE-and RE-model » are significant (P=0.000). These are the two models that have the expectations theory of the term structure as their theoretical base. Predicted yields bonds, coupon and maturity were calculated for a holdout sample and found to be accurate. The estimation of our models applied to banking institutions over a period of 13 years, we show that:

-The maturity is significant and gives a positive relationship with the actuarial rate of return.

-The coupon is significant but gives a positive relationship with the actuarial rate of return. From these results, we found that the interest rate has an impact on the bond yield. These results indicate that useful yield bonds can be formed from ex post corporate bond data. These yield bonds can be employed in an ex ante sense to obtain bond prices, a host of empirical questions can be investigated.

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