Assignement FI 18 Dicembre 2022

Matteo Teruggi Marco Sella Fabio Vaccari Alberto Noe

December 2022

1 Main Comments

We considered the interest rate term structure [0.25 0.5 1 2 3 5 7 10 20 30] from 1st September 1981 to 7th September 2022. In the excel spreadsheet it is possible to select an unconstrained time horizon. The covariance matrix C is estimated, subsequently eigenvalues and eigenvector matrix are extracted. Graphical outputs are loading sensitivities, sorted standardized eigenvalues, term structure of volatility (diagonal elements of C).

While in Matlab, for each date t, unless the last 250 observations, we considered the sub-sample starting on the date t and ending in the date t+250. Outputs are loading sensitivities, term structure of volatility, correlation matrix and shift size in time series. Additionally, a multivariate normality check had been performed, exploiting the link between squared Mahalanobis distance and Chi-Square distribution. After this we propose to have a look at the volatility *surface*, Cumulative explained variance of the three principal components and an elasticity summarizing a term structure of volatility downward (normal) or upward (pathological) sloping.

Before performing PCA, we observe that decorrelation effect arises over time: in the video we see the first rows switching from positive correlation to zero. The most convectional interpretation of Change in slope, Change in level and Change in curvature is generally holding, thought in times of financial frictions and/or economic downturns might be extremely hard to detect any pattern in PCA Components, e.g. second half 1992 and 2008. The interpretation of the first component as a shift in level is substantially tackled, concerning the second component we observe a changing steepness in time-series excursion and, sometimes, an unexpected loss of monotonicity. The third component, which is by far the less relevant, captures the curvature effect in many, but not all, observations: in fact it is not uncommon to observe multiple change in directions.

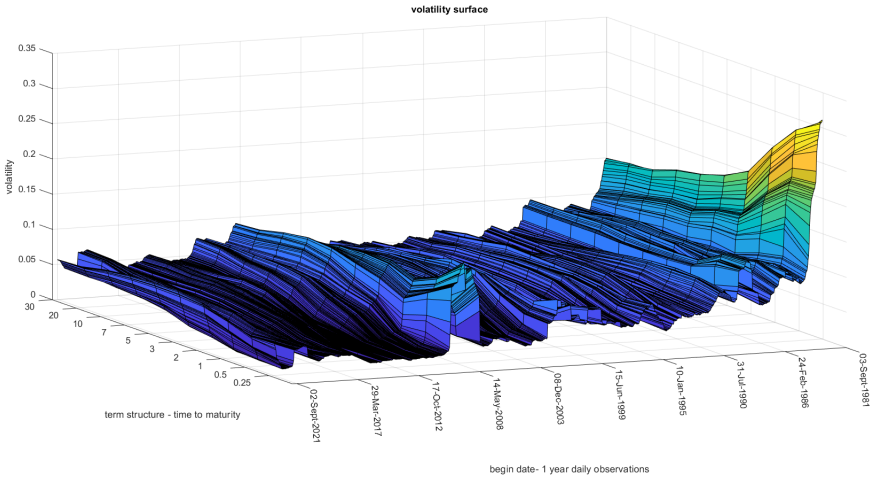
Concerning the shift size, it captures the width of confidence bound on interest rate shifts (and so risk). Unsurprisingly, the shift size for the first component presents in general the most relevant magnitude, while the third component shows a negligible size. During financial instability, shift size reaches 40 bps, while during QE it was, in general, ¿10 for all the maturities.

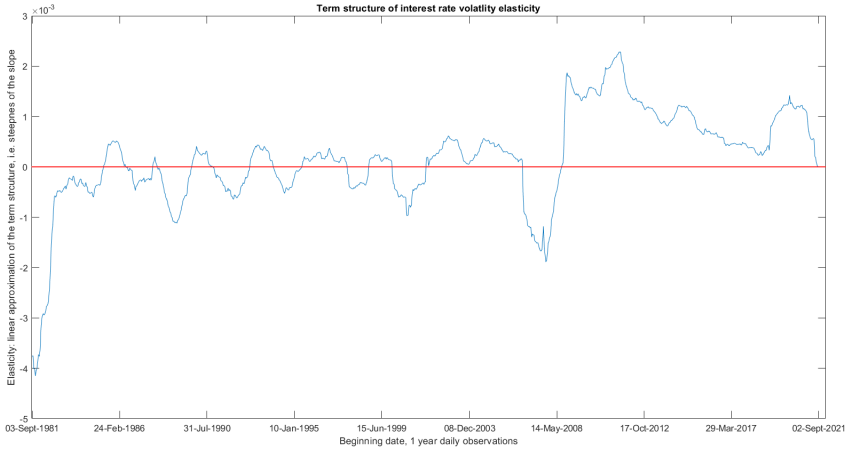
Looking at term structure of volatility, in the first years of the sample we have the orthodox downward sloping pattern, that starts to disappear and late

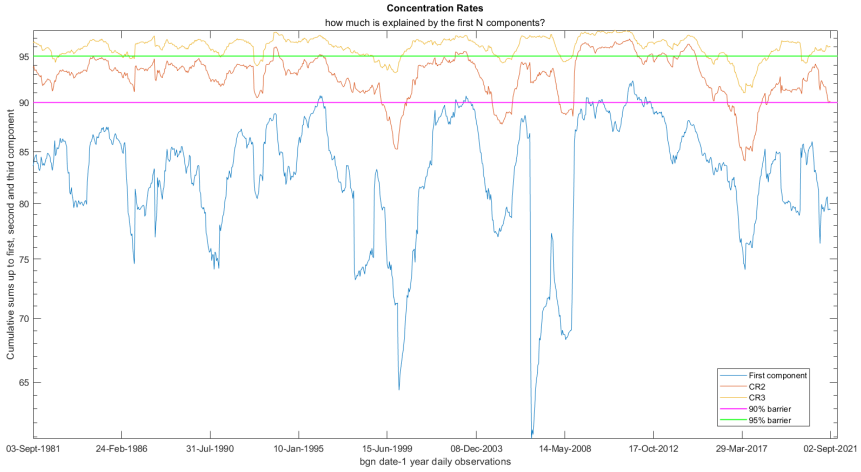
80s with a strange parabolic pattern. During QE, vice versa, the pathological upward slope is observed. We consider in conclusion steepens of term structure of volatility in time series: before 2008 crisis, periods of upward and downward term structure were regularly alternating, while from QE the highest steepness has been reached and curves no longer returned to orthodox structure.

In conclusion, relying on the first 3 PC seems a suitable choice: while the share explained by the first component can decrease up to 60% in presence of financial frictions, the three PC always explain at minimum 93% of total variance. Furthermore, the first two rarely hit the 90% barrier.

Click here for the videos.


volatility surface
volatility
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
30
20
10
7
5
3
2
1
0.5
0.25
term structure - time to maturity
02-Sept-2021
29-Mar-2017
17-Oct-2012
14-May-2008
08-Dec-2003
15-Jun-1999
10-Jan-1995
31-Jul-1990
24-Feb-1986
03-Sept-1981
begin date- 1 year daily observations


Term structure of interest rate volatlity elasticity
×10^-3
3
2
1
0
-1
-2
-3
-4
-5
Elasticity: linear approximation of the term strcuture, i.e. steepnes of the slope
03-Sept-1981
24-Feb-1986
31-Jul-1990
10-Jan-1995
15-Jun-1999
08-Dec-2003
14-May-2008
17-Oct-2012
29-Mar-2017
02-Sept-2021
Beginning date, 1 year daily observations


Concentration Rates
how much is explained by the first N components?
Cumulative sums up to first, second and third component
95
90
85
80
75
70
65
03-Sept-1981
24-Feb-1986
31-Jul-1990
10-Jan-1995
15-Jun-1999
08-Dec-2003
14-May-2008
17-Oct-2012
29-Mar-2017
02-Sept-2021
bgn date-1 year daily observations
First component
CR2
CR3
90% barrier
95% barrier