A new standard of European Bond Commission: risk-free spot yield curve and credit spreads

Sergey Smirnov

PRMIA Russia Regional Director

International Conference
"Global Risk Management Practices and Emerging Market's Particular Issues"
Moscow, June 2006

The present methodology

- was discussed at the EFFAS-EBC Methods & Measures Committee during meetings in Amsterdam (June 2004), Zürich (October 2004), Paris (October 2005), Budapest (June 2006) and adopted at the plenary session of EFFAS-EBC meeting in Budapest (June 2006)
- was prepared by:
  - Sergey Smirnov, EBC member;
  - Alexey Zakharov;
  - Roman Rachkov;
  - Victor Lapshin;
  - Vladimir Zdorovenin;
  - Stepan Evstratov

Aims of the Standard

- Development of standardized rules for constructing and calculation of the risk-free zero-coupon spot yield curve and credit spreads based on the bond market data (prices, quotes, bid-ask spreads, outstanding volumes etc.) available for government notes (medium and long-term) nominated in Euro
- Risk-free zero-coupon yield curve gives market practitioners a common reference point for accurate estimation of present value of money, especially for financial engineering and risk management applications.

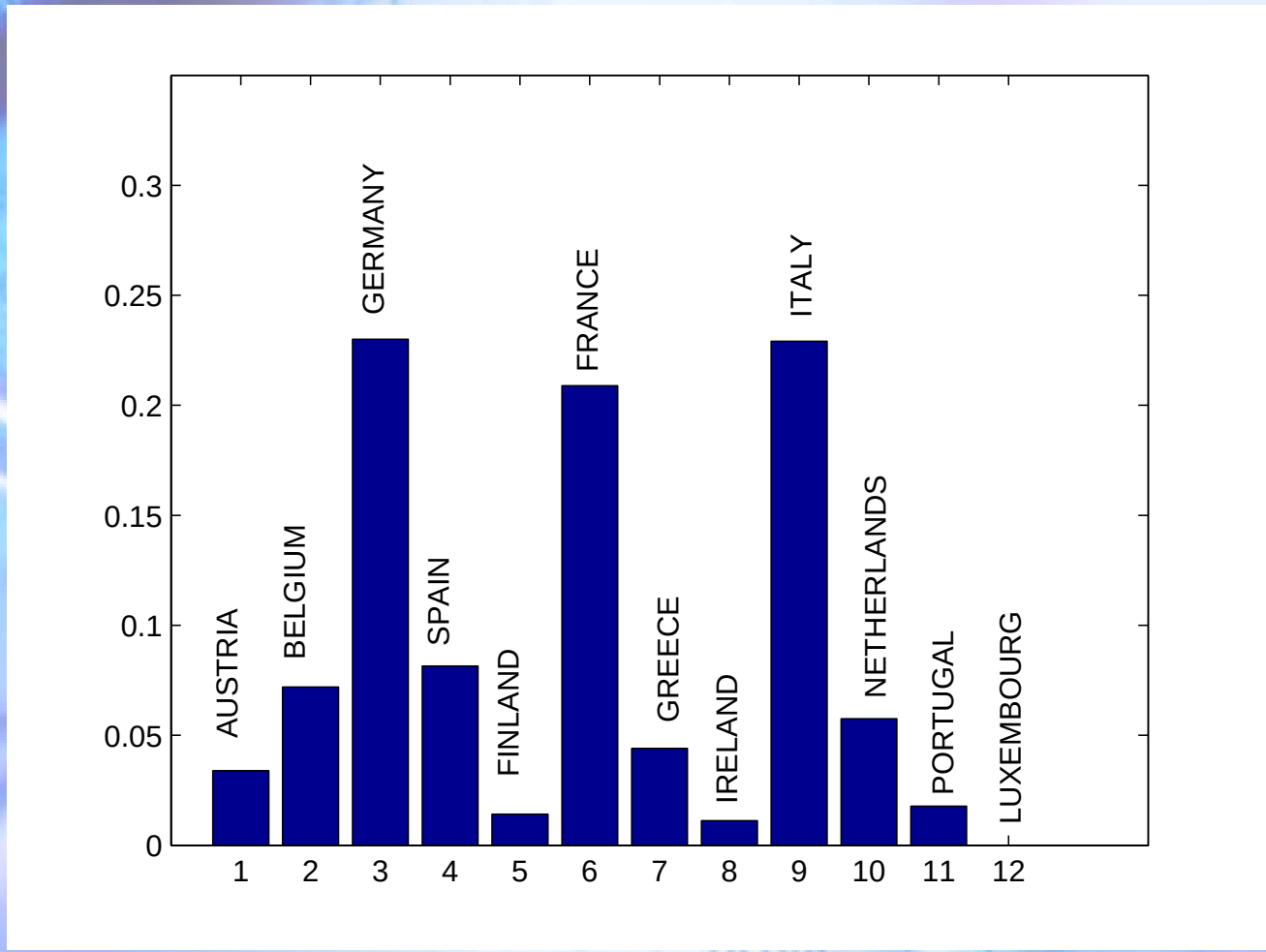
Main difficulty

- The risk-free spot yield curve in dollar is definitely easier, since all US federal government notes and bonds have the same credit rating (although the liquidity may vary).
- The main difficulty of our case is that the notes we need to analyze are of different credit quality.
- Currently there is no generally accepted standard for determination of the risk-free zero yield curve in the Eurozone

Issuers of Euro-nominated government bonds

- The Euro-nominated debt securities are issued by 12 countries: Austria, Belgium, Finland, France, Germany, Greece, Italy, Ireland, Luxembourg, the Netherlands, Portugal and Spain.
- The number of outstanding issues varies from one (Luxembourg) and three (Ireland) to around fifty (Germany, Italy). The major issuers are Italy, France and Germany. The credit quality of the obligors varies substantially too, as well as liquidity .

Market share (as of June 2005)



Convention: continuous compounding

- The standard use continuous compounding as the conventional relation between the discount function and the spot yield: $d(t) = exp(-t\, r(t))$, where $d(t)$ is the discount factor and $r(t)$ is spot rate at maturity t.
  - the usual convention for derivatives pricing based on continuous time models,
  - more consistent relation between discount factors and spot rates, because in this case the bond duration, up to sign, represents the relative price sensitivity to the parallel shifts of spot yield curve, and this formula for the sensitivity is *invariant with respect to the shape of the spot yield curve*.

Best practice procedure for calculation of credit spreads

- The procedure for calculation of credit spreads on a “credit model independent basis” relies on a known risk-free zero yield curve:

  In order to find the credit spread of a bond issuer, choose a parallel shift of the risk-free zero yield curve that fits best the bond price data for this particular issuer

- The evident benchmark for the dollar-denominated debt market is the U.S. Treasuries market so that there are no problems with determination of the relevant yield curve.

Limitations of the procedure

- Although this approach can only be applied to non-callable bonds, and it also ignores the liquidity premium effect and the term structure of credit spreads, it provides a reasonably good approximation of the actual credit spreads, especially in consideration of the improvement related with the term structure of credit spreads adjustment suggested below.

Relative Risk-Free Spot Yield Curve

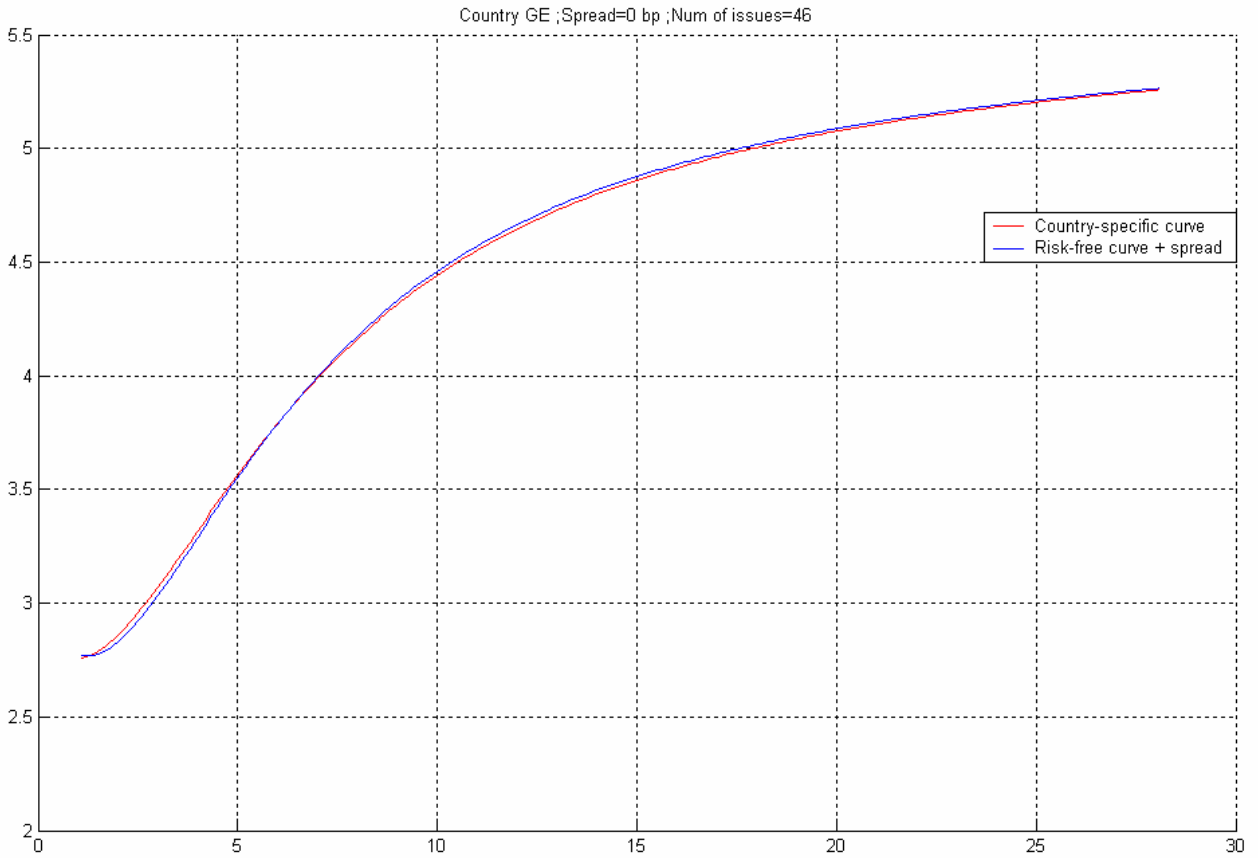
The main idea is to use the best practice procedure of credit spreads calculation mentioned above in order to construct the risk-free zero yield curve for the Eurozone by solving the inverse problem.

- That means that we should choose a risk-free zero yield curve so that the credit spreads relative to this curve would be estimated with most precision.
- The problem have a non-unique solution, and the corresponding curve is defined up to an additive constant (shift), that we call relative risk-free spot yield curve.

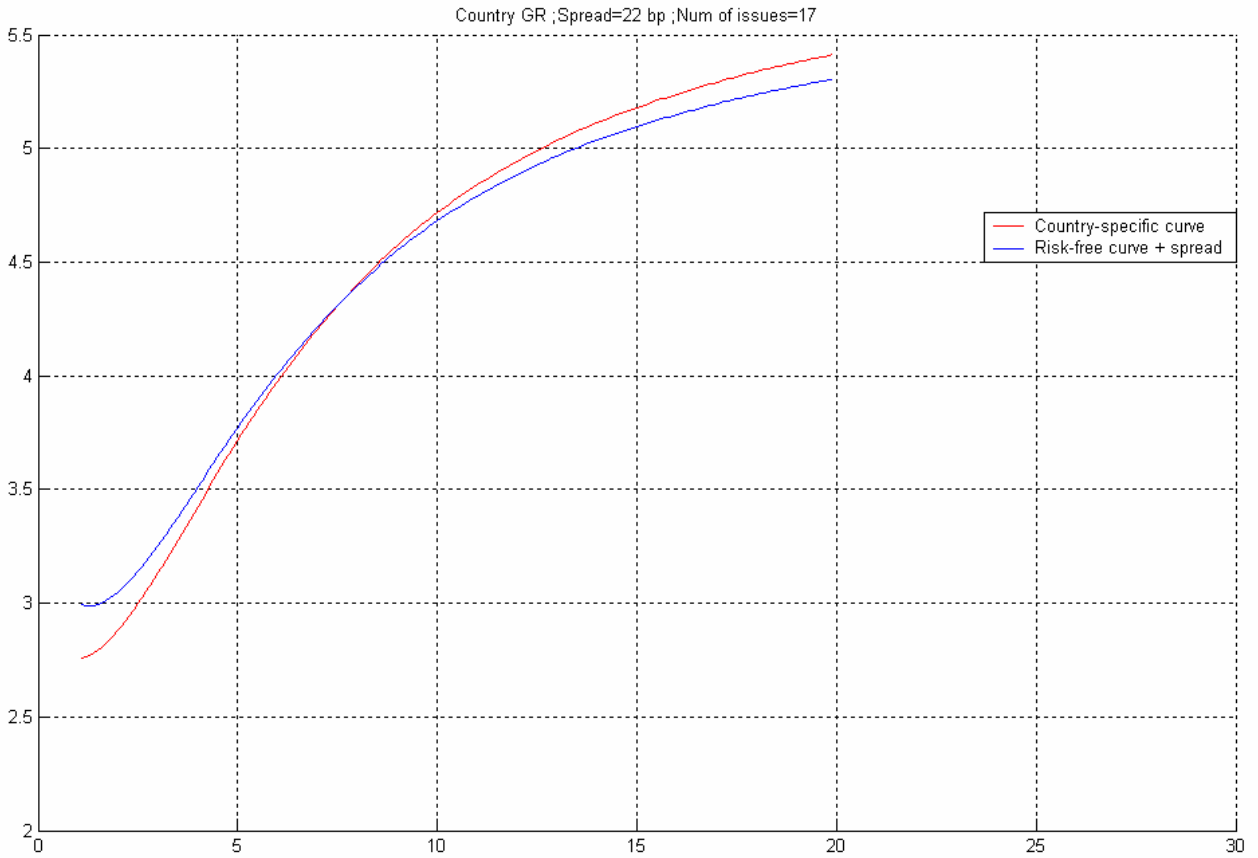
Refinement of procedure

- We can further improve the proposed methodology by taking into account the term structure of credit spreads. To capture this second order effect, an additional parameter should be introduced, such as a (permanent) slope individual for each country. In this case, the relative risk-free spot yield curve for the Eurozone will be accurate within two parameters: the level and the slope of the curve.
- In practice, it is not reasonable to double the number of estimated parameters of term structure of credit spreads. For instance, the slope parameter can be estimated in addition to the level parameter only for the countries where a clear manifestation of sloping credit spreads is observed.

Spot yield curves for Germany, 18.11.2002



Spot yield curves for Greece, 18.11.2002



Absolute Risk-Free Spot Yield Curve

In order to construct the absolute risk-free spot yield curve, an additional procedure (and possibly, additional data) must be used to determine the *level* (and, in case of the advanced specification of the model, the slope) of the risk-free yield curves.

Appropriateness of Euribor Swap Rate Data

- Empirical evidence show that the swap curve cannot be directly used for the yield level parameter estimation. Swap curve can be situated above the spot yield curve for a particular sovereign issuer.
- The conclusion is that evaluation of the level of risk free spot yield curve for the Eurozone should be based exclusively on the bond market data to avoid a noise coming from an exogenous input data.

Naïve approach

- The most primitive approach that seems to be natural to apply is to define the risk-free spot yield curve as the lowest country yield curve obtained with the help of shift of the base curve, i.e. of the relative risk-free spot yield curve.
- The advantage of such approach is its “model independent” character.
- Disadvantage is the level of the defined yield curve can be too volatile when the leader (the country with the lowest yield curve) changes frequently. This is now typical for the Eurozone bond market, so that it is a substantial reason to try other approaches.

Average Yield Curve Level

After constructing the relative risk-free yield curve, which is defined up to a parallel shift, the “average” shift parameter is chosen in the following way:

- We create a portfolio consisting of all euro-nominated bonds in the market, where each bond is weighed by its market value. This portfolio represents the whole market.
- Next, we choose the shift parameter so that the theoretical market value of the portfolio, calculated by discounting all its future cash flows, is equal to its current market value, calculated from the market prices.

Average Yield Curve

- The resulting curve level may be considered as an *index* that characterizes the level of interest rates in the market. The yield curve corresponding to this level will be referred as *Average Yield Curve*
- This index curve is an extension of the Average Gross Redemption Yield described in

  Brown P.J. Constructing & calculating bond indices, a guide to the EFFAS standardized rules, 1994.

Risk-free yield level

We introduce the risk-free yield level as the a lower confidence bound of the minimal yield curve level among all countries of Eurozone at the next moment of time (typically, one day) given confidence level (typically 0,99).

- The estimation of this bound is similar to Value-at-Risk calculation

Risk-Free Spot Yield Curve Linked to Average Yield Curve

- The (Absolute) Risk-Free Spot Yield Curve is obtained using Relative Risk-Free Spot Yield Curve with the risk-free yield level
- It is *anticipated* rather then current lowest level yield curve. It is a tool to exclude possible market manipulations
- We propose to model stochastic evolution of all spreads with respect to Average Yield Curve Level in order to estimate the risk-free spot yield curve for a given date.
- We propose a 9-step algorithm as one of the possible ways of solving the problem

9-step algorithm

1. Fix the base period (several days before the date the calculations are being made for). We suggest 40 trading days.
2. Fit the yield curve and country-specific spreads for the base period.
3. If linear spreads are present, they have to be transformed to constant ones. For example evaluate them for maturity equal to the average duration of country's bonds. Or just discard them if one is sure that these spreads are too high to be able to influence the minimum.

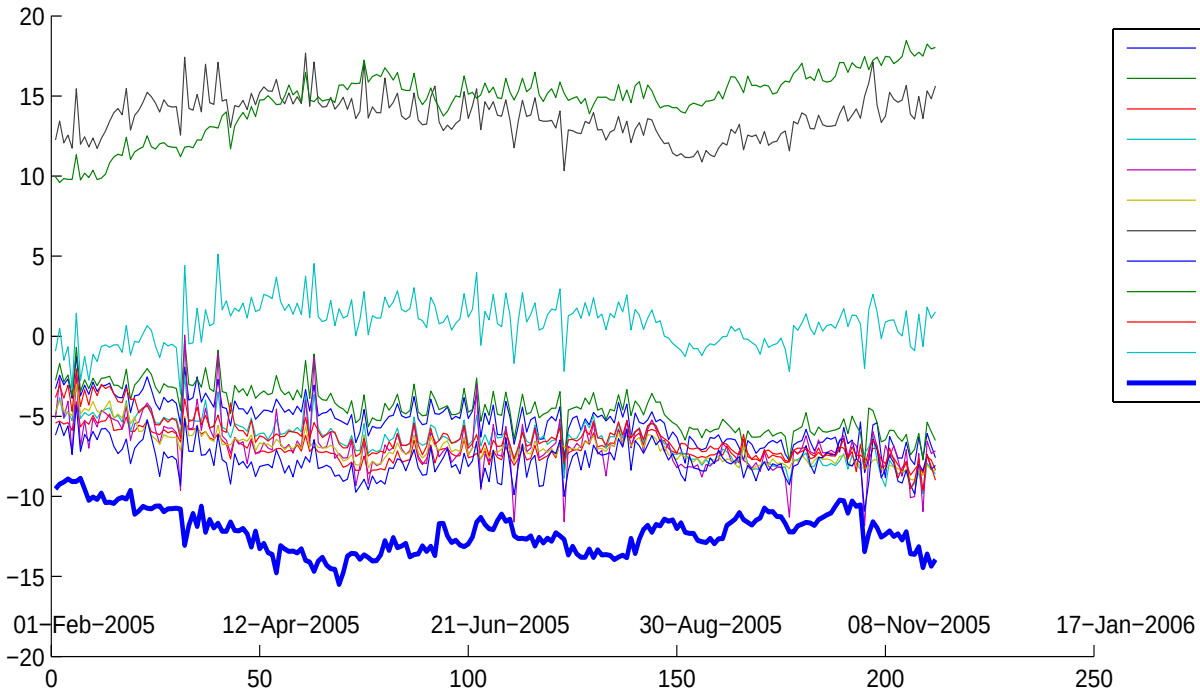
9-step algorithm

4. For each day of base period calculate the Average Yield Curve Level and subtract it from all specific spreads. From now on all spreads are considered relative to this index level.
5. Remove the linear trend from the spreads time series.
6. Within the base period estimate a linear factor model with 3 factors.
7. The results include the factor values estimation over the base period. For each of these (uncorrelated) factors estimate a first order autoregression model.

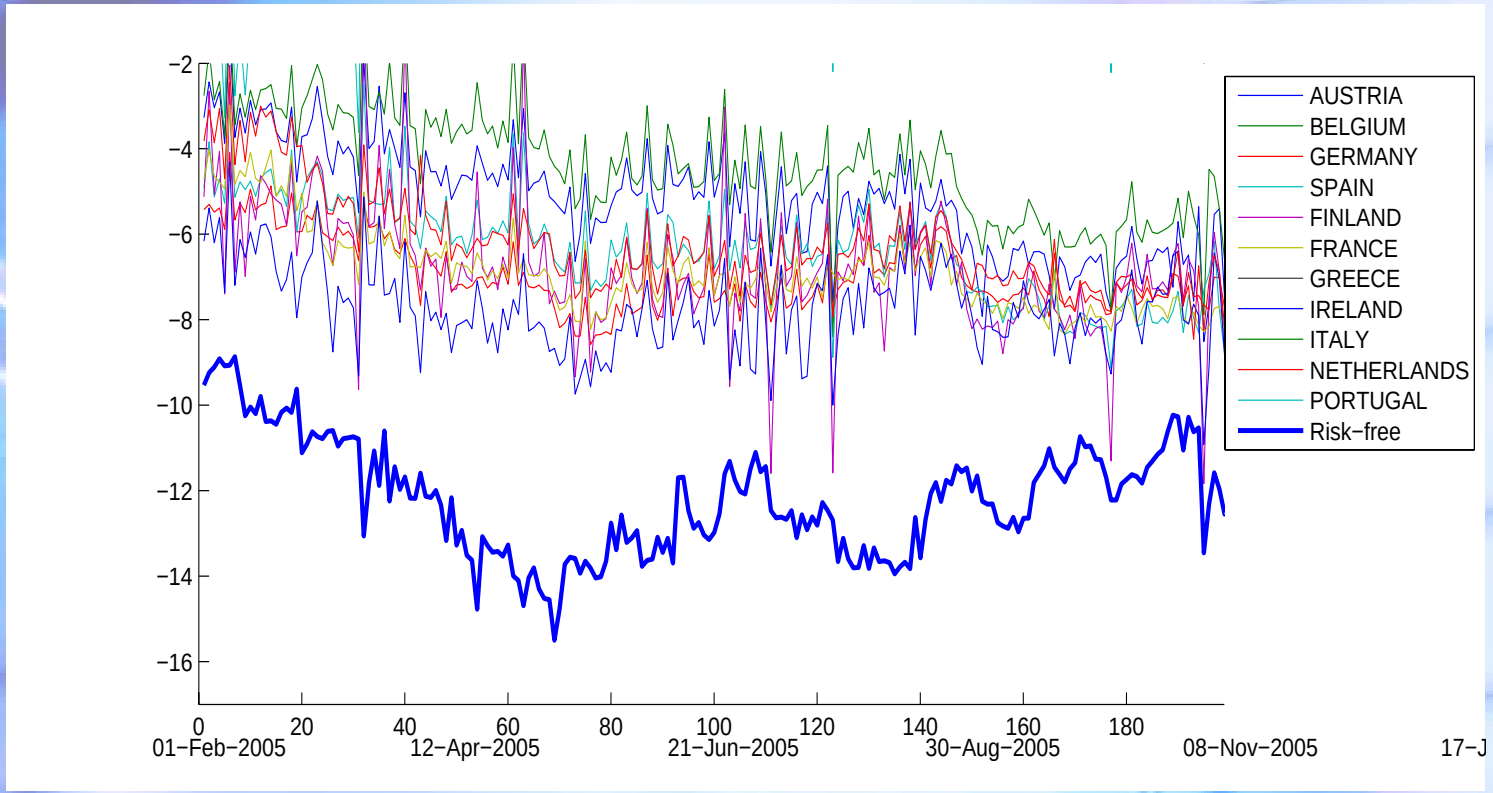
9-step algorithm

8. The previous step gave us a distribution of factor values for the next time moment. Thus we are able to derive a distribution of country-specific spreads for the next time moment using the information of pp.5-6. Via Monte-Carlo simulation we find the confidence interval for the minimum of the specific spreads for the next time moment. The level of confidence may be chosen by an expert judgement. We have used values of 1% and 5% for practical evaluations.
9. The lower bound of this confidence interval is the risk-free spread over the index curve determined in p 4.

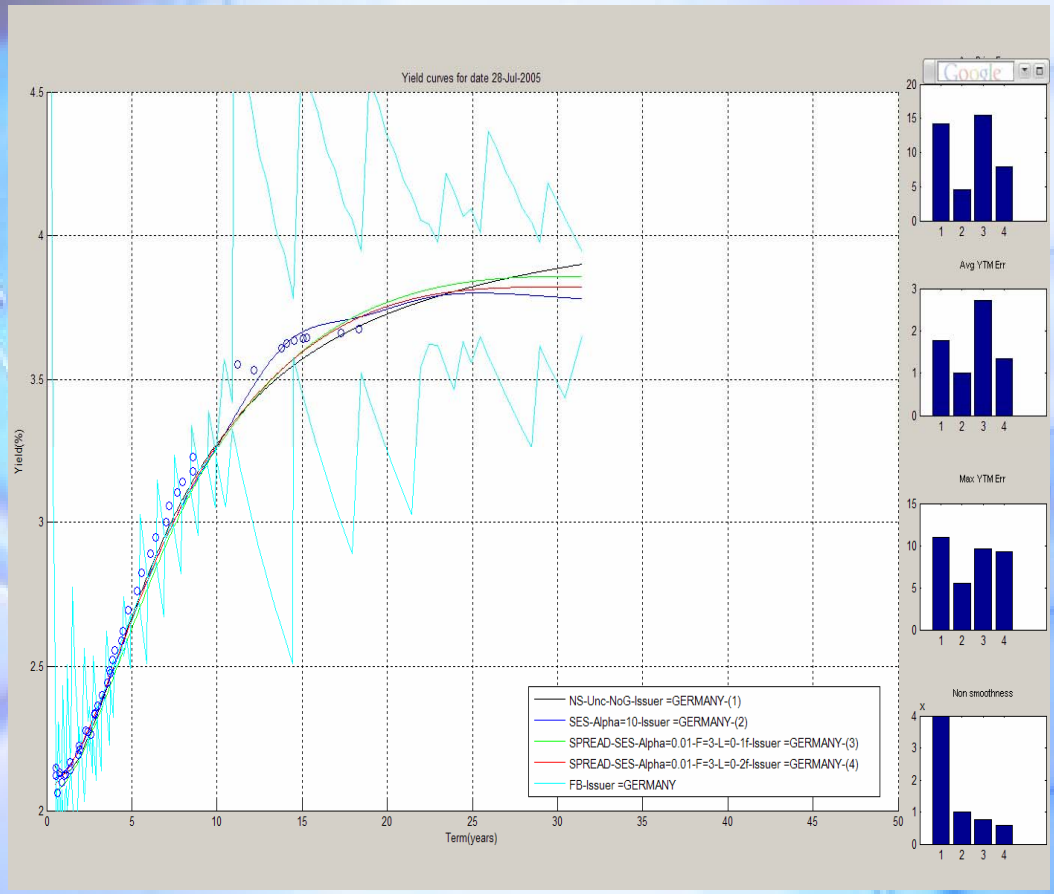
Country spreads relative Average Yield Curve Level



Lowest country spreads

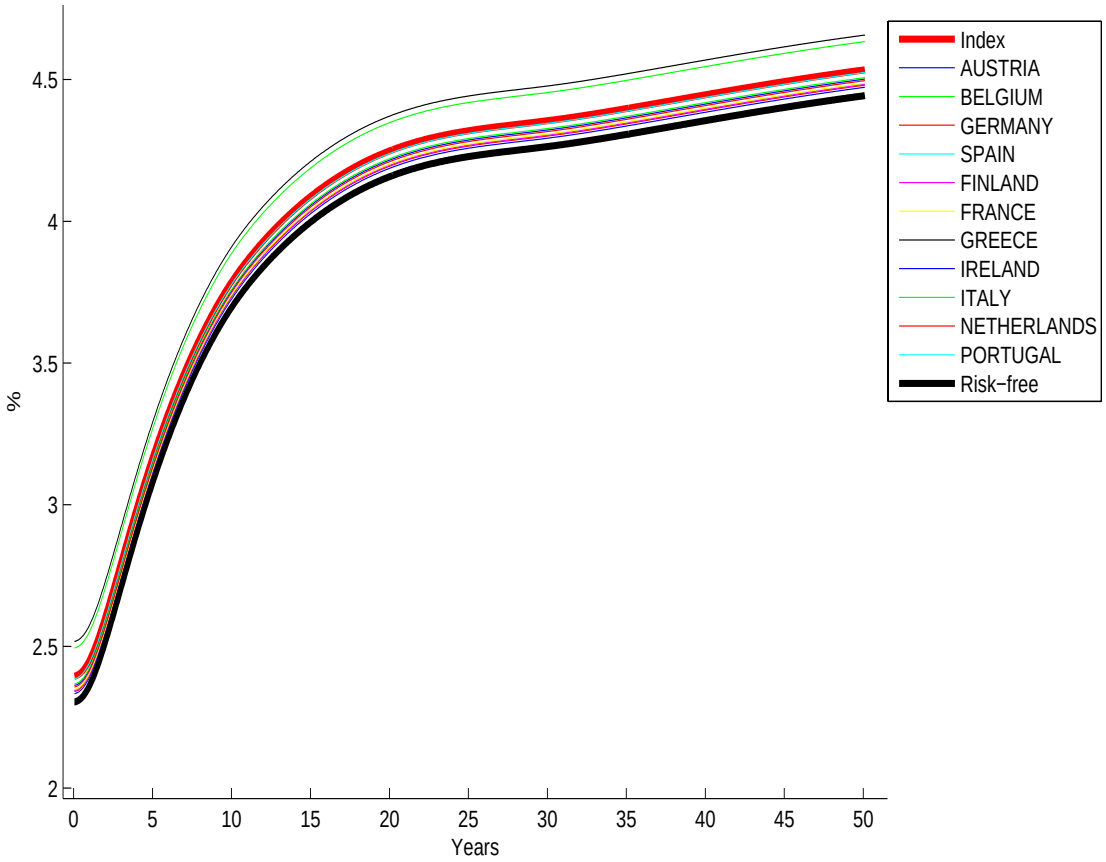


Why the splines are better then a parametric fitting

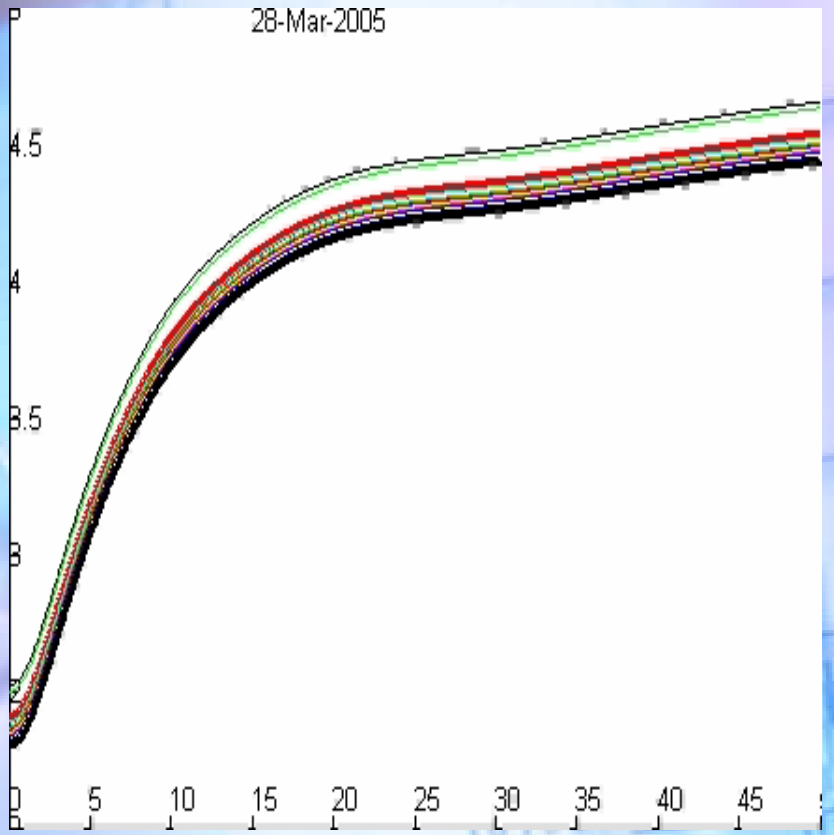


German zero-coupon yield curves (July 28th, 2005)

Eurozone yield curves



Evolution of Eurozone yield curves



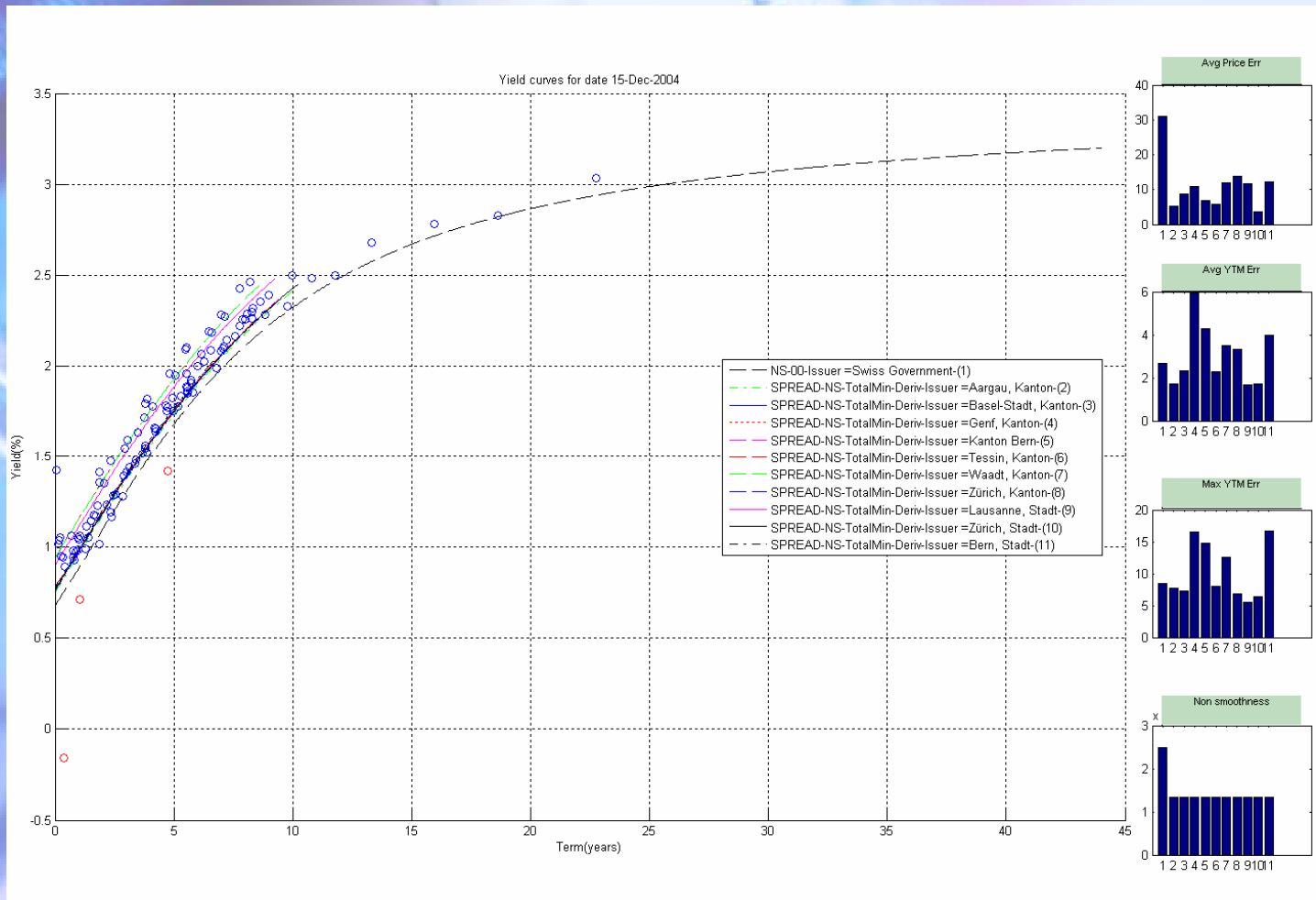
Possible applications

- The Risk-Free Spot Yield Curve and credit spreads can be calculated on a day basis or more frequently by one of the agencies like International Index Company that publish iBoxx indices.
- They can become benchmarks for professional use. They would be useful for financial engineering purposes, risk management, fixed income research, asset allocation and performance evaluation.

Universality of the Methodology

- The approach developed for construction of a risk free zero-coupon yield curve in the Eurozone is also applicable to construct a risk free zero-coupon yield curve in a particular country, using benchmark government, municipal and corporate bonds.
- In case of low liquid market the procedure for yield curve construction should be more elaborate. We suggest to perform projections for missing market data (using historical data) at the first stage and after that apply a fitting method at the second stage.

Swiss bond market relative risk free spot yield curve



Russian market: credit spreads and risk free zero coupon yield curve