SARIVA Inc. new bond pricing

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SARIVA Inc. is a mining company. It concluded a new bond origination with Morgan Sachs to finance the exploration of a new site in the North of Scotland.

According to the bankers, the project could be very profitable but is quite risky, especially if within three years, after it made big investment in the new site, SARIVA Inc. discovers that the site is not exploitable.

In order to reinsure the investors, the bankers originated a particular bond with the following caracteristics: + the nominal of the bond is 140 MEUR ; + the maturity is 5 years (in 2022) ; + 40 % of the nominal will be reimbursed in 2020 ; + the coupon rate is 5 %.

The bankers now have to price these bonds. To do so, they have several information at their disposal : + the characteristics of several SARIVA Inc. bonds treated on the market; + the risk-free zero-coupon yield curve.

## Risk Free Zero-Coupon Yield Curve

The Risk Free Zero-Coupon Yield Curve (RF\_ZC\_YC) was upload from Reuberg, the financial data provider. It is based on the EURIBOR rates for less than one year maturity and the swap against EURIBOR for the others using XXX et XXX techniques, detailed in XXXX.

RF\_ZC\_YC<-read.csv2("RF\_ZC\_YC.csv", header=TRUE)  
pander(RF\_ZC\_YC)

|  |  |
| --- | --- |
| Year | Yield |
| 1 | 0.01 |
| 2 | 0.012 |
| 3 | 0.014 |
| 4 | 0.02 |

RF\_ZC\_YC\_Plot<-gvisLineChart(RF\_ZC\_YC)  
plot(RF\_ZC\_YC\_Plot)

## Firm debt

### List of the SARIVA Bonds

SARIVA Inc. originated several bonds during the last decades : here is the list of the different bonds with their coupon rate, nominal, maturity and market price today.

SARIVA\_Bonds<-read.csv2("SARIVA\_Bonds.csv", header = TRUE, sep="\t")  
pander(SARIVA\_Bonds)

|  |  |  |  |
| --- | --- | --- | --- |
| Bonds | Coupon.rate | Maturity | Price |
| Bond 1 | 0.05 | 1 | 101 |
| Bond 2 | 0.055 | 2 | 102 |
| Bond 3 | 0.05 | 3 | 99 |
| Bond 4 | 0.06 | 4 | 100 |

### Payment Schedule

We can easily computed the expected cash flows expected from these bonds

SARIVA\_PaymentSchedule<-matrix(0, nrow=dim(SARIVA\_Bonds)[1], ncol=max(SARIVA\_Bonds$Maturity))  
rownames(SARIVA\_PaymentSchedule)=rownames(SARIVA\_Bonds)  
colnames(SARIVA\_PaymentSchedule)=SARIVA\_Bonds$Maturity  
  
for (i in 1:dim(SARIVA\_Bonds)[1])  
{  
 SARIVA\_PaymentSchedule[i,SARIVA\_Bonds$Maturity[i]]<-100  
 SARIVA\_PaymentSchedule[i,1:SARIVA\_Bonds$Maturity[i]]<-SARIVA\_PaymentSchedule[i,1:SARIVA\_Bonds$Maturity[i]]+100\*SARIVA\_Bonds$Coupon.rate[i]  
}  
pander(SARIVA\_PaymentSchedule)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 2 | 3 | 4 |
| 105 | 0 | 0 | 0 |
| 5.5 | 106 | 0 | 0 |
| 5 | 5 | 105 | 0 |
| 6 | 6 | 6 | 106 |

The payment schedule of SARIVA Inc. is thus the following (without taking into account the new bond to be originated).

SARIVA\_PaymentSchedule\_Total<-apply(-SARIVA\_PaymentSchedule, 2, sum)  
SARIVA\_PaymentSchedule\_Total<-data.frame(cbind(1:4,SARIVA\_PaymentSchedule\_Total))  
SARIVA\_PaymentSchedule\_Plot<-gvisColumnChart(SARIVA\_PaymentSchedule\_Total)  
plot(SARIVA\_PaymentSchedule\_Plot)

## SARIVA Zero-Coupon Yield Curve

From this bond, we want to deduce the SARIVA Inc. Zero-Coupon Yield Curve using the *bootstrapping method* introduced in [Lecture 1\_2](http://defaultrisk.free.fr/PDF/Lesson1_2.pdf) and then deduce the SARIVA Inc. Zero-Coupon Yield Curve. ###SARIVA Zero-Coupon Bond Prices We recall from Lesson1\_2 that:

And thus:

We now apply this numerically:

SARIVA\_ZC\_BP<-solve(SARIVA\_PaymentSchedule)%\*%SARIVA\_Bonds$Price  
pander(SARIVA\_ZC\_BP)

|  |
| --- |
| 0.96 |
| 0.91 |
| 0.85 |
| 0.79 |

### SARIVA Inc. Zero-Coupon Yield Curve

We recall the formula that links Zero-Coupon Bond Price to the Zero-Coupon Yield Curve, introduced in [Lecture 1\_2](http://defaultrisk.free.fr/PDF/Lesson1_2.pdf):

and thus:

We apply this result numerically to compute SARIVA Inc. Zero-Coupon Yield Curve:

SARIVA\_ZC\_YC<-(-(1/SARIVA\_Bonds$Maturity)\*log(SARIVA\_ZC\_BP))  
pander(SARIVA\_ZC\_YC)

|  |
| --- |
| 0.039 |
| 0.046 |
| 0.053 |
| 0.059 |

### SARIVA Zero-Coupon Rates - Linear Interpolation

We use linear interpolation to deduce a curve from the points for the Risk-Free Zero-Coupon Yield Curve and the SAVIRA Inc. one.

Interp\_RF\_ZC\_YC<-approx(RF\_ZC\_YC$Year,RF\_ZC\_YC$Yield)  
Interp\_SARIVA\_ZC\_YC<-approx(rownames(RF\_ZC\_YC),SARIVA\_ZC\_YC)  
SARIVA\_Spreads<-data.frame(cbind(Interp\_RF\_ZC\_YC$x,Interp\_SARIVA\_ZC\_YC$y-Interp\_RF\_ZC\_YC$y))  
colnames(SARIVA\_Spreads)<-c("Maturity", "Spread")

The difference between the two is called the SAVIRA Inc. spread that we plot here:

SARIVA\_Spreads\_Plot<-gvisLineChart(SARIVA\_Spreads)  
plot(SARIVA\_Spreads\_Plot)

## SARIVA's Cumulative Probability of Default

Even if it is not a necessity for the purpose of the exercice, we compute hereafter the Cumulative Probability of Default (Cum. PD) of SAVIRA Inc. based on market prices of its bonds.

We recall the formula deduced from the no-arbitrage principle that states that:

And thus:

where is the *spread*.

SARIVA\_CumulativeProbabilityOfDefault<-data.frame(cbind(SARIVA\_Spreads[,1],1-exp(-SARIVA\_Spreads[,2]\*SARIVA\_Spreads[,1])))  
SARIVA\_CumulativeProbabilityOfDefault\_Plot<-gvisLineChart(SARIVA\_CumulativeProbabilityOfDefault)  
plot(SARIVA\_CumulativeProbabilityOfDefault\_Plot)

In the end, we see that the implied probability of default, on 5-year horizon, is XX % and the market that this cumulative probability is increasing quickly the three first years and then stay stable[^1]. [^1]: It might because of some other risky project that SARIVA Inc. is conducting on the short term. # SARIVA's new bond price We recall that SARIVA Inc. new debt has the folowing reimbursment structure.

SARIVA\_NewBond\_CashFlows<-data.frame(cbind(c(1,2,3,4),c(10, 70, 7, 147)))  
SARIVA\_NewBond\_CashFlows\_Plot<-gvisColumnChart(SARIVA\_NewBond\_CashFlows)  
plot(SARIVA\_NewBond\_CashFlows\_Plot)

To compute the price of the bond sum all the cash flows discounted with the SAVIRA Inc. Zero-Coupon Yield Curve that we estimated above.

SARIVA\_NewBond\_Price<-sum(SARIVA\_NewBond\_CashFlows[,2]\*exp(-SARIVA\_ZC\_YC\*(SARIVA\_NewBond\_CashFlows[,1])))

The price of the bond is thus 195.4147736.

## Set options back to original options  
options(op)