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The Estimation of Relationship Between Actuarial Rate of Return, Maturity and Coupon: The Case of Tunisia

Sonia Elmguirhi*

Doctor in Finance and Teacher at Ministry of Education-Tunisia
**Corresponding author: elmguirhi.sonia@hotmail.fr*

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Abstract—The aim of this paper is to study the estimation of the relationship between the actuarial rate of return, maturity, and coupon issued by the Tunisian banking and financial institutions, knowing that it is a significant component of financing. Therefore, this relationship issue is an essential link between investments. An important first step is to study yield bonds. For various forms of financial research.To date, the research has primarily focused on the yield bonds for institutions, except for studies conducted by institutions, financial and banking. There are regression models that are tested by different methods. The first model focuses only on the relationship between the actuarial rate of return, maturity, and coupon. The other models are prominently featured in the published literature regarding the yield of bonds. From these models, we discovered that the interest rate has an impact on the yield bonds. These results indicate that the maturity and coupon have a significant impact and exhibit a favorable correlation with the actuarial rate of return. Our estimation of our models proves to provide a high level of explained variation in the yields observed in the Tunisian bonds market.

Keywords— coupon, maturity, actuarial rate of return

I. INTRODUCTION

The liberalization of Tunisia's interest rates increases the independence of financial and banking institutions in setting their prices. The volatile interest rates are a source of banking and financial risks that must be managed to take advantage of market opportunities and avoid capital losses. The interest rate risk represents market risk, which has a very significant impact on the returns of various financial assets. Indeed, bonds borrowing is one way of ensuring the liquidity of financial and banking institutions. Consequently, several countries have recourse to bonds loans, including Tunisia, whose economy is fragile. The objectives of bonds issuance are: to diversify bank products more and more, since bonds borrowing is also a component of net bank income, it is a security's transaction. The nature of bonds activity is part of banking policy aimed at countering the increase in its commitments and reaching targeted market shares by moving towards the mobilization of stable resources in the medium and long term. The structure of interest rates on bonds that differ in the timing of interest payments and maturities. Many tests of the theory of the structure of the term were conducted through the relationship between the actuarial rate of return, coupon and maturity. In our study, we focus on the most important external financing resource such as bonds borrowing. While the objective of the bonds issue is to consolidate long-term resources in order to preserve its balance in terms of job-resource adequacy, to ensure better financing of loans in the medium and long term.

In the case of Tunisia, it evolved within a regulatory framework characterized by a strict credit framework, an interest rate administration, exchange controls by the central bank and the use of bonds issues as a result of tighter bank liquidity, in view of strong credit growth and regulatory capital requirements. A question will be tried in this research can be formulated as follows:

-What is the relationship between actuarial rate of return (ARR), coupon and maturity?

In the present work, we will try to analyze this relationship econometrically: actuarial rate of return (ARR), coupon, maturity.

II. LITERATURE REVIEW

Many researchers focused on the relationship between interest rate and yield bonds. We mention the interpretive theories of the term interest rate structure.The purpose of the study of the future structure of

interest rates is to explain the differences between short-term interest rates and long-term rates, i.e. the interpretation of changes in interest rates by term has a certain proactive assurance. To analyze this structure, an investor needs interpretive theories: pure forecasting theory, preferred habitat theory, liquidity preference theory and market fragmentation theory. Since 1930, J.Fisher highlighted the role of expectations in determining the nominal interest rate level. Fisher (1930) refers to the rise in the nominal interest rate that results from these expectations[24]. In the face of an uncertain future, Hortz (1940) and Meiselman (1962) both called for Fisher's anticipation theory. It considers its clients to be speculators who are capital risk averse [15].We study the notion proposed by Modigliani and Soch (1966) as an extension of the previous two theories[16]. By adopting an equation of the duration of instruments to their investment horizon as a single investment base, brokers determine the horizon that determines the preferred habitat of each operator who wants to completely protect it from interest rate risk. Naturally, brokers do not prefer a short horizon for lenders and a long horizon for exporters.This horizon depends mainly on the structure of its resources. Thus, can be analyzed the structure of the curve through 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 structure. It can be positive or negative. On the other, the theory of preference for liquidity, 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. This situation is then considered the most common, and the longer the loan lasts, the higher the non-liquidity premium. Culbertson (1957) developed the rate structure theory, emphasizing that investors have preferences for particular maturities[4]. These researchers have been trying to determine the mechanisms affecting the shape and evolution of the structure by term. Various models have been proposed to describe the term structure of interest rates. These models are used to describe the relationship between the rate and its term. Besides, 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 equilibrium models utilized in this theory are the Cox, Ingersoll, and Ross (1985) [12] and Vasicek (1977) models[18], which each have a single variable that controls how the interest rate changes. Next, the two models of Salomon Brothers and the "paris-bas" model, based on the 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 a comparison with a yield curve model previously proposed by Cohen et al.

Nonetheless, the bonds represent a significant source of financing, thus being utilized for business development through credit. Banking companies work hard to deliver their good image by improving the performance of the company and managing and developing the company's money in creating the value of the company to compete with other companies. The banking sector is a sector under consideration because it is the heart of the country's economy. As an investment instrument, fluctuations in the bond yields generated by investors may occur from time to time. Changes in the return had an impact on the asking price for the identical bond. Therefore, investors and exporters should always pay attention to bonds prices and other factors affecting changes in yield bonds. There are three factors that affect yield to maturity: internal factors, bonds characteristics, and external factors. Several factors, including leverage, interest rates, and the yield of bonds up to maturity can be affected.

There exist numerous rationales for the preference of bonds over stocks among investors. The rate of return on bonds is generally defined to reduce the risk of loss. Another reason is that the issuer has been cancelled, and bond investors are encouraged to prioritize other creditors. Accoding to Fitriadi & Marsoem, 2022 [14], bonds investors will obtain returns at a rate known as the yield. Yields will fluctuate over time as interest rates change, which will affect the asking price of bonds. The yield will result from the discrepancy in the bid price of the bonds during trading. The return to maturity (YTM) is the cumulative return that investors will receive from the date of purchase and hold until the date of maturity. The research conducted by Nurfauziah & Setyarini (2004) [14] stated that the interest rate harms yield to maturity. In contrast, Yanto and Darmansyah (2021) concluded that the interest rate did not influence yield to maturity because interest rates were at normal levels, this would greatly reduce bonds trading.

This research aims to supplement empirical evidence of the impact of interest rates and maturity on yield bonds. The objective of this research is to aid and guide investors in selecting future profitable investments.

III.METHOD

In concrete terms, these bonds have created more liquidity. So, the yield bonds are based on a number of variables that are used in the measurement.The yield bonds have a considerable influence on the overall financial

market.The high-yield bonds market was hit hard during the 2008 financial crisis, reflecting widespread distress across the financial system. Salomon Brothers has navigated these turbulent financial conditions by maintaining its expertise in risk assessment, enabling it to make smart decisions during market downturns. Therefore, we use the model "Solomon Brothers" to test the case of Tunisia, as all financial and banking institutions in Tunisia rely on bonds for financing. The diversity of bonds issuers means that investors have the flexibility to adjust their portfolios according to their risk tolerance and goals. This diversity is a key factor in the success of Salomon Brothers in raising funds. However, yield to maturity is analyzed based on the impact of its price rising or falling over time. This is a critical factor for investors because it helps them assess the true potential return on an investment. As Salomon Brothers has shown, a deep understanding of these financial complexities can be a significant advantage in the high-yield market. Therefore, bonds are a form of investment that pays an interest or coupon on the principal. We use the model to study bonds issuance in Tunisia through the relationship between ARR, maturity, and coupon in order to avoid similar risks in the future.The analysis of the variables makes it possible to measure the actuarial rate of return, maturity and coupon. 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:

$$\mathbf{Y^1 = f\ (m^2,\ c^3)} \qquad \textbf{(1)}$$

- Y: This is the actuarial rate of return on the bonds
- m: It's maturity
- 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 bonds' portfolio, this model relates the actuarial yield, maturity and coupon. The model Salomon Brothers:

$$\mathbf{Y = a_0 + a_1 log(m) + a_2 \frac{1}{m} + a_3 \times c} \qquad \textbf{(2)}$$

IV. Results and Discussion

A. *Data and descriptive static*

In this paper, we analyze different variables, Actuarial rate of return, maturity, coupon. More precisely, we examine these variables during the period from January 1, 2010, until December 31, 2022, on annual frequencies and all financial information (central bank financial data) relating to bonds issues of financial and banking institutions in Tunisia. So, we present the descriptive static of the endogenous variables and the explanatory variables which appear in the following **Table 1**:

TABLE 1
DESCRIPTIVE STATIC OF DIFFERENT VARIABLES

	ARR	m	c	1/m	Log(m)
Mean	0.057	4.99	2.81	0.33	0.6
Std.dev	0.012	3.057	1.9	0.28	0.31
Max	0.1	13	8.54	1	1.114
Min	0.0365	1	0.55	0.077	0
Skewness	1.18	0.6	1.04	1.54	-0.52
Kurtosis	4.01	2.57	3.62	4.16	2. 36
p-value	0.000	0.000	0.000	0.000	0.000

[2]Y : ARR : actuarial of rates return.
[3]m: maturity
[4]c :coupon

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As presented in **Table 1** showed descriptive statistics.The actuarial rate of return, maturity and coupon all have mean values that are greater than standard deviations. This indicated that the research data are either clustered or homogeneous. The actuarial rate of return has a minimum value of 0.057, a maximum value of maturity=4.99, an average value of coupon= 2.81. The actuarial rate of return has minimum a standard deviation of 0.012, and 3.057 of maturity. The 4.99 average indicates a high level of income for investors to hold bonds to maturity. The asymmetry between different variables in terms of skewness and kurtosis are well documented, implying they are normally distributed.

B. Correlation Matrix

TABLE 2
CORRELATION MATRIX OF DIFFERENT VARIABLES

	ARR	**m**	**c**	**1/m**	**Log(m)**
ARR	1				
M	0.82	1			
C	1	0.82	1		
1/m	-0.5	-0.77	-0.5	1	
Log(m)	0.71	0.94	0.71	-0.93	1

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

C. Analysis Graphic

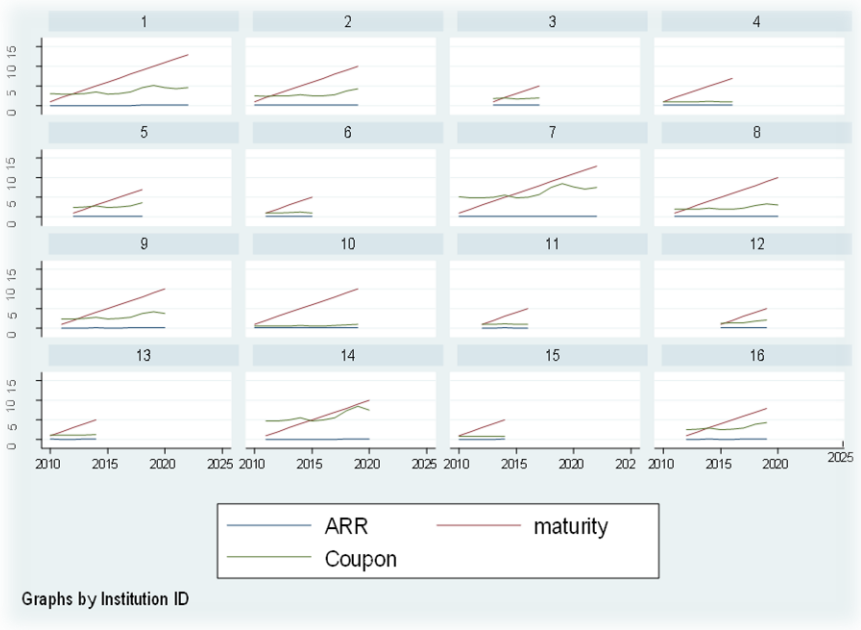

Figure. 1 Plots of actuarial rate of return (ARR), maturity and coupon

We show that the different relationships **ARR**, **maturity**, **coupon** of all institutions in Tunisia. It can say, this Figure N°1 the variable **ARR** represented in parallel with coupon and interest rate. But, we compare difference lower between **ARR-coupon**. Besides, the relationship between **ARR** and **maturity** are starting from the same position, but the curve of **maturity** increases remarkably.

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D. Empirical Validation

1) Results from unit root test

TABLE 3
UNIT ROOT TEST OF DIFFERENT VARIABLES

TypeTest	**Levin-Lin-Chu Test**			**Fisher-type Test**		
Variable	**ARR**	**c**		**m**	**Log(m)**	**1/m**
t-statistics	-1.39	-1.39	**P**	18.52	232.32	562.94
			Z	0.16	-5.76	-17.53
			L*	0.14	-14.7	-38.83
			Pm	-1.68	25.04	66.36
Critical value of 5%	0.08	0.0816		0.9	0.00	0.00

We first examine these different variables using two classical unit root tests: «Levin-Lin-Chu (2002) test» and Fisher-type unit-root test. I'm performing several tests on panel data. From **Table3**, we apply a unit root test with different test such as the augmented «Levin-Lin-Chu» test. In level, the t-statistics of these variables are greater than the critical values of "Levin-Lin-Chu"test. We can accept the hypothesis (H1) is said different variable **ARR**, **coupon** to be stationary and statistical significance. But, the variable «**maturity**» is tested by Fisher-type unit root test:

H_0: All panels contain unit roots
H_1: 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 **maturity** (18.52; 0.16; 0.14 and -1.68). But, we used logarithmic of variable **maturity** for change result by test Fisher unit root. This new result shows that variable becomes stationary "t-statistic=0.00".

2) Estimation Results Using Different Methods

The results obtained show the estimation of a relationship between the actuarial rate of return, maturity and coupon by adopting these two models:

- **Model 0: Y=f (m, c)**

- **Model 1:** $\mathbf{Y = a_0 + a_1 log(m) + a_2 \frac{1}{m} + a_3 \times c}$

We use a double step method to estimate from **table4** 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». The OLS «Ordinary Least Squares» is a specific method within linear regression used for estimating the coefficients of a linear regression model by minimizing the sum of squared errors. The FE (Fixed Effects) model, the unobserved effects are assumed to be correlated with the independent variables. The RE (Random Effects) model, the unobserved effects are assumed to be uncorrelated with the independent variables.

With **hypothesis :** **H1:** maturity and coupon have an effect on the actuarial rate of return on the bonds.
H2: maturity and coupon has not affected on the actuarial rate of return on the bonds.

- Based on two methods, (**OLS** and **FE-RE**), the F statistic test output of two models (**model0** and **model1**) revealed that the Prob value (F-statistic) is 0.000 less than 0.05. We were able to conclude that the first hypothesis was accepted. The maturity and coupon variables can have an impact on the return rate. These results concluded that the chosen model is adequate to predict the amount of income an investor would receive from holding bonds until maturity. Then, The R-square value is 0.29. This meant that the

independent variable used in this research can influence the dependent variable by 29%, while 71% is influenced by other factors not examined in this research model.

TABLE 4
ESTIMATION OF ACTUARIAL RATE OF RETURN, MATURITY, AND COUPON

		Model 0		Model 1		
		m	**c**	**Log(m)**	**1/m**	**C**
Methods 1: OLS	**Coeff**	0.0022	-0.00004	0.05	0.037	-0.0004
	Std.dev	0.00036	0.0005	0.01	0.01	0.0005
	P> t	0.000	0.942	0.000	0.001	0.939
	F	25.6		17.1		
	P>F	0.000		0.000		
	R^2	0.29		0.292		
Methods 2: Perform FE- And RE-model	**Coeff**	0.0009	0.01	0.02	0.013	0.01
	Std.dev	0.0002	0.0009	0.006	0.005	0.0009
	P> t	0.000		0.001	0.021	0.000
	F	238.85		159.97		
	P>F	0.000		0.000		
	Coeff	0.0016	0.006	0.034	0.025	0.007
	Std.dev	0.0002	0.0009	0.006	0.006	0.0009
	P> t	0.000		0.000		
	chi2	280.54		290.14		
	P>chi2	0.000		0.000		

- Based on the output of the t-test for the OLS models, we found that the probability value of the coupon is 0.942 and 0.939 greater than 0.05. From this, we could conclude that the second hypothesis is rejected. This meant that interest rates did not affect the ARR. But, we show the probability value for maturity is 0 < 0.05. From this, we can conclude that the maturity has to impact positively on the ARR. We used logarithmic of maturity affected (log(m)) positively and significantly influences the ARR with Probability value for 0<0.05.Besides, Inverse Maturity has an impact positively on the ARR with probability value for 0.001<0.05.
- Based on the output of the t-test for the Perform FE- and RE-models, we found that the probability value of the coupon, maturity is 0<0.05. This meant that coupon and maturity affect the ARR. We used logarithmic of maturity affected (log(m)) positively and significantly influences the ARR with Probability value for 0<0.05 . Besides, Inverse Maturity has an impact positively on the ARR with probability value is 0 significance above 0.05.

E) DISCUSSION

This research shows that maturity and coupon affect actuarial returns simultaneously. Information asymmetry can be avoided by providing sufficient information to the enterprise. Companies can voluntarily disclose bonds ratings as well as yield to maturity and coupon. The purpose of this information is to send a good signal between investors and company owners so that internal and external institutions of the company will not be affected by lack of information. Voluntary disclosure of yields bonds is intended to be a means of communicating the advantages of the company. The advantages of the company are the advantages of the company's financing, invested capital and other types of assets. Second, the interest rate variable has a partial impact on the actuarial return of the bonds.The results of this study are consistent with those of Suryaningprang & Suteja's (2019) [21] and Mega & Widayat's (2019) investigations, which found that interest rates positively impacted yield to maturity. Continued positive trends indicate higher interest rates and bond yields for investors. This allows investors to see when interest rates are rising. This suggests that now is the best time to look for bonds, but not the best time to earn capital gains. Investors are even able to see exactly when interest rates are falling. This suggests that this may be the best time to sell bonds or earn capital gains. In addition, interest rates can also serve as a benchmark for investors to determine their expected returns. This is great when investors are willing to speculate in riskier instruments (as long as their value is higher), but investors are more likely to speculate in safer instruments. From the results of this study, the interest rate variable has the greatest impact on bond yields. In the positive direction, that is, H. When interest rates are rising, it is a good time to buy bonds and an inappropriate time to earn capital gains. Therefore, investors should hold the bonds. Whereas if the interest

rate decrease, it is the right time to sell bonds or realize capital gain. Furthermore, the interest rate may be used as a benchmark for determining the expected yield from investors and the expected coupon rate from bonds. Therefore, when the interest rate has decrease, it is the right time to issue or sell bonds. The outcome supports the theory put forth by Van Horne and Wachowicz (1997) [11], according to which the market will anticipate an increase in the rate of return if interest rates rise. Furthermore, Tandelilin (2007) [2] made the same claim, i.e., that a high interest rate will increase return on investment in line with investor requirements. Also, this study showed consistent results or supports earlier studies by Kadir (2007) [21] who found that the interest rate has positive, a significant effect on the bond yield.

The higher the future interest rate, the lower the expected bonds yield which reduced the demand for these bonds. The decline in demand for bonds after interest rates rise and their costs decrease caused institutions to receive fewer funds, so the yields offered by companies are also lower. An increase or decrease in interest rates has no impact on yield to maturity due to stronger factors such as an assessment of the amount of risk that occurs. Since interest rates imply a positive outcome for bond yields in the primary market, a decrease in interest rates declared by the interest rate is often the driving force behind governments to lower yields in the primary market. Meanwhile, governments should prepare preliminary measures against rising rates. The results of our research did not seem to be in line with previous analysis and become one among the various findings as a result of the unsteady rate can have a sway on investment in securities together with stocks and bonds. However, they do not corroborate the findings of research by Thompson and Vaz (1990), as well as Nurfauziah and Setyarini (2004) [2], which concluded that the yield of bonds is not significantly impacted by the interest rate. The bonds ratings are one of the limitations of this research because there is still great importance to bonds ratings to reduce the risk and ensure yield for bonds, where the bonds rating is one indicator of bonds quality. The rating evaluated the potential future risk of certain bonds. Bonds with high-rated ratings meant that they were relatively safe and avoided the possibility of default. Bonds ratings also serve as a replication of bonds yields. The rating of bonds has a negative impact on yields in relation to their maturity. This analysis follows the idea that ratings and yields are inversely proportional, so that if the bonds rating is raised, the yield offered may decrease. Bonds with higher ratings can have a smaller risk of default, which reduces their impact on bonds yields. Investors may speculate on investing their capital in the company. The higher a bonds rating is, the lower the probability of default. A low default risk can make bonds more attractive to investors, which will increase the cost of bonds. Bonds costs that continue to rise can cause bonds yields to decline due to the magnitude of the lower risk. On the contrary, the bonds with a lower rating and their higher risk, necessitating a higher return in order to meet the achievable risk, necessitating a higher return in order to meet the achievable risk. This adjustment is reasonable in terms of risk and return concepts, as investors are inclined to invest in riskier instruments if the investments yield higher returns, as opposed to investing in risk-free instruments.

V. 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 bonds market. The models that are reported in the yield bonds literature as being good explanatory models were run with corporate. These Models Salomon Brothers are significant and have the expectation's 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 financial institutions over a period of 13 years, we show that: -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 yield bonds. These results indicate that useful yield bonds can be formed from ex post corporate bonds data. These yield bonds can be employed in an ex ante sense to obtain bonds prices, a host of empirical questions can be investigated.

According to the interest rate data used in this research, volatile rates can have a negative impact on investments in securities such as stocks and bonds. Rising inflation can discourage investors from saving a large portion of their funds because it is considered to be very risky. When inflation increased, costs increased because the investors faced uncertainty when running their businesses. Rising inflation caused investors to keep their funds in foreign investments because they were tended to be lucrative. This suggested that rising inflation was causing greater uncertainty for investors. Particularly for domestic investors, this has raised return expectations to drive the increased returns demanded by investors. Domestic investors tend to focus more on returns. Bonds ratings have a negative impact on corporate bonds returns. The findings revealed that bonds ratings were taken into account by investors when assessing the suitability of a bond for investment, assessing the degree of risk, and determining the anticipated YTM increase.

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