Norwegian Government Debt

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18 April 2023

Abstract

A quick overview of Norwegian Government Debt Trading and Data.

1 Instruments for Norwegian Government Borrowing

Norwegian State (Ministry of Finance)
issues two types of debt instruments

- Treasury Bills
- Government Bonds

Treasury bills

Treasury bills are government securities, with an original maturity of less than one year. Treasury bills do not pay any fixed or floating interest during the life of the bill. A Treasury bill is therefore a zero-coupon security. This means that the bill is issued at a discount, i.e. the offer price is lower than the face value and the return on the bill will be the difference between the offer price and the face value paid at maturity.

Treasury bills are normally issued in connection with IMM dates each year. The IMM dates are the third Wednesday in March, June, September and December. New 12-month Treasury bills are issued on each IMM date. Existing Treasury bills are usually expanded at auctions held between the IMM dates.

Definition from Norges Bank

Government bonds

A bond is an interest-bearing security with an original maturity of more than 1 year.

Government bonds have a fixed interest rate (called the coupon rate) which determines the amount of interest payable on a specific date once a year, over the life of the bond. At maturity, the bondholder is paid the face value of the bond in addition to the coupon rate. Information concerning government bonds usually includes both the coupon rate and the date of maturity. Each bond is registered in the Norwegian Central Securities Depository with a special International Securities Identification Number (ISIN). The bond's coupon rate reflects the market rate at the time that the bond was first issued. Therefore, there are different coupon rates on different bonds since market rates have varied over time.

Norwegian government bonds are normally issued with a maturity of between two and eleven years. Four to six benchmark loans which cover the benchmark yield curve have been established.

Definition from Norges Bank

2 Why does the Norwegian Government Issue Debt?

The Norwegian State is in the enviable position that it does not really *need* to borrow to finance a government budget deficit. Why does the government still issue bills and bonds?

Here is the official position:

> **Why government debt?**
> On the whole, the Norwegian government's net asset position is positive. This means that total assets exceed total debt. Government assets include deposits in Norges Bank, investments made by the Government Pension Fund Global, shares in domestic enterprises, lending and direct investment in state banks, state-owned enterprises and state limited companies. Government debt consists primarily of government bonds and Treasury bills.
> In most countries, the government must issue government securities in domestic or foreign currency in order to have funds to repay existing debt which falls due and to finance government activities. Since the Norwegian government's net asset position is positive, the government could repay all government debt without raising new loans.
> The Norwegian government nevertheless chooses to raise new loans by issuing Treasury bills or government bonds because:
>
> - The government must have a certain liquidity reserve in order to be able to cover daily payments. There are wide daily fluctuations in outgoing and incoming payments in government accounts, and it is difficult to calculate the size of these flows in advance. This is particularly the case for incoming tax payments. Adjustments in the government borrowing program can only partially smooth these fluctuations. The aim is therefore to ensure that the normal cash reserves do not fall below NOK 50 billion.
> - Government borrowing affects the banking system's total deposits in/borrowing from Norges Bank. The implementation of the government borrowing program may therefore be adjusted to some degree to Norges Bank's operations to manage liquidity in the banking system.
> - Another objective of government borrowing is to maintain and develop smoothly functioning and efficient financial markets in Norway. By issuing government bonds and Treasury bills, the government provides a risk-free yield curve for investments with a maturity of from about one month to about 10 years. Another important aspect of government securities is that they increase liquidity in the Norwegian capital market. Without the supply of government securities, the markets would be less efficient. Other loans and debt instruments are often priced in relation to government loans. Thus, government loans provide a good overview of the Norwegian securities market.
>
> The objective of the government's debt management is to ensure that the government has adequate liquidity at the lowest possible cost. The government's interest income and overall exposures due to changes in interest rate levels must also be taken into account when evaluating borrowing costs.
>
> *Statement from Norges Bank*

A primary reason for the maintenance of government issued securities is that they provide a *service* for the capital market, government securities provide *benchmarks*.

The most important benchmark is the *risk free interest rate(s)*

3 Trading of Government Debt

All treasury securities are listed at the Oslo Stock Exchange (OSE), and traded there. In figure 1 we show examples of the way the market works, an electronic trading platform, reporting the best bid and ask prices, and the last trade price. Note that all trading is in terms of bond prices.

Figure 1 Trading of Norwegian Government Securities at the Oslo Stock Exchange

The trading picture of Norwegian Treasury Securities on selected days. 2012: Quotes from the Oslo Stock Exchange. 2021: Quotes from Euronext

Panel A: 29 jun 2012

Statslån benchmark

Kursutvikling | Avkastning

Ticker	Kjøper	Selger	Siste	+/-	Tid	Omsatt (mill)	Siste reg	Basis	Eff. rente	Sluttdato	Kupong	Utestående (mill)
NST16	99,67	99,70	99,68	-	28 jun	0	28.06.2012	Siste	1,52	19.09.2012	-	81 218
NST17	99,28	99,35	99,29	-	28 jun	0	28.06.2012	Siste	1,54	19.12.2012	-	104 158
NST18	98,93	99,03	99,00	-	28 jun	0	28.06.2012	Siste	1,42	20.03.2013	-	17 000
NST19	98,56	98,67	98,62	-	28 jun	0	28.06.2012	Siste	1,45	19.06.2013	-	11 000
NST470	104,20	104,35	104,36	-	28 jun	0	28.06.2012	Siste	1,39	15.05.2013	6,50	66 544
NST471	110,10	110,26	110,37	-	28 jun	0	28.06.2012	Siste	1,29	15.05.2015	5,00	58 125
NST472	112,80	113,27	113,00	-	12:13	315	28.06.2012	Siste	1,47	19.05.2017	4,25	47 737
NST473	118,20	118,65	118,45	0,05	10:42	350	28.06.2012	Siste	1,65	22.05.2019	4,50	35 000
NST474	115,20	115,85	115,40	-0,50	10:42	25	28.06.2012	Siste	1,80	25.05.2021	3,75	33 000
NST475	99,40	100,03	99,65	-0,35	10:42	175	28.06.2012	Siste	2,00	24.05.2023	2,00	13 000

Panel B: 20 jan 2021

EURONEXT Live markets

NAVN	UTSTEDER	MARKED	SLUTTDATO	KUPONGRENTE	SISTE	%	DATO/TID
NST474	NO0010572878	XOSL	2021-05-25	3.75%	% 101,731	-0,22%	30 Nov 2020
NST475	NO0010646813	XOSL	2023-05-24	2.0%	% 104,249	-0,04%	02 Dec 2020
NST476	NO0010705536	XOSL	2024-03-14	3.0%	% 108,76	0,03%	20 Nov 2020
NST477	NO0010732555	XOSL	2025-03-13	1.75%	% 105,37	-0,11%	04 Dec 2020
NST478	NO0010757925	XOSL	2026-02-19	1.5%	% 104,715	-0,41%	02 Dec 2020
NST479	NO0010786288	XOSL	2027-02-17	1.75%	% 106,665	0,07%	03 Dec 2020
NST480	NO0010821598	XOSL	2028-04-26	2.0%	% 109,285	-1,15%	30 Nov 2020
NST481	NO0010844079	XOSL	2029-09-06	1.75%	% 108,185	-0,04%	30 Nov 2020
NST482	NO0010875230	XOSL	2030-08-19	1.375%	% 105,025	0,25%	25 Nov 2020

4 From Prices to Interest Rates

A bond is traded in terms of its price, but one will typically discuss interest rates instead of bond prices.

We therefore translate the bond prices into the equivalent interest rates.

Exercise 1.

It is today 29 jun 2012, and you observe the following prices and interest rates for Norwegian State T-bills, traded at the Oslo Stock Exchange.

Ticker	Price (last)	Final Date	Coupon
NST16	99.68	19 sep 2012	-
NST17	99.29	19 dec 2012	-
NST18	99.00	20 mar 2013	-
NST18	98.62	19 jun 2013	-

On 29 jun 2012 the price of a Treasury bill maturing on 19 jun 2013 is 98.62. What is the implicit annualised interest rate in this price?

Solution to Exercise 1.

If we approximate the time period for this security to one year, the annual interest rate r implicit in the current bond price B_0 is (remember the Treasury bill pays of 100 at maturity.)

$$B_0 = 98.62 = \frac{100}{1+r}$$

$$r = \frac{100}{98.62} - 1 = 1.4\%$$

However, the correct way of finding the implicit annual interest rate takes into account that this price corresponds to interest not over a full year, but over a period starting 29 jun 2012 and ending 19 jun 2013, which is not a full year, but 355 days.

The easiest way of finding the annualized interest rate is to first find the implicit continously compounded interest rate of a period of $\frac{355}{365} = 0.9726$ years, and then transform this to an annualized interest rate:

$$B_0 = 98.62 = e^{-\frac{355}{365}r}100$$

Solving for r:

$$\frac{98.62}{100} = e^{-\frac{355}{365}r}$$

$$\ln(98.62) - \ln(100) = -\frac{355}{365}r$$

$$-0.01389610519\,(-\cdot 365355) = r = 0.01428 \approx 1.43\%$$

Translating this to annualized interest r_n:

$$(1 + r_n) = e^r$$

$$r_n = e^r - 1 = 0.01439009958 \approx 1.44\%$$

The annualized interest rate implicit in the T-bill price is 1.44%

This implicit interest rate is typically called the *yield*.

Note that we can calculate corresponding yields for the various bond maturities.

The collection of yields calculated at the variuos maturities is called the *term structure of interest rates*.

Figure 2 is some current examples of data from the Norwegian Central Bank web page, which has taken care of the transformation into interest rates

Figure 2 Current treasury rate observations

Bills

	3-mth	6-mth	9-mth	12-mth
05.09.2017	0.36	0.36	0.36	0.41
04.09.2017	0.37	0.36	0.36	0.41
01.09.2017	0.36	0.36	0.36	0.41
31.08.2017	0.36	0.36	0.36	0.41
...				

Bonds

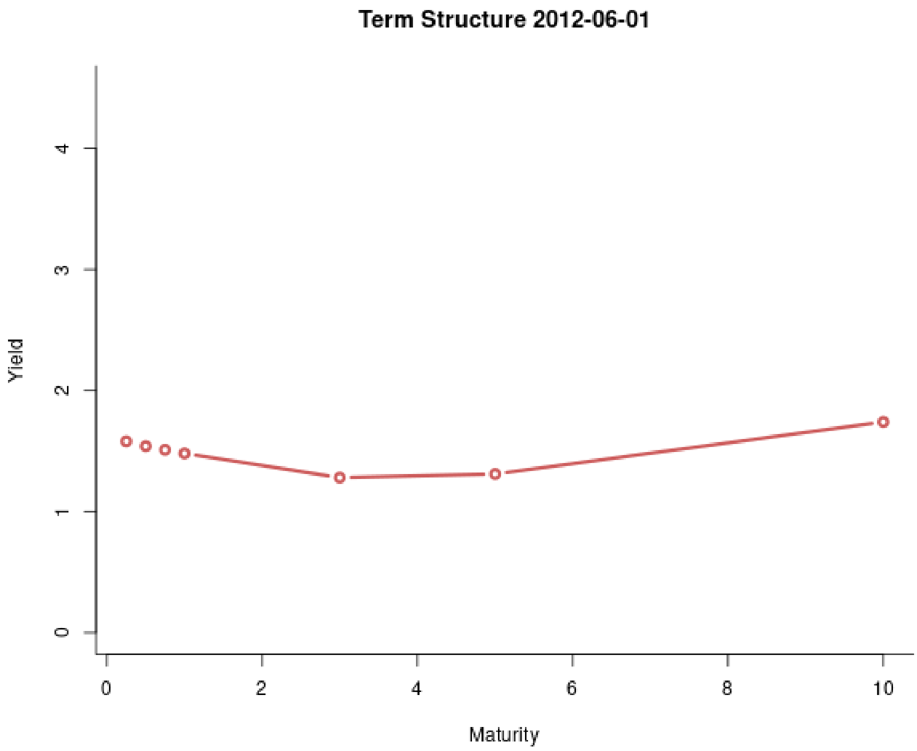
	3-year	5-year	10-year
05.09.2017	0.76	1.02	1.56
04.09.2017	0.76	1.03	1.58
01.09.2017	0.76	1.04	1.60

Source: Oslo Stock Exchange 4 pm. Calculations by Norges Bank.

5 Term Structure

The relationship between interest rates and maturity is often showed graphically by plotting the yield versus the maturity. Let us first show a recent example, in figure 3.

Figure 3 Term Structure 2012 jun 1

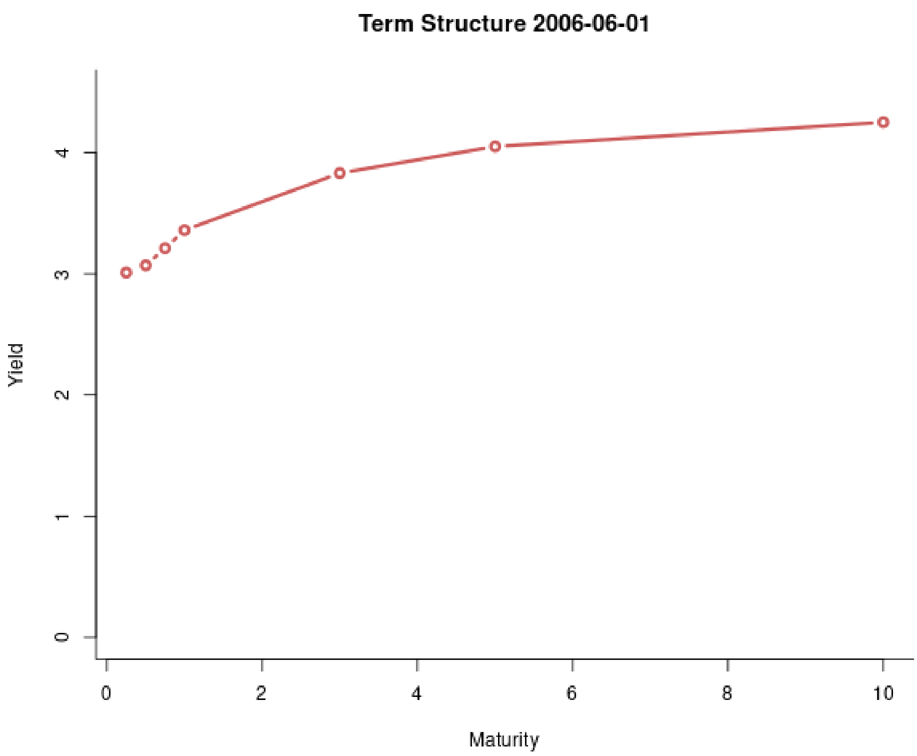


The relationship between interest rate (yield), and maturity of the underlying bond. Using Norwegian Treasury bond prices traded on 28 jun 2012, and resulting benchmark yields (calulated by Norges Bank).

Note the low level of the interest rate, and the U shaped relationship between maturity and yield. This low level is actually untypical.

In figure 4 we show an example from january of 2006, where the term structure is increasing: The long term debt has a lower yield.

Figure 4 Term Structure 2006 jan 2



The relationship between interest rate (yield), and maturity of the underlying bond. Using Norwegian Treasury bond prices traded on 2 jan 2006, and resulting benchmark yields (calulated by Norges Bank).

6 Time series evolution of Norwegian Interest Rates

6.1 The near past (since 2000)

We look at the evolution of government interest rates.

As we have seen the interest rate is different for different maturities (term structure).

We first show interest rates for three different maturities: 3m, 1y and 5y:

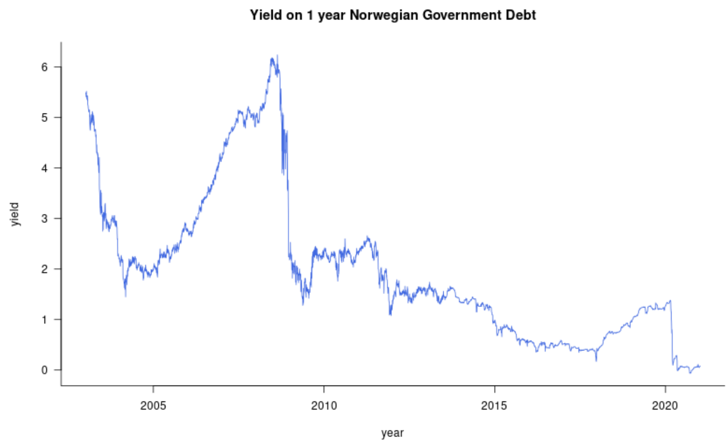
6.2 The distant past (20th century)

For the longer history we don't have a long series of short term interest rates. We therefore show the time series of 3 year interest rates in figure 7.

Figure 5 Time series of Norwegian interest rates

3m

Panel B: 1 year



Panel C: 5 year maturity

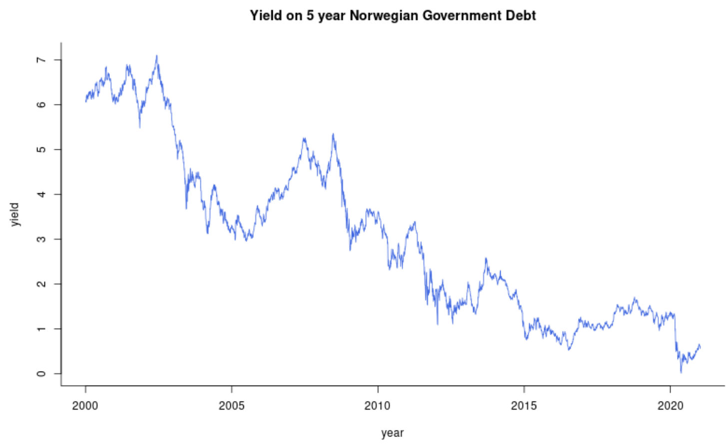


Figure 6 Time series selected maturities

Figure 7 Yield on 3 year Government Debt

Source Eitrheim, Klovland, and Qvigstad (2006) and Norges Bank

7 Both Time and Term Structure

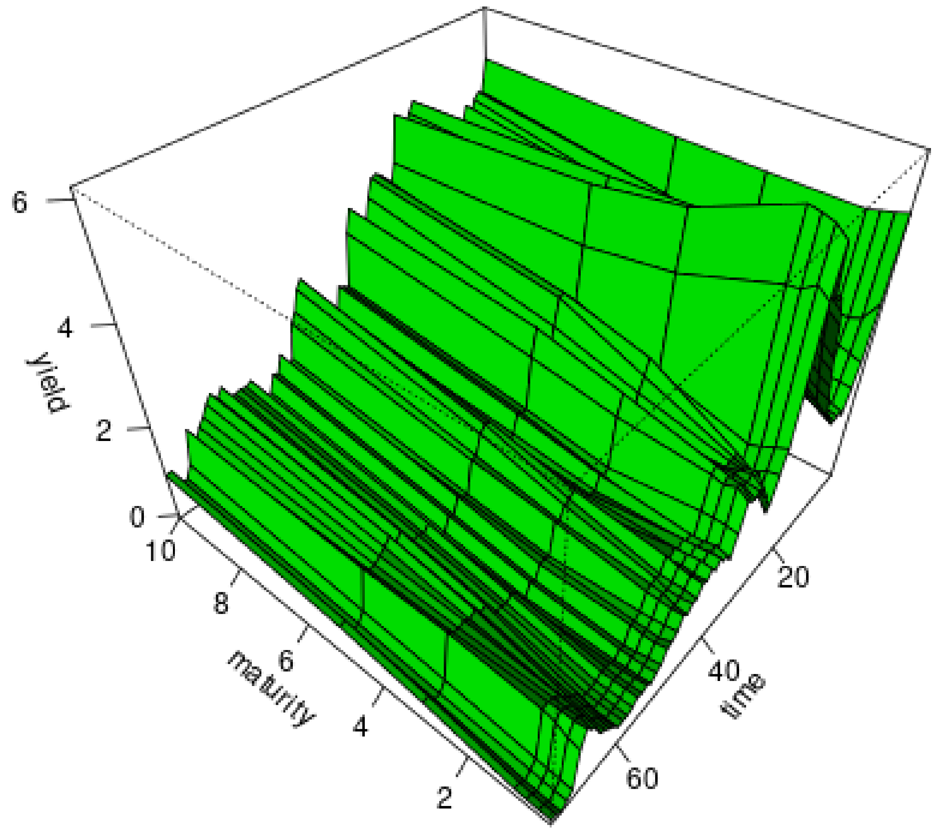
Now, as we have seen, there are several things varying which we can calculate from observed government bonds:

- Level of interest rates are changing
- Shape of term structure shifts.

It is hard to vizualize both of these at the same time, but we can make a try.

Consider the following plot, which plots quarterly term structures starting in 2003.

Figure 8 Time series evolution of term structures 2003-2012



The perspective has ben set so that the current term structure is closest to the viewer, and the older ones moves backward (and to the right) in the figure.

A couple of points it is possible to observed in this picture.

- The typical term structure is upward sloping, with the short term interest rate the lowest.
- There are exceptions, in particular the case (in 2006) with a very high short term interest rate.

  This episode is when the central bank pushed the interest rate up (higher than the rates for the rest of the world.) The interest rates came back down very soon. It also looks like the market was suspecting this, since the long term rates were low.

8 Plotting Term Structures using R

Will now go through how one can use R to generate the various pictures.

8.1 Reading data

Data: Two files with their structures
  Recent data
  renter_dag.csv

```
DATES,FOLIO.NOM,RESERVE.NOM,DLAAN.NOM,NIBORFIX.TN.NOM,......
2.Jan.86,ND,ND,8.10,12.60,12.68,NA,12.62,NA,12.81,12.94, ....
3.Jan.86,ND,ND,9.90,13.60,12.60,NA,12.53,NA,12.84,12.93, ...
6.Jan.86,ND,ND,10.70,13.40,12.72,NA,12.74,NA,12.88,13.02, ...
7.Jan.86,ND,ND,10.80,13.90,13.05,NA,13.17,NA,13.12,13.27, ...
...
```

  Historical data from 1921 onwards

```
Norwegian bond yields by maturity
Year:month;ST2;ST3;ST4;ST5;ST6;ST7 ...
1921:01; ;;6.09;6.09;6.21;6.27;6.30 ...
1921:02; ;;6.79;6.79;6.76;6.72;6.68 ...
1921:03; ;;6.95;6.95;7.02;7.01;6.98 ...
.....
```

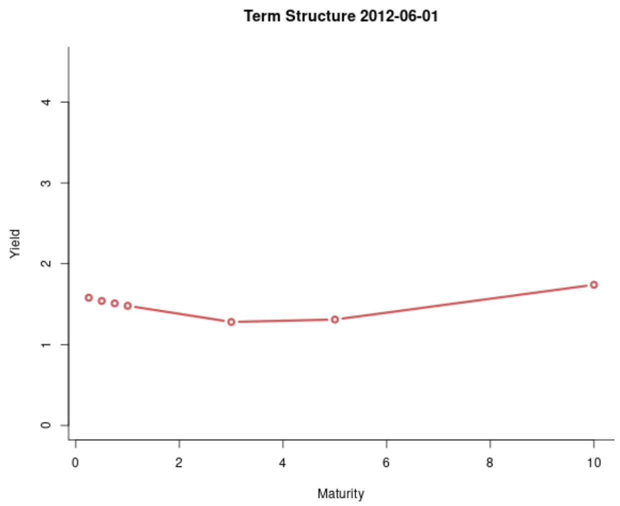
  Reading these two files

```
                                        # read file renter_dag.csv pulled from Norges Bank 
Sys.setlocale(category="LC_ALL","C")
library(zoo)
library(xts)
int <- read.zoo("../data/renter_dag.csv",
                header=TRUE,format="%d-%b-%y",sep=",",
                na.strings=c("ND","NA"))
head(int)
folio <- int$FOLIO.NOM
head(folio)
names(folio)[1] <- "folio"
head(folio)
folio <- na.omit(folio)
head(folio)
folio <- as.xts(folio)
head(folio)

dlaan <- int$DLAAN.NOM
names(dlaan)[1] <- "dlaan"
s3m <-  int$STATSVKL.3M.EFF
names(s3m)[1] <- "s3m"
s6m <-  int$STATSVKL.6M.EFF
names(s6m)[1] <- "s6m"
```

```
s6m <- na.omit(s6m)
s9m <-  int$STATSVKL.9M.EFF
names(s9m)[1] <- "s9m"
s9m <- na.omit(s9m)
s12m <- int$STATSVKL.12M.EFF
names(s12m)[1] <- "s12m"
s12m <- na.omit(s12m)
s3y <-  int$STATSOBL.3Y.EFF
names(s3y)[1] <- "s3y"
s3y <- na.omit(s3y)
s5y <-  int$STATSOBL.5Y.EFF
names(s5y)[1] <- "s5y"
s5y <- na.omit(s5y)
s10y <- int$STATSOBL.10Y.EFF
names(s10y)[1] <- "s10y"
s10y <- na.omit(s10y)

f <- function (x) as.yearmon(format(x,nsmall=2),"%Y:%m")
HistInt <- read.zoo("../data/norway_historical_bond_yields.csv",
                    header=TRUE,sep=";",FUN=f,skip=1)
```

8.2 Term structures on daily basis

Look at the following picture.



It has been generated using the following code

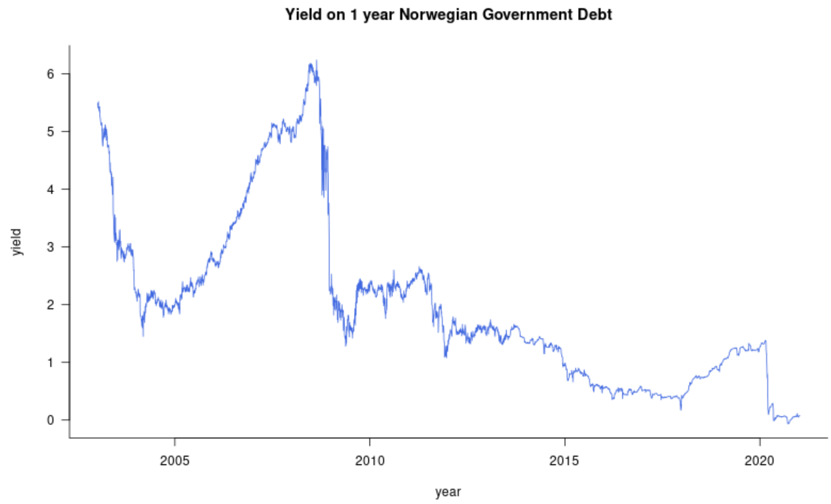
```
source("~/data/2020/nb_data/read_renter.R")
outdir <- "../../results/2020_01_plot_term_structure/"
mat <- c(3/12,6/12,9/12,1,3,5,10)
data <- as.xts(merge.zoo(s3m,s6m,s9m,s12m,s3y,s5y,s10y))
tail(data)

vec06 <- matrix(data["2006-06-01"])
```

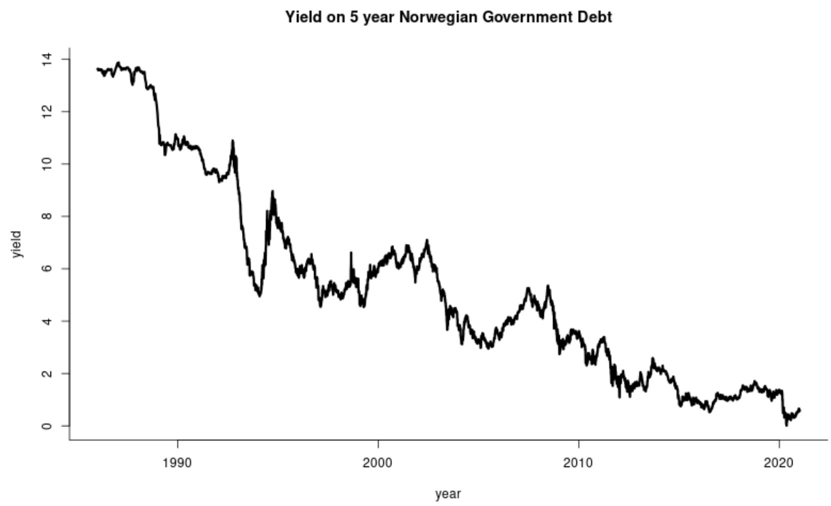
```
print(vec06)
vec12 <- matrix(data["2012-06-01"])
print(vec12)
vec19 <- matrix(data["2019-06-03"])
print(vec19)
vec20 <- matrix(data["2020-01-13"])
print(vec20)

outfile <- paste0(outdir,"term_structure_2006_06_01.png")
png(outfile, width=600, height=500)
plot(mat,vec06,ylab="Yield",
     ylim=c(0,4.5),
     main="Term Structure 2006-06-01",
     xlab="Maturity",
     bty="n",
     lwd=3,
     col="indianred",
     type="b")
box(bty="L")
dev.off()

outfile <- paste0(outdir,"term_structure_2012_06_01.png")
png(outfile, width=600, height=500)
plot(mat,vec12,ylab="Yield",
     ylim=c(0,4.5),
     main="Term Structure 2012-06-01",
     xlab="Maturity",
     bty="n",
     lwd=3,
     col="indianred",
     type="b")
box(bty="L")
dev.off()

outfile <- paste0(outdir,"term_structure_2019_06_03.png")
png(outfile, width=600, height=500)
plot(mat,vec19,ylab="Yield",
     ylim=c(0,4.5),
     main="Term Structure 2019-06-03",
     xlab="Maturity",
     bty="n",
     lwd=3,
     col="indianred",
     type="b")
box(bty="L")
dev.off()

outfile <- paste0(outdir,"term_structure_2020_01_13.png")
png(outfile, width=600, height=500)
```

```
plot(mat,vec20,ylab="Yield",
     ylim=c(0,4.5),
     main="Term Structure 2020-01-13",
     xlab="Maturity",
     bty="n",
     lwd=3,
     col="indianred",
     type="b")
box(bty="L")
dev.off()

outfile <- paste0(outdir,"term_structures_06_12_20.png")
png(outfile, width=600, height=500)
plot(mat,vec06,ylab="Yield",
     ylim=c(0,4.5),
     main="Term Structures, Norway",
     xlab="Maturity",
     type="b",
     lwd=3,
     col="blue",
     bty="n",
     lty=1)
lines(mat,vec12,ylab="",
     ylim=c(0,4.5),
     main="",
     xlab="",
     type="b",
     col="green",
     lwd=3,
     lty=2)
lines(mat,vec20,ylab="",
     ylim=c(0,4.5),
     main="",
     xlab="",
     type="b",
     col="indianred",
     lwd=3,
     lty=3)
legend("bottomright",
       legend=c("2006-06-01","2012-06-01","2020-01-13"),
       lty=c(1,2,3),
       lwd=c(2,2,2),
       col=c("blue","green","indianred"))
box(bty="L")
dev.off()
```

8.3 Time series

The series for the near and distant pasts, as time series





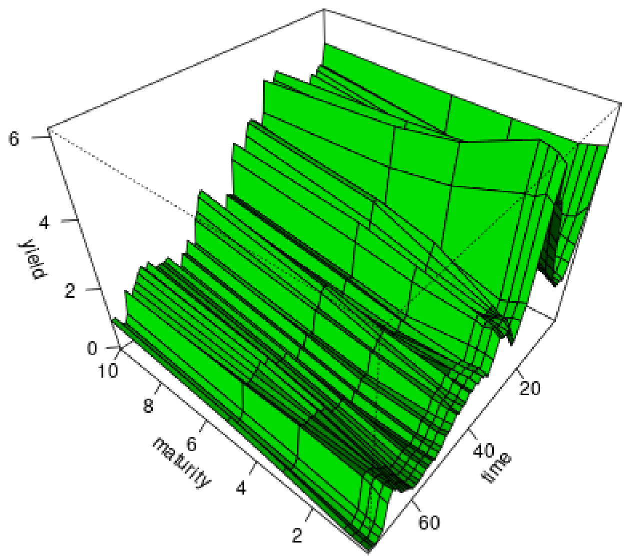
Has been generated using the following code

```
                                        # time series plots of Interest Rates of Norwegian (
library(zoo)
library(xts)
source("../2023_01_read_treasuries/read_renter.R")
outdir <- "../../results/2023_01_plot_time_series/"
filename <- paste0(outdir,"folio.png")
png(filename,width=800,height=500)
folio <- xts(as.numeric(folio),order.by=index(folio))
plot.zoo(folio,
         main="Folio",
         ylab="yield",
         col="royalblue",
         bty="n",
         lwd=3,
         type="l")
box(bty="L")
```

```
dev.off()

s3m <- xts(as.numeric(s3m),order.by=index(s3m))
filename <- paste0(outdir,"s3m.png")
png(filename,width=800,height=500)
plot.zoo(window(s3m,
                start=as.Date("2000-01-01")),
         main="Yield on 3 month Norwegian Government Debt",
         ylab="yield",
         xlab="year",
         col="royalblue",
         bty="n",
         bty="n",
         lwd=3,
         type="l")
box(bty="L")
dev.off()

s12m <- xts(as.numeric(s12m),order.by=index(s12m))
filename <- paste0(outdir,"s12m.png")
png(filename,width=800,height=500)
plot.zoo(window(s12m,start=as.Date("2000-01-01")),
         main="Yield on 1 year Norwegian Government Debt",
         ylab="yield",
         xlab="year",
         col="royalblue",
         ltw=3,
         las=1,
         bty="n",
         type="l")
box(bty="L")
dev.off()

s5y <- xts(as.numeric(s5y),order.by=index(s5y))
filename <- paste0(outdir,"s5y.png")
png(filename,width=800,height=500)
plot.zoo(window(s5y,start=as.Date("2000-01-01")),
         main="Yield on 5 year Norwegian Government Debt",
         ylab="yield",xlab="year",
         col="royalblue",
         ltw=3,
         bty="n",
         type="l")
box(bty="L")
dev.off()


s3y <- xts(as.numeric(s3y),order.by=index(s3y))
filename <- paste0(outdir,"s3y.png")
```

```
png(filename,width=800,height=500)
plot.zoo(s3y,
         main="Yield on 3 year Norwegian Government Debt",
         ylab="yield",
         bty="n",
         lwd=3,
         xlab="year",
         type="l")
box(bty="L")
dev.off()

filename <- paste0(outdir,"Hist5year.png")
png(filename,width=800,height=500)
plot.zoo(s5y,
     main="Yield on 5 year Norwegian Government Debt",
     ylab="yield",
     xlab="year",
     bty="n",
     col="royalblue",
     lwd=3,
     type="l")
box(bty="L")
dev.off()
```

8.4 3 d plots



Generated by the following code:

```
# produce a three dimensional plot of norwegian term structures
source("../2023_01_read_treasuries/read_renter.R")
outdir <- "../../results/2023_01_plot_term_stru_3d/"

mat <- c(3/12,6/12,9/12,1,3,5,10)
data <- merge.zoo(s3m,s6m,s9m,s12m,s3y,s5y,s10y)
data <- na.locf(data)[endpoints(na.locf(data),"quarters")]
data <- as.xts(data)["2003/"]
term <- as.matrix(data)
times <- 1:dim(term)[1]

filename <- paste0(outdir,"term_structure_2003_2012_3d.png")
png(filename,width=500,heigh=500)
persp(mat,times,t(term),ylab="time",xlab="maturity",zlab="yield",
      theta=-140,phi=40,expand=0.8,shade=0.9,
      col="green",ticktype="detailed")
dev.off()
```

References

Øyvind Eitrheim, Jan T Klovland, and Jan F Qvigstad, editors. *Historical Monetary Statistics for Norway 1819–2003*. Number 35 in Norges Bank Occasional Papers. Norges Bank, 2006.