Modeling and forecasting the yield curve

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Motivation

- The yield curve is a good predictor of economic cycles

➡ An usual term structure would be positive, but if it tends to flatten and have downslopes could be a sign of recession

- The yield curve can be used as a benchmark for prices of other securities*
- Could be seen as an indicator of investors' expectations about future developments of interest rates

The **yield curve** is a benchmark for the economic activity

- * involving a particular risk (for example)

Objectives

- (I) General aspects on T-securities, data used
- (II) Dynamics of **yield curve in Romania**
- (III) Specific algorithms to determine the **principal elements of the yield curve**
- (IV) What drives the yield curve (or specific elements of yield curve more exactly)?
    - (IV.1) **global**, **regional** or **local factors**?
    - (IV.2) correlation with **macroeconomic indicators**

(I) Overview of yields computation

- Current yield
- **Yield to maturity** ⟶ **quoted on the market**
- Yield to redemption
- **Zero Coupon Bond Yield** ⇨ Useful for comparison of T-securities with different coupon rates

  ↘ not directly quoted, should be computed

*data used in this study:: **zero coupon yields- Anderson method (cubic spline)**

period: Sep. 2011- Mar. 2015

maturities: 6M, 9M, 1Y, 2Y, 3Y, 4Y, 5Y, 6Y, 7Y, 8Y, 9Y, 10Y

source: Thomson- Reuters

Sources of bond yield returns can be classified as:

- **Periodic coupons payments**
- **Reinvesting principal**
- **Revenues from reinvesting coupons**

(II) RO Yield curve (1)

Structure of maturities

- short-term (<= 1 year)
- medium term (1-3 years)
- long-term (>= 5 years)

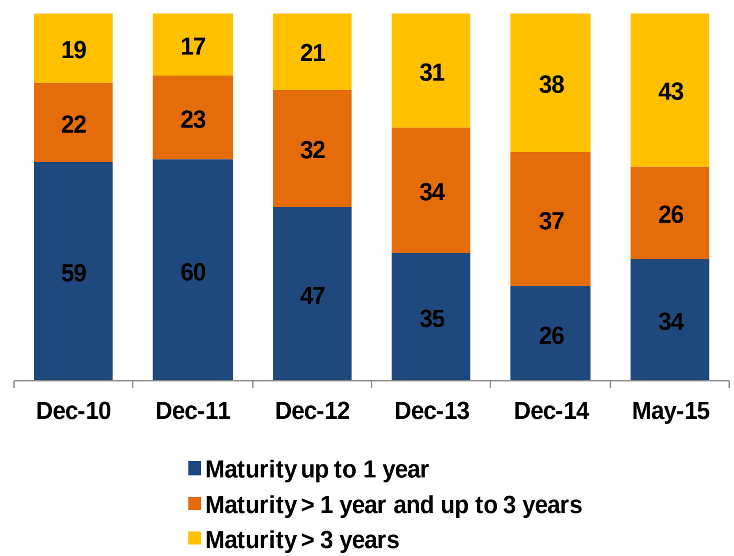
Local banks $\notin$ Other residents

Non-residents

38 outstanding RON ISINs (25-June-2015)

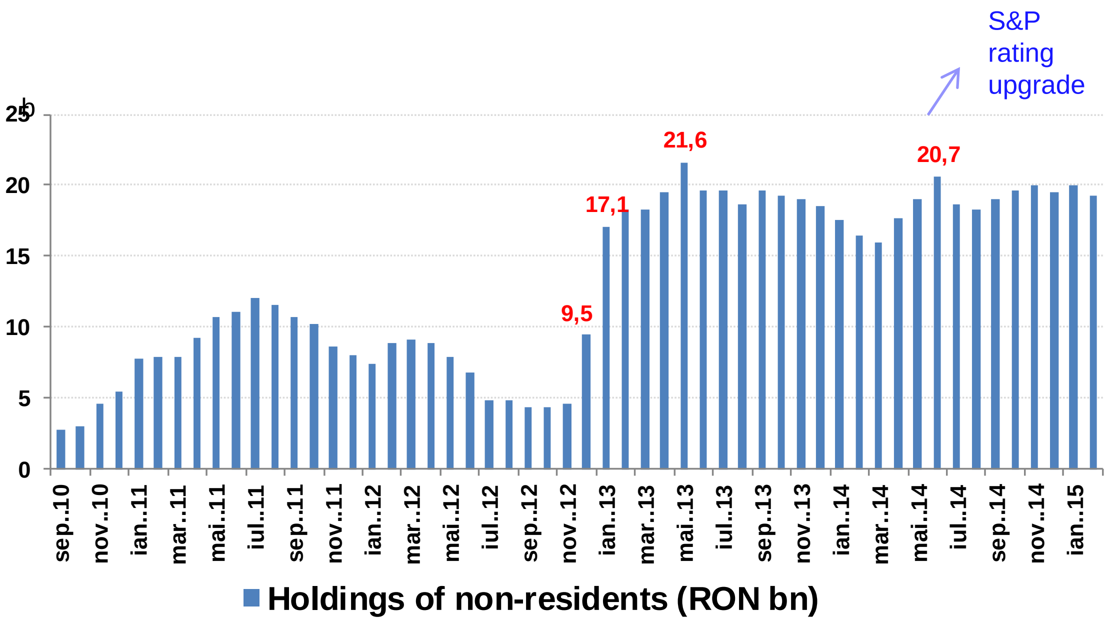
Rebalancing of debt structure

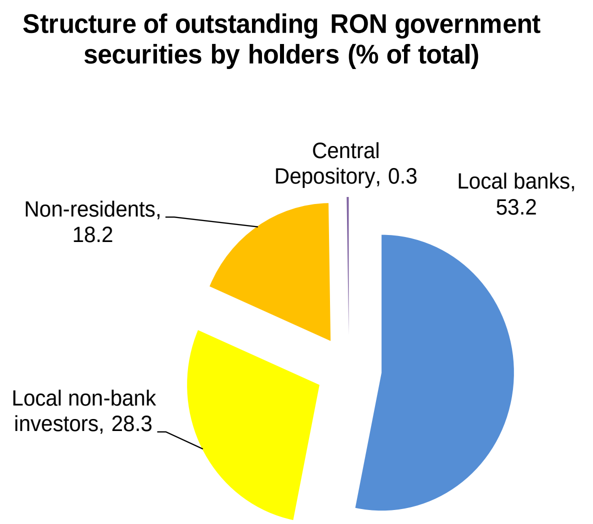
Maturity profile of outstanding RON government securities (% of total)



RO Yield curve(2)

- Inclusion of Romanian T-bonds in international indices such as Barclays MLCGI (Nov'12) and JPM GBI-EM (Jan'13) ⇒ ++ non-residents



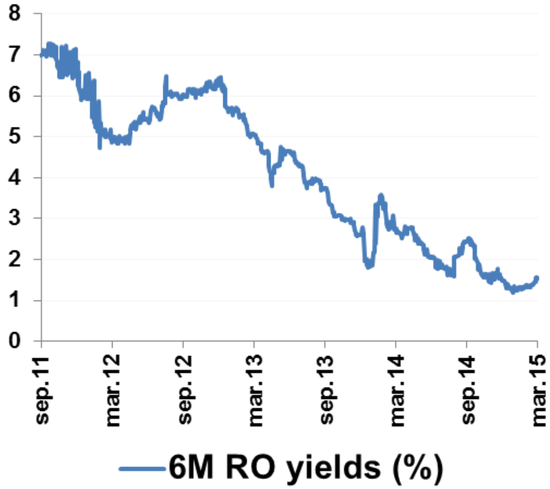


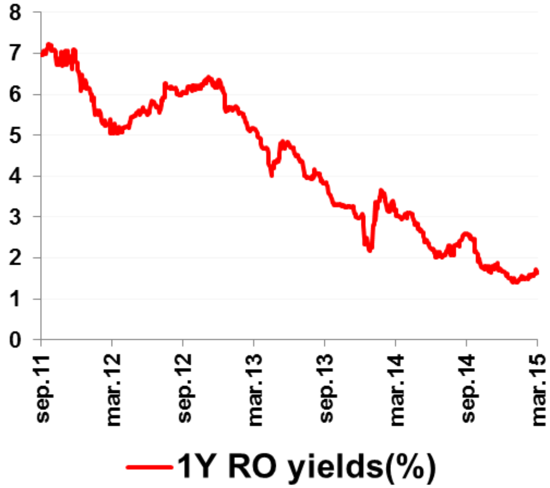
Data as of end-February 2015

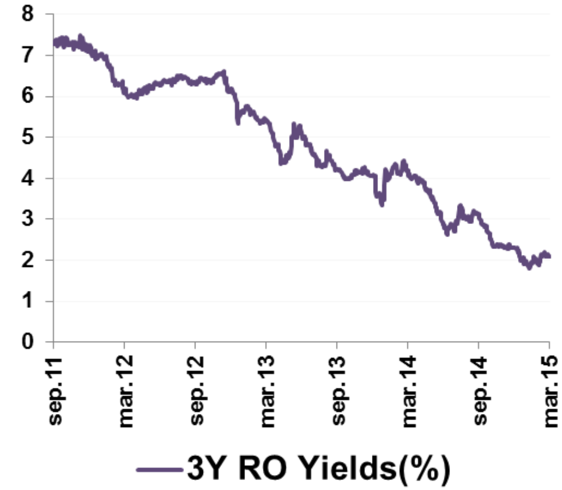
Source Ministry of Finance, own computations

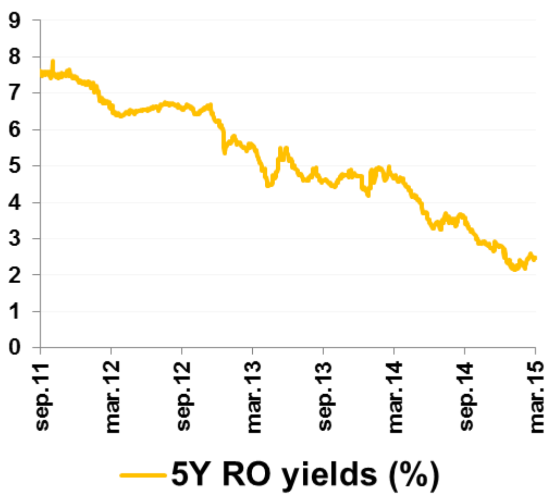
Dynamics of RO T-securities yields

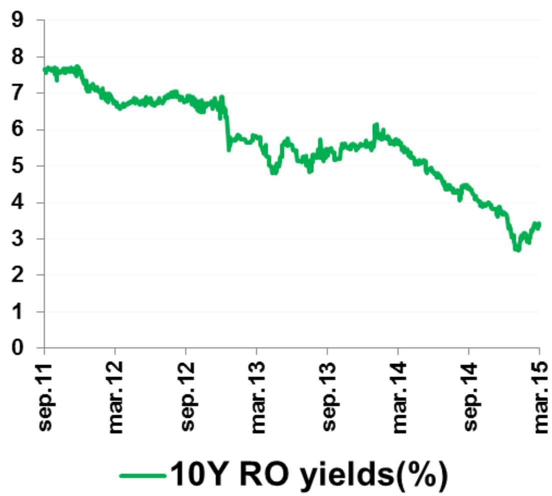
(Sep.2011 - Mar.2015, daily data)



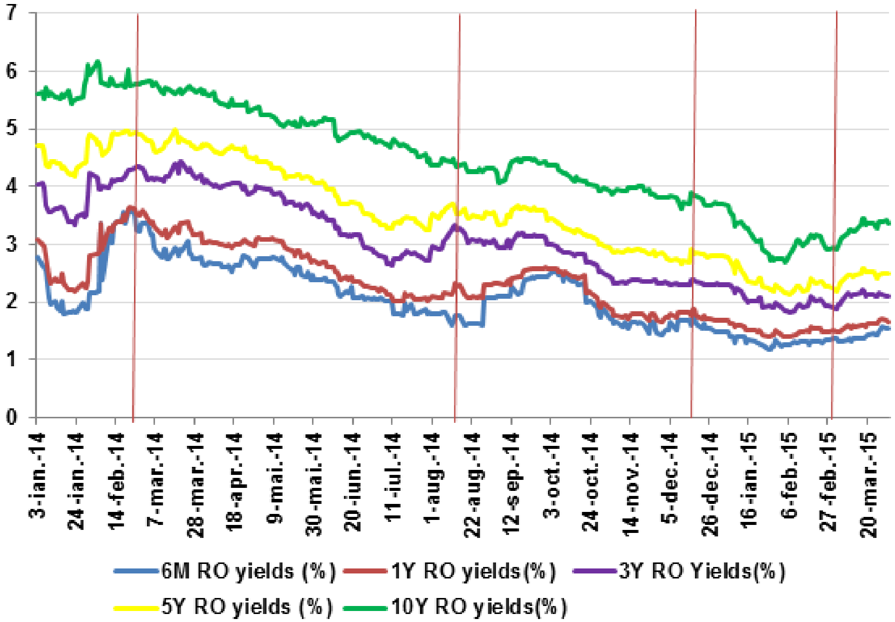


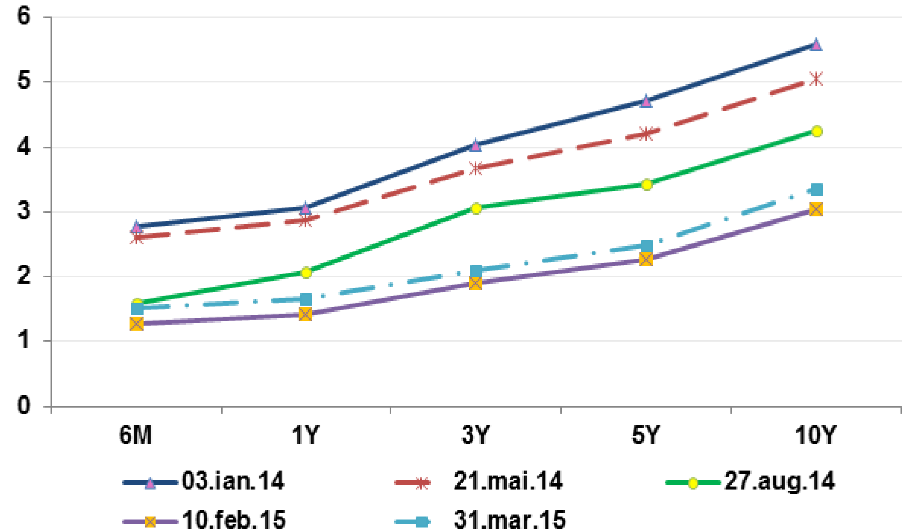






RO Yield curve during Jan'14 -Mar'15





Drivers:

NBR's monetary policy decisions

uncertainty on the political scene (the breakup of the governing alliance)

Russia-Ukraine conflict

Greek bailout program

Literature review

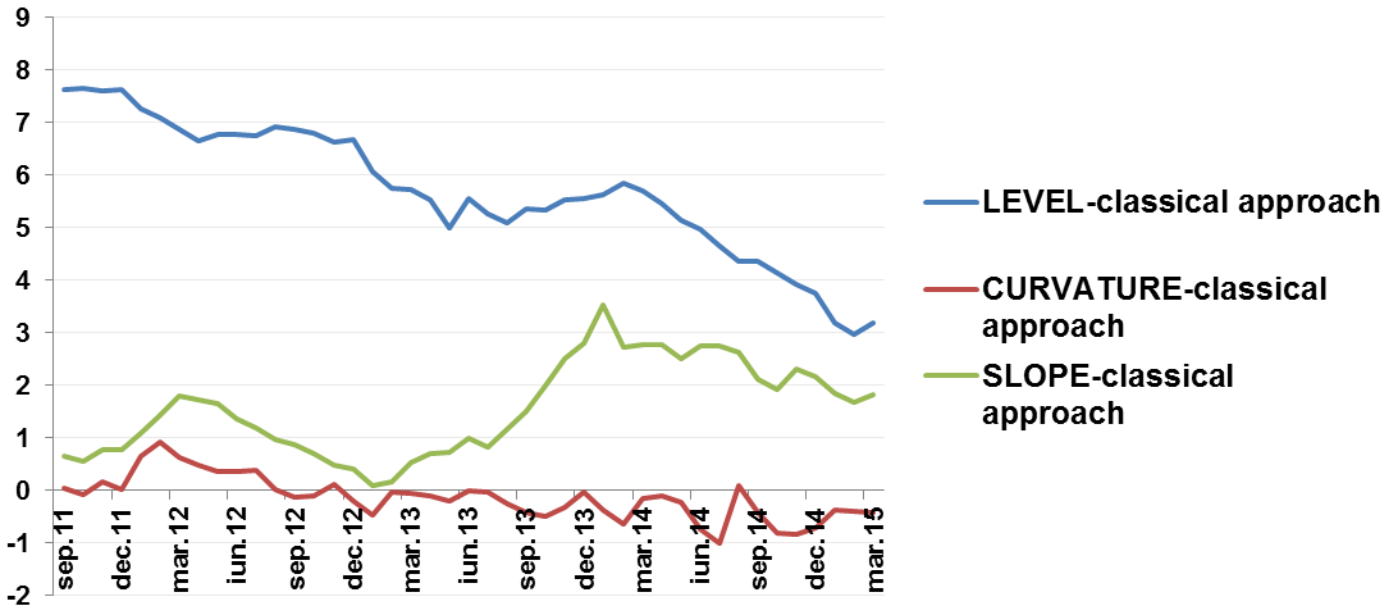
- Merton (1973), Vasicek (1977), Cox,Ingersoll & Ross (1985) → **"traditional" models**
- Nelson and Siegel (1987), Litterman & Scheinkman (1991),Balduzzi (1996), Bliss (1997), Dai & Singleton (2000), Diebold &Li (2006)→ **yield curve could be characterised by three factors**
- Svensson (1994) → **four factors**
- Diebold & Li (2008), Mehl (2009), Hoffmaister (2010) →**interactions between yield curves in a global market**
- Carriero (2010), Laurini & Hotta (2010) → focus on **Bayesian estimation methods**
- Ang & Piazessi (2003), Monch(2006), Koopman(2010) → **linkage with macroeconomy**

(III) How to determine the three characteristics (level, slope, curvature) of the RO yield curve?

(a) Classical approach

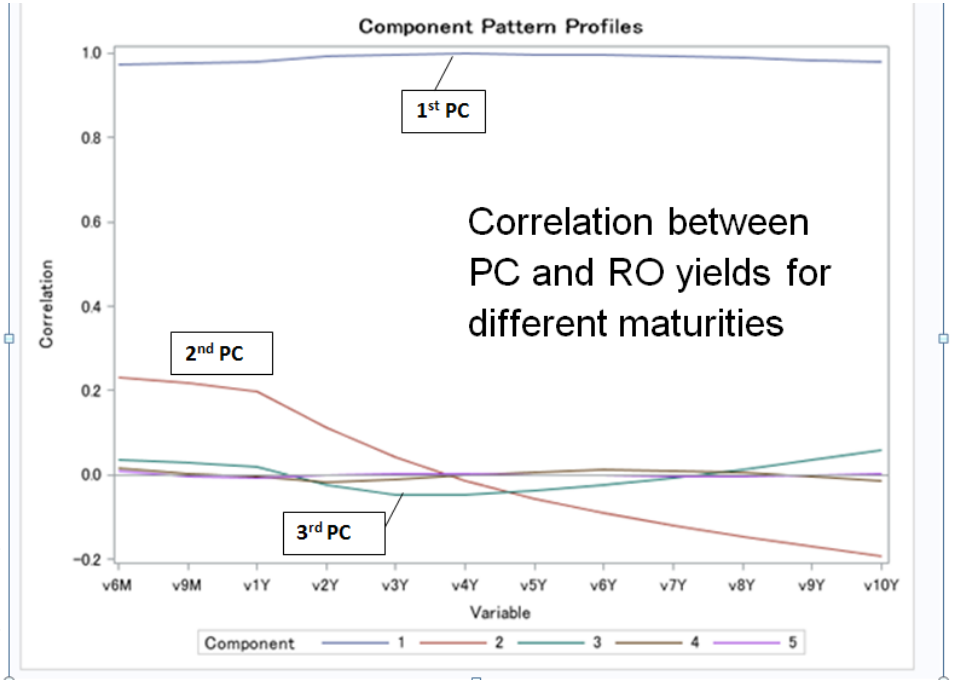
→ does NOT take into account yields for ALL maturities

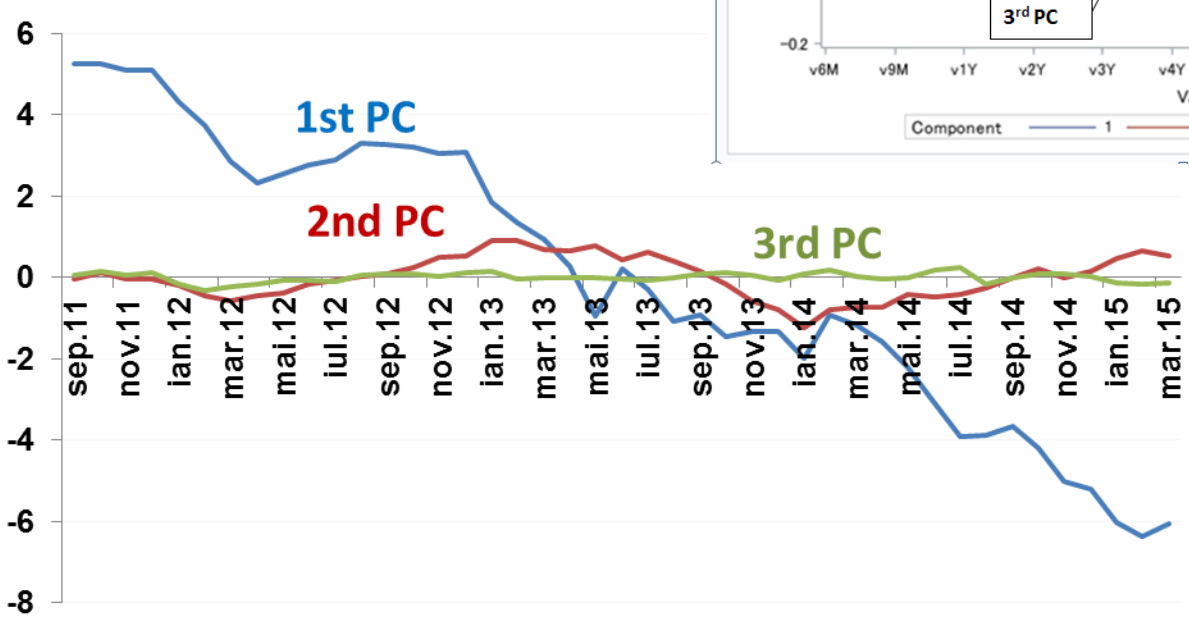
$$level = y_l$$
$$slope = y_l - y_s$$
$$curvature = 2y_m - (y_s + y_l)$$



(b) Principal component analysis

Eigenvalues of the Correlation Matrix				
	Eigenvalue	Difference	Proportion	Cumulative
1	11.7137216	11.4430774	0.9761	0.9761
2	0.2706441	0.2565159	0.0226	0.9987
3	0.0141283	0.0128596	0.0012	0.9999
4	0.0012687	0.0010564	0.0001	1.0000
5	0.0002123		0.0000	1.0000



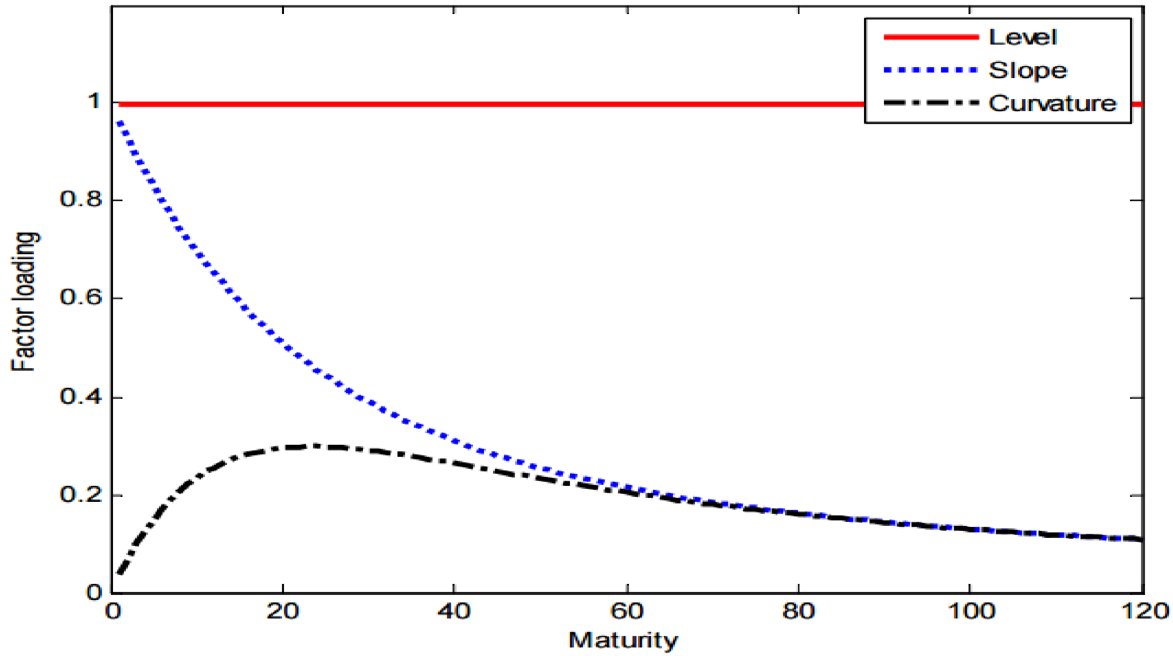


(c) Adjusted Nelson-Siegel approach

- Nelson & Siegel (1987) —Yield curve: $y_t(\tau) = b_{1t} + \frac{b_{2t}(1 - e^{-\lambda_t \tau})}{\lambda_t \tau} - b_{3t} e^{-\lambda_t \tau}$
- Diebold & Li (2006) propose an adjustment of Nelson-Siegel model:

$$y_t(\tau) = l_t \times \mathbf{1} + s_t \times \frac{\mathbf{(1 - e^{-\lambda_t \tau})}}{\boldsymbol{\lambda_t \tau}} + c_t \times \left(\frac{\mathbf{(1 - e^{-\lambda_t \tau})}}{\boldsymbol{\lambda_t \tau}} - \boldsymbol{e^{-\lambda_t \tau}}\right)$$

$l_t = b_{1t}$; $s_t = b_{2t} - b_{3t}$; $c_t = b_{3t}$



(c) Adjusted Nelson-Siegel approach
Model estimation(1)

- Yields for various maturities $\tau_1, \tau_2, \ldots \ldots . \tau_M$

- $$\begin{pmatrix} y_t(\tau_1) \\ y_t(\tau_2) \\ \vdots \\ \vdots \\ \vdots \\ y_t(\tau_M) \end{pmatrix} = \begin{pmatrix} 1 & \frac{1-e^{-\lambda_t \tau_1}}{\lambda_t \tau_1} & \frac{1-e^{-\lambda_t \tau_1}}{\lambda_t \tau_1} - e^{-\lambda_t \tau_1} \\ 1 & \frac{1-e^{-\lambda_t \tau_2}}{\lambda_t \tau_2} & \frac{1-e^{-\lambda_t \tau_2}}{\lambda_t \tau_2} - e^{-\lambda_t \tau_2} \\ \vdots & \vdots & \vdots \\ 1 & \frac{1-e^{-\lambda_t \tau_M}}{\lambda_t \tau_M} & \frac{1-e^{-\lambda_t \tau_M}}{\lambda_t \tau_M} - e^{-\lambda_t \tau_M} \end{pmatrix} \underbrace{\begin{pmatrix} l_t \\ s_t \\ c_t \end{pmatrix}}$$

$$\boldsymbol{y_t} = X_{\lambda_t} \beta_t$$

$$\min_{\lambda_t, l_t, s_t, c_t} \sum_{i=1}^{M} \left(l_t + s_t \frac{1 - e^{-\lambda_t \tau_i}}{\lambda_t \tau_i} + c_t \left(\frac{1 - e^{-\lambda_t \tau_i}}{\lambda_t \tau_i} - e^{-\lambda_t \tau_i}\right) - y_t(\tau_i)\right)^2$$
$$= \min_{\lambda_t, \beta_t} \left(X_{\lambda_t} \beta_t - y_t \right)^T \left(X_{\lambda_t} \beta_t - y_t \right)$$

(c) Adjusted Nelson-Siegel approach
Model estimation(2)

- λ_t= constant => OLS

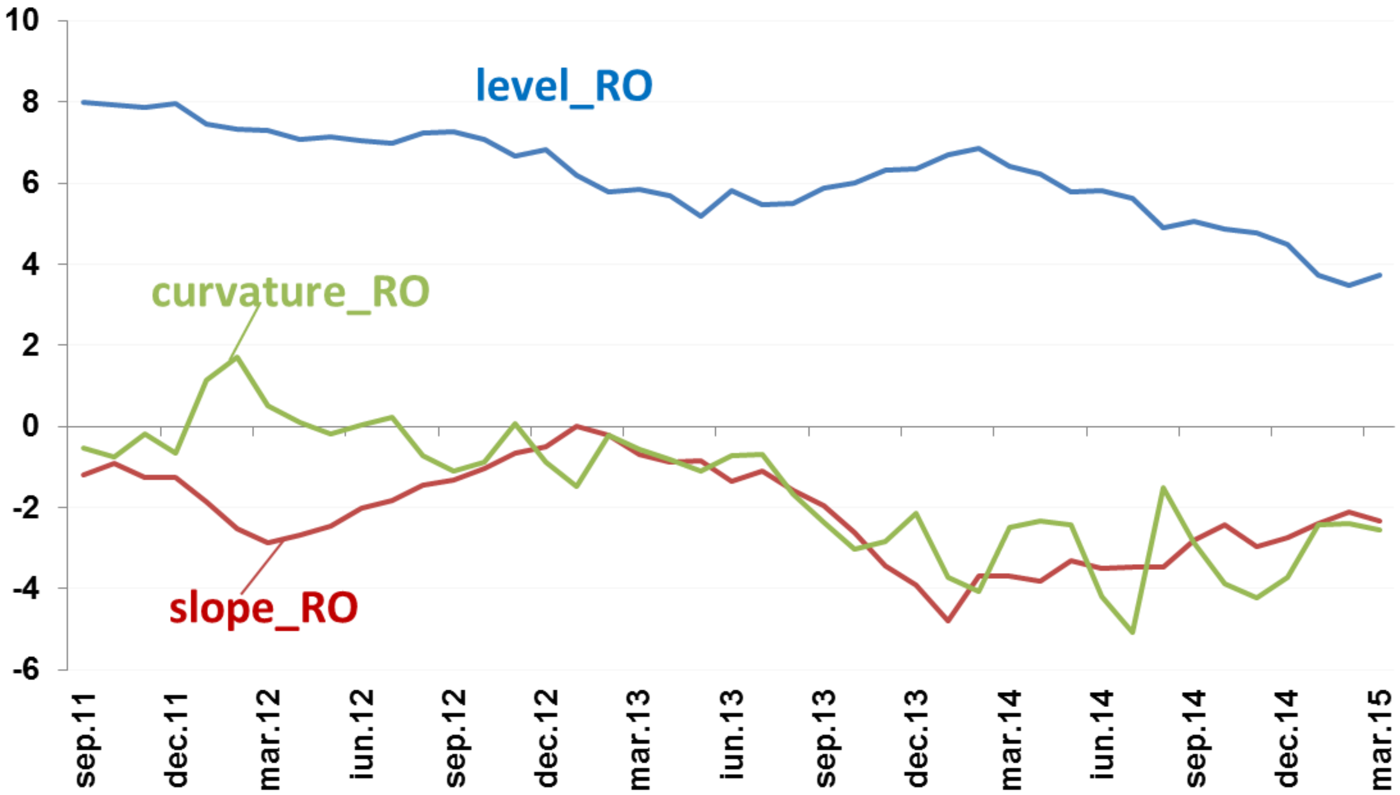
(++tractability & --additional restrictions)

✓ The parameter ***λ*** is the level at which the medium term component takes a maximum value

⇨ **λ=0.0609 (30 months)**

(c) Adjusted Nelson-Siegel approach

Results of estimation



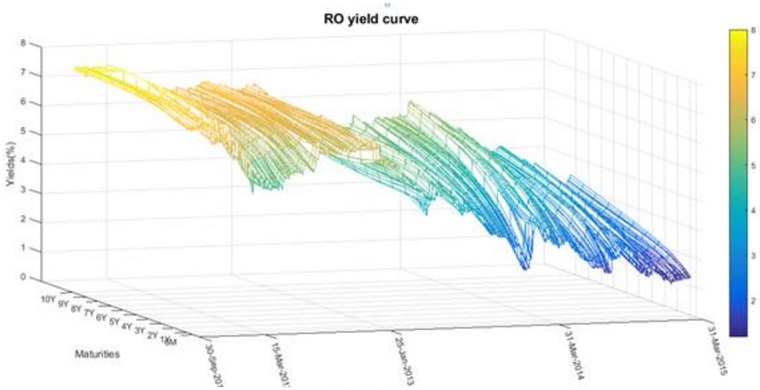
! Adjusted Nelson-Siegel model tracks the negative of yield curve slope (in classical approach)

(IV) Dynamics of yield curves in RO, HU, PL, GE, US, JP

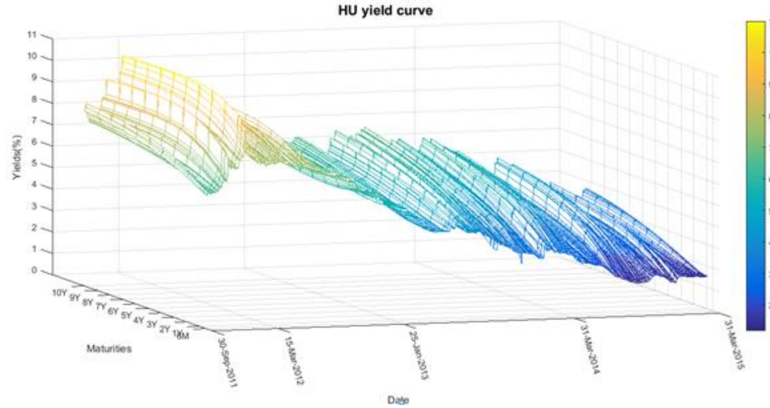
Sep.2011-Mar.2015

Maturities: 6M to 10Y

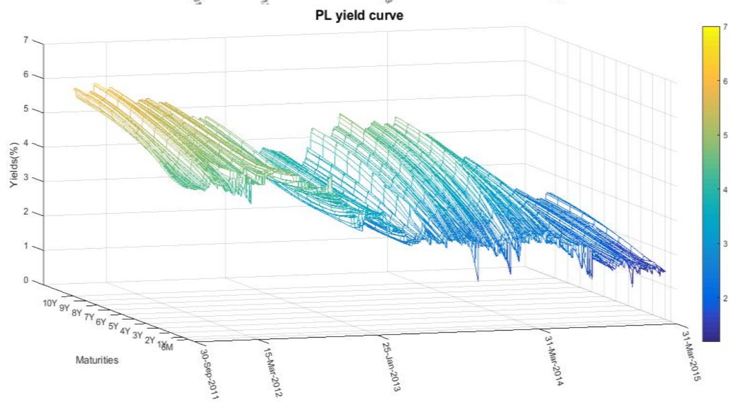
RO



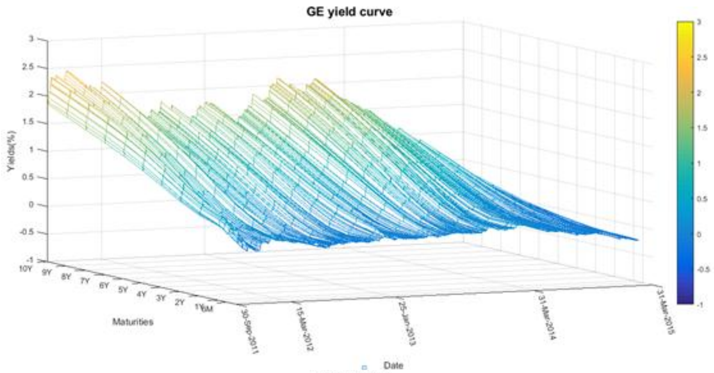
HU



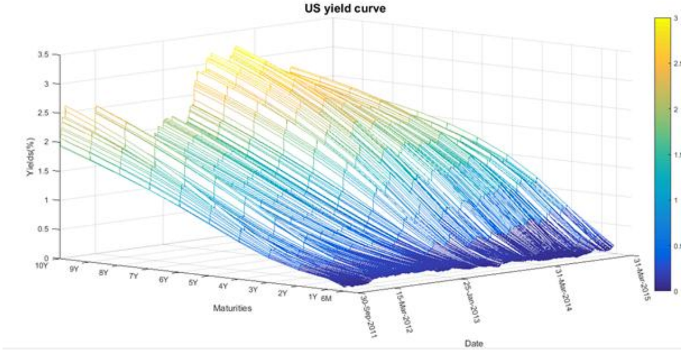
PL



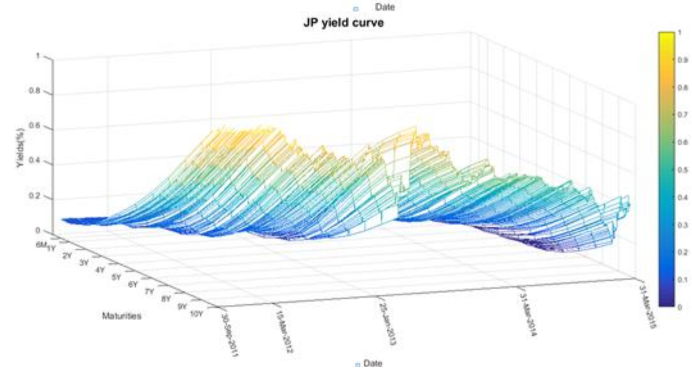
GE



US

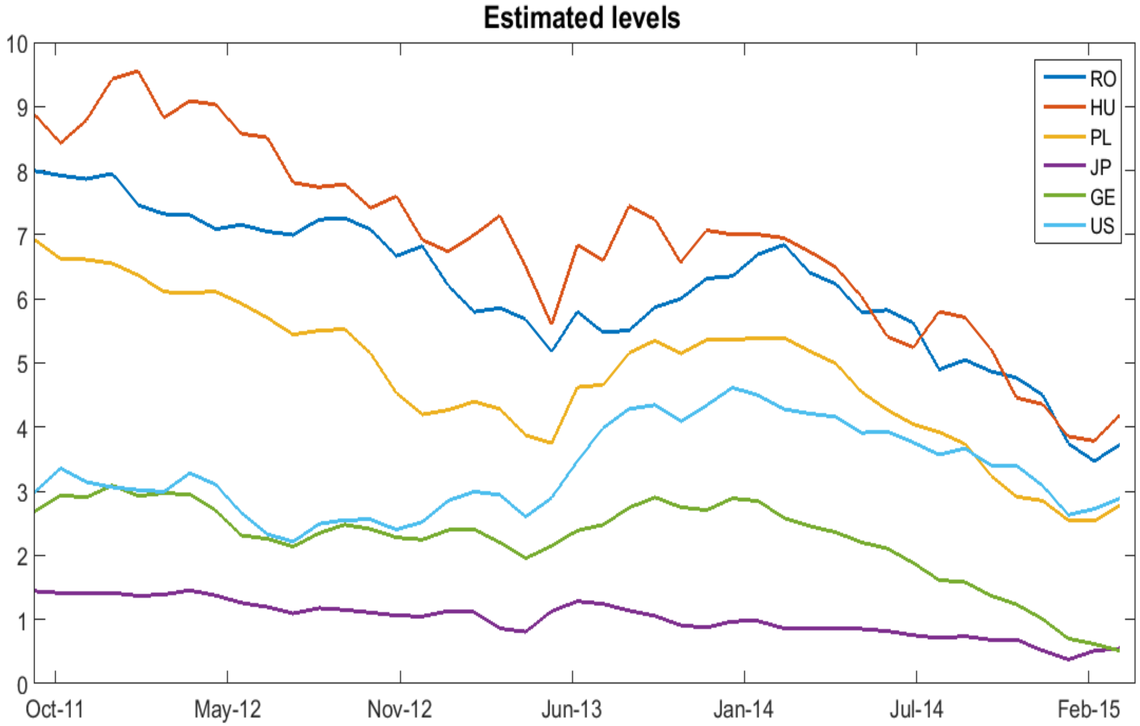


JP



Additional hints for the existence of unobservable “global factors”

Preliminary analysis (1)



Level factors: RO,HU,PL

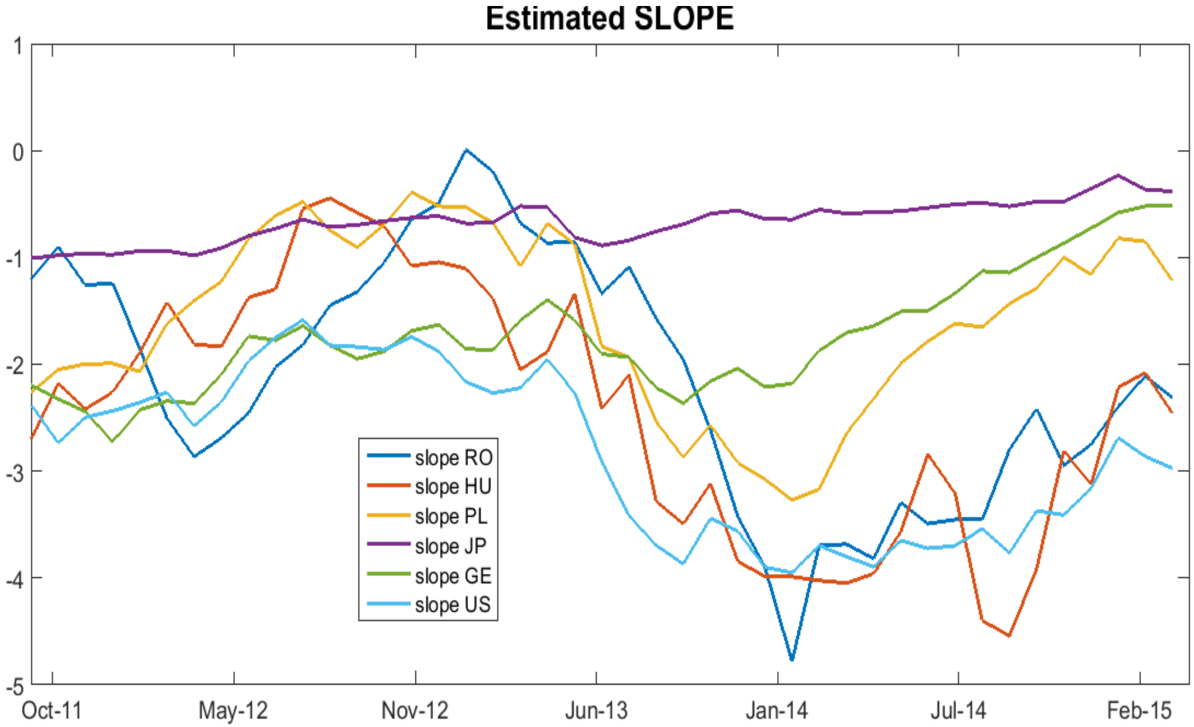
	PC1	PC2	PC3
Eigenvalue	4,81	0,13	0,09
Variance prop(%)	95,7	2,6	1,7
Cumulative prop(%)	**95,7**	**98,3**	100,0

Level factors: RO,HU,PL,US,GE,JP

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	5,22	0,56	0,13	0,06	0,02	0,01
Variance prop(%)	86,9	9,3	2,2	1,0	0,4	0,1
Cumulative prop(%)	**86,9**	**96,3**	98,4	99,5	99,9	100,0

Additional hints for the existence of unobservable "global factors"

Preliminary analysis (2)



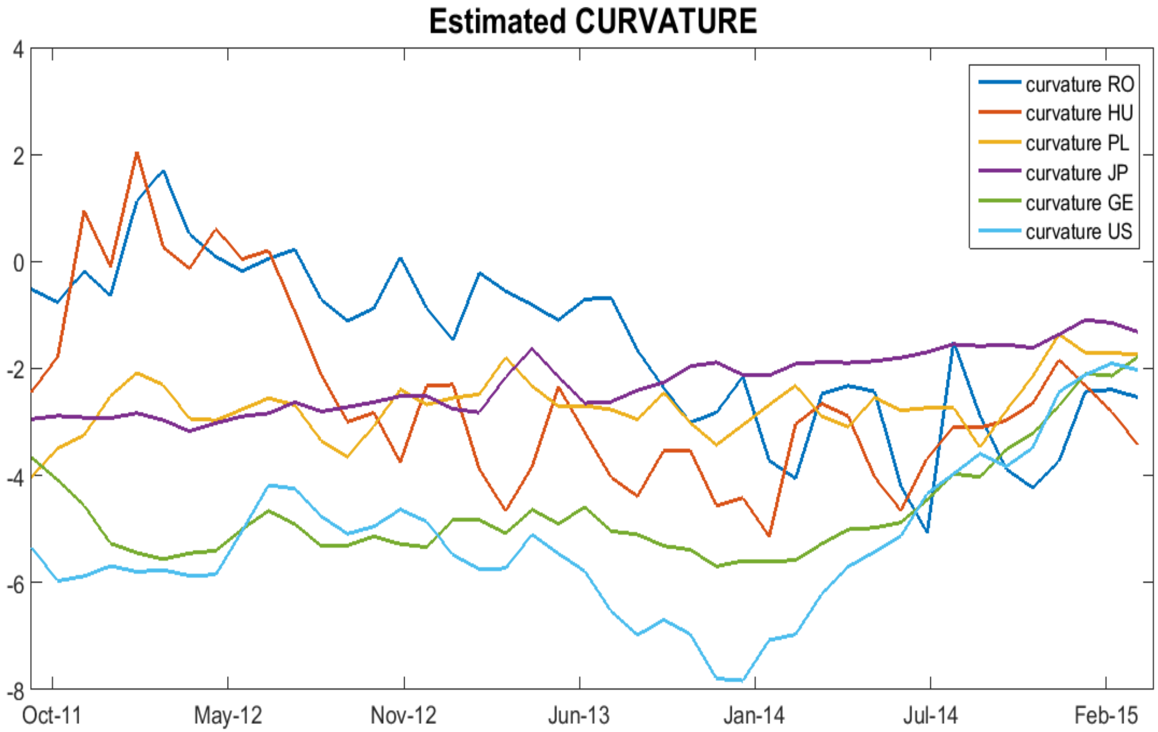
Slope factors: RO,HU,PL

	PC1	PC2	PC3
Eigenvalue	2,78	0,43	0,23
Variance prop(%)	80,9	12,4	6,7
Cumulative prop(%)	**80,9**	**93,3**	100,0

Slope factors: RO,HU,PL,US,GE,JP

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	3,29	0,57	0,40	0,07	0,03	0,01
Variance prop(%)	75,3	13,1	9,2	1,5	0,8	0,2
Cumulative prop(%)	**75,3**	88,4	97,6	99,1	99,8	100,0

Additional hints for the existence of unobservable "global factors"
Preliminary analysis (3)



Curvature factors: RO,HU,PL

	PC1	PC2	PC3
Eigenvalue	4,43	1,12	0,26
Variance prop(%)	76,2	19,3	4,5
Cumulative prop(%)	**76,2**	**95,5**	100,0

Curvature factors: RO,HU,PL,US,GE,JP

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	4,70	3,21	0,93	0,21	0,14	0,06
Variance prop(%)	50,8	34,7	10,1	2,3	1,6	0,6
Cumulative prop(%)	**50,8**	85,5	95,5	97,8	99,4	100,0

(IV.1) Moving to N-country framework…
How to estimate the global (unobservable) factors?
Global model construction and assumptions (1)

- $y_{it}(\tau) = l_{it} + s_{it}\left(\frac{1-e^{-\lambda_{it}\tau}}{\lambda_{it}\tau}\right) + c_{it}\left(\frac{1-e^{-\lambda_{it}\tau}}{\lambda_{it}\tau} - e^{-\lambda_{it}\tau}\right) + v_{it}(\tau)$
- 6 countries included in the analysis : RO,HU,PL,GE,JP,US

Define a **global yield curve** - Diebold&Li (2008) :

$$Y_{gt}(\tau) = l_{gt} + s_{gt}\left(\frac{1-e^{-\lambda_t\tau}}{\lambda_t\tau}\right) + c_{gt}\left(\frac{1-e^{-\lambda_t\tau}}{\lambda_t\tau} - e^{-\lambda_t\tau}\right) + v_{gt}(\tau)$$

H1

$$\begin{pmatrix} l_{gt} \\ s_{gt} \\ c_{gt} \end{pmatrix} = \begin{pmatrix} \Phi_{11} & \Phi_{12} & \Phi_{13} \\ \Phi_{21} & \Phi_{22} & \Phi_{23} \\ \Phi_{31} & \Phi_{32} & \Phi_{33} \end{pmatrix} \begin{pmatrix} l_{gt-1} \\ s_{gt-1} \\ c_{gt-1} \end{pmatrix} + \begin{pmatrix} U_{gt}^{l} \\ U_{gt}^{s} \\ U_{gt}^{c} \end{pmatrix}$$

H2

$$U_{gt}^{F} \ errors \begin{cases} EU_{gt}^{F}U_{gt'}^{F'} = (\sigma_g)^2 \ if \ \ t = t' \ and \ F = F' \\ 0 \ , \ otherwise \end{cases}, \quad F = l, s, c$$

Global model construction and assumptions (2)

H3

- $l_{it} = \alpha_i^l + \beta_i^l l_{gt} + \varepsilon_{it}^l$
- $s_{it} = \alpha_i^s + \beta_i^s s_{gt} + \varepsilon_{it}^s$
- $c_{it} = \alpha_i^c + \beta_i^c c_{gt} + \varepsilon_{it}^c$

Assume $\sigma_g^F = 1$ as the magnitude of global factors and factors loadings are not separately identified

Where ε_{it}^F are local factors and follow:

H4

$$\begin{pmatrix} \varepsilon_{it}^l \\ \varepsilon_{it}^s \\ \varepsilon_{it}^c \end{pmatrix} = \begin{pmatrix} \psi_{11} & \psi_{12} & \psi_{13} \\ \psi_{21} & \psi_{22} & \psi_{23} \\ \psi_{31} & \psi_{32} & \psi_{33} \end{pmatrix} \begin{pmatrix} \varepsilon_{it-1}^l \\ \varepsilon_{it-1}^s \\ \varepsilon_{it-1}^c \end{pmatrix} + \begin{pmatrix} u_{it}^l \\ u_{it}^s \\ u_{it}^c \end{pmatrix}$$

H5

$$u_{it}^F \; errors \begin{cases} Eu_{it}^F u_{it'}^{F'} = \left(\sigma_i^F\right)^2 \; if \; i = i', t = t' \; si \; F = F' \\ 0 \; , \; otherwise \end{cases}, \; F = l, s, c$$

Global model construction and assumptions (3)

In the current global framework, yield curve might be described as follows:

- $$\begin{bmatrix} y_{1t}(\tau_1) \\ y_{1t}(\tau_2) \\ \vdots \\ y_{Nt}(\tau_{J-1}) \\ y_{Nt}(\tau_J) \end{bmatrix} = A \begin{bmatrix} \alpha_i^l \\ \alpha_i^s \\ \vdots \\ \alpha_N^s \\ \alpha_N^c \end{bmatrix} + B \begin{bmatrix} l_{gt} \\ s_{gt} \\ c_{gt} \end{bmatrix} + \begin{bmatrix} v_{1t}(\tau_1) \\ v_{1t}(\tau_2) \\ \vdots \\ v_{Nt}(\tau_{J-1}) \\ v_{Nt}(\tau_J) \end{bmatrix} + A \begin{bmatrix} \varepsilon_{1,t}^l \\ \varepsilon_{1,t}^s \\ \vdots \\ \varepsilon_{N,t}^s \\ \varepsilon_{N,t}^c \end{bmatrix}$$

- $$A = \begin{pmatrix} 1 & \frac{1-e^{-\tau_1\lambda}}{\tau_1\lambda} & 0 & \dots & & 0 & 0 \\ 1 & \frac{1-e^{-\tau_2\lambda}}{\tau_2\lambda} & 0 & \dots & & 0 & 0 \\ & & & & & & \vdots \\ \vdots & \vdots & \ddots & \ddots & & \vdots & \frac{1-e^{-\tau_{J-1}\lambda}}{\tau_{J-1}\lambda} \\ 0 & 0 & \dots & \dots & & 1 & \\ 0 & 0 & \dots & \dots & & 1 & \frac{1-e^{-\tau_J\lambda}}{\tau_J\lambda} \end{pmatrix} \qquad B = \begin{pmatrix} \beta_1^l & \beta_1^s(\frac{1-e^{-\tau_1\lambda}}{\tau_1\lambda}) & \beta_1^c(\frac{1-e^{-\tau_1\lambda}}{\tau_1\lambda} - e^{-\tau_1\lambda}) \\ \beta_1^l & \beta_1^s(\frac{1-e^{-\tau_2\lambda}}{\tau_2\lambda}) & \beta_1^c(\frac{1-e^{-\tau_2\lambda}}{\tau_2\lambda} - e^{-\tau_2\lambda}) \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ \beta_N^l & \beta_N^s(\frac{1-e^{-\tau_J\lambda}}{\tau_J\lambda}) & \beta_N^c(\frac{1-e^{-\tau_J\lambda}}{\tau_J\lambda} - e^{-\tau_J\lambda}) \end{pmatrix}$$

N is the number of countries, J is the number of tenors

Global model estimation (1)

Multi step approach, more convenient

(1) Estimate the model for each country

$$y_{it}(\tau) = l_{it} + s_{it}\left(\frac{1-e^{-\lambda_{it}\tau}}{\lambda_{it}\tau}\right) + c_{it}\left(\frac{1-e^{-\lambda_{it}\tau}}{\lambda_{it}\tau} - e^{-\lambda_{it}\tau}\right) + v_{it}(\tau)$$

and obtain series of level, slope and curvature factors

(2) Estimate a dynamic factor model composed of:

$$\begin{pmatrix} l_{gt} \\ s_{gt} \\ c_{gt} \end{pmatrix} = \begin{pmatrix} \Phi_{11} & 0 & 0 \\ 0 & \Phi_{22} & 0 \\ 0 & 0 & \Phi_{33} \end{pmatrix} \begin{pmatrix} l_{gt-1} \\ s_{gt-1} \\ c_{gt-1} \end{pmatrix} + \begin{pmatrix} U_{gt}^{l} \\ U_{gt}^{s} \\ U_{gt}^{c} \end{pmatrix} \quad (1)$$

H1'

- $l_{it} = \alpha_i^l + \beta_i^l l_{gt} + \varepsilon_{it}^l$
- $s_{it} = \alpha_i^s + \beta_i^s s_{gt} + \varepsilon_{it}^s$
- $c_{it} = \alpha_i^c + \beta_i^c c_{gt} + \varepsilon_{it}^c$
- $$\begin{pmatrix} \varepsilon_{it}^{l} \\ \varepsilon_{it}^{s} \\ \varepsilon_{it}^{c} \end{pmatrix} = \begin{pmatrix} \psi_{1,i} & 0 & 0 \\ 0 & \psi_{2,i} & 0 \\ 0 & 0 & \psi_{3,i} \end{pmatrix} \begin{pmatrix} \varepsilon_{it-1}^{l} \\ \varepsilon_{it-1}^{s} \\ \varepsilon_{it-1}^{c} \end{pmatrix} + \begin{pmatrix} u_{it}^{l} \\ u_{it}^{s} \\ u_{it}^{c} \end{pmatrix} \quad (2)$$

H4'

-as there is little cross-factor dynamic interaction, we assume the matrices of coefficients in (1) and (2) are diagonal

Global model estimation (2)

⇨ We can estimate the model factor by factor

- For each of the three state-space models there would be 25 parameters to estimate
- Maximum likelihood is difficult to implement in multi-country framework because of the large number of parameters to be estimated ⇨ the Bayesian approach using Markov Chain Monte Carlo methods is more suitable
- If Φ= $(\alpha_i, \beta_i, \psi_{1,i}, \sigma_i, \Phi_{11})$, F= global factors(latent) and Z are estimated levels at previous step we want to simulate from a posteriori distribution $P(\Phi, F|Z)$
- Using Gibbs algorithm this would be equivalent with simulating from conditional distributions : $P(\Phi|\mathrm{F}, \mathrm{Z})$ and $P(F|\Phi, \mathrm{Z})$

Global Level - estimation summary

j=1; repeat {

- Step 1: simulate from $P(\Phi|F,Z)$
  - $l_{it} = \alpha_i^l + \beta_i^l l_{gt} + \varepsilon_{it}^l$
  - $\varepsilon_{it}^l = \psi_{1,i}\varepsilon_{it-1}^l + u_{it}^l$ → σ_i^2
  - $l_{gt} = \Phi_{11}\, l_{gt-1} + U_{gt}^l$

  Regression with AR(1) errors

- Step 2: simulate from $P(F|\Phi,Z)$
  - $l_{it} = \alpha_i^l + \beta_i^l l_{gt} + \varepsilon_{it}^l$
  - $\varepsilon_{it}^l = \psi_{1,i}\varepsilon_{it-1}^l + u_{it}^l$
  - $l_{gt} = \Phi_{11} l_{gt-1} + U_{gt}^l$

  Model in "state-space" form

Observation equation: $$\begin{bmatrix} l_{1t}^* \\ \vdots \\ l_{6t}^* \end{bmatrix} = \begin{bmatrix} \alpha_1(1-\varphi_{1,11}) \\ \vdots \\ \alpha_6(1-\varphi_{6,11}) \end{bmatrix} + \begin{bmatrix} \beta_1 & -\beta_1\varphi_{1,11} \\ \vdots & \vdots \\ \beta_6 & -\beta_6\varphi_{6,11} \end{bmatrix} \begin{bmatrix} L_t \\ L_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ \vdots \\ u_{6t} \end{bmatrix}$$

$l_{it}^* = (1-\varphi_{i,11})\alpha_i + \beta_i L_t - \varphi_{i,11}\beta_i L_{t-1} + u_{it}$

Transition equation: $$\begin{bmatrix} L_t \\ L_{t-1} \end{bmatrix} = \begin{bmatrix} \theta_{11} & 0 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} L_{t-1} \\ L_{t-2} \end{bmatrix} + \begin{bmatrix} U_t \\ 0 \end{bmatrix}$$

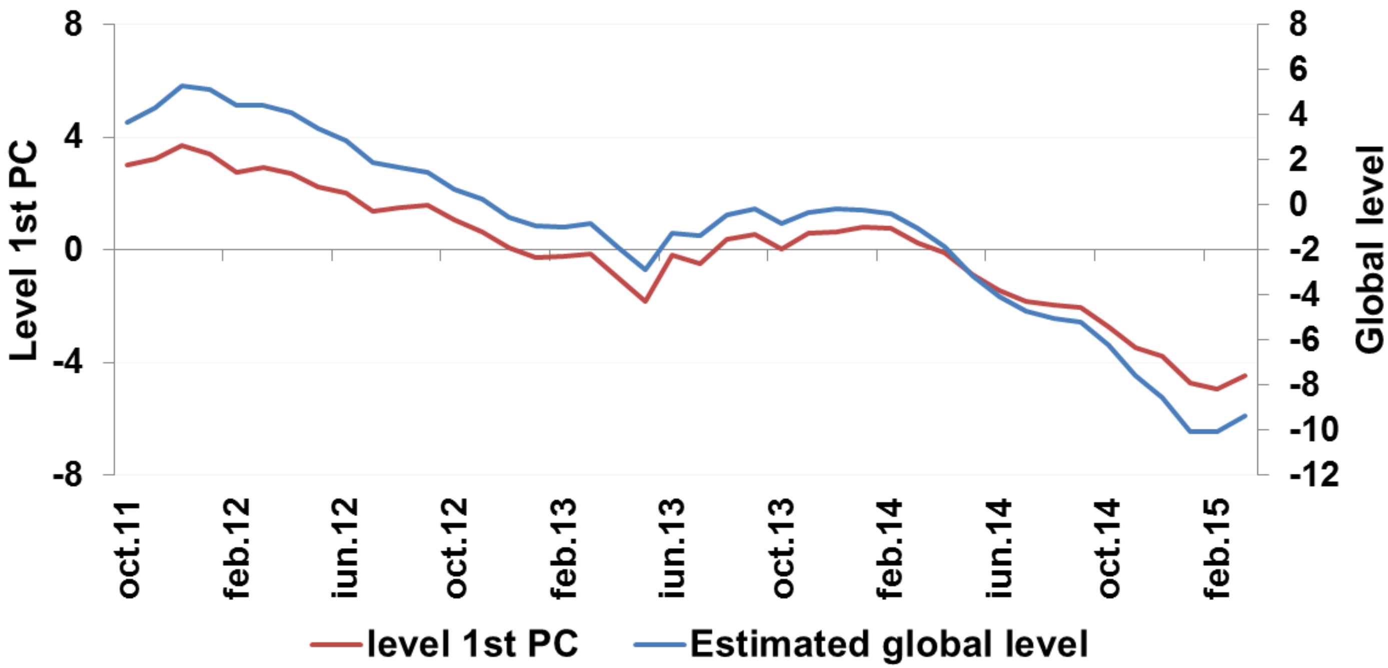
- **Kalman filter**
- **Carter-Kohn algorithm**

if j<=200000 then discard simulation; j++} until j=1000000;

Global model - Results of estimation (1)

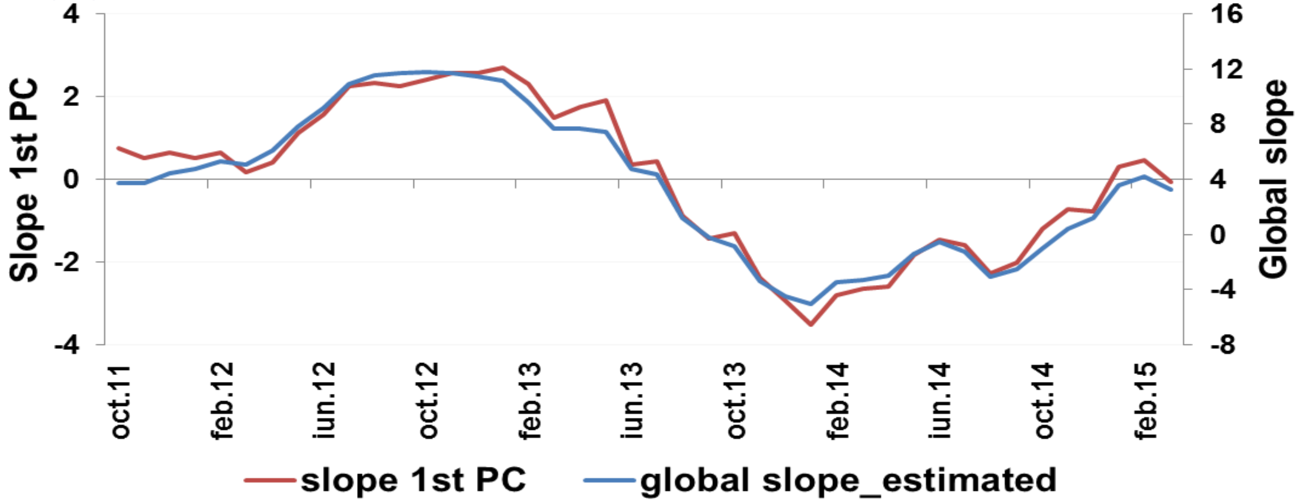
- Even if there are hints that two latent factors could explain the evolution of level factors (for example), in the case of the countries analyzed in this paper the second factor proved to be statistically insignificant ⇨ re-estimate the model to include only a global factor

➢ "global " LEVEL

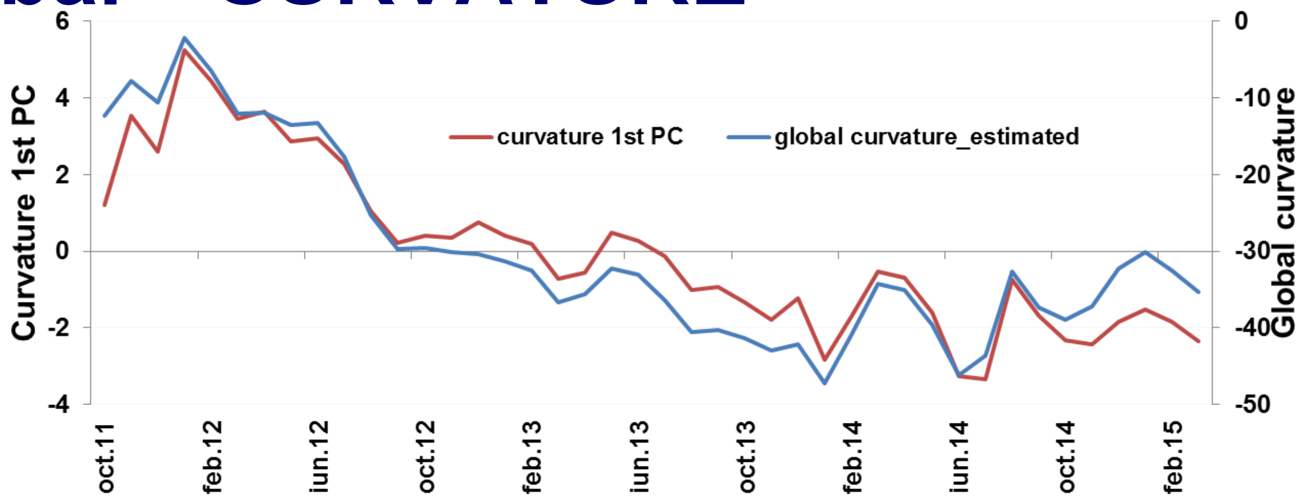


Global model - Results of estimation (2)

- “global ” SLOPE



- “global ” CURVATURE



Global model - Results of estimation (3)

Weight of global factors ->Variance decomposition

- As global and local factors estimated by Kalman filter prove to be quite correlated (ρ=0,35), we will orthogonalise them by regressing the local country factors on the extracted global factors
- $$var(l_{it}) = (\beta_i^l)^2 var(l_{gt}) + var(\varepsilon_{it}^l)$$ H3

Variance decomposition (%)	RO	HU	PL	JP	GE	US
Lglobal	93,5	96,8	97,5	84,9	95,0	98,6
Llocal	6,5	3,2	2,5	15,1	5,0	1,4

Variance decomposition (%)	RO	HU	PL	JP	GE	US
Sglobal	67,5	93,3	64,9	8,6	43,4	90,0
Slocal	32,5	6,7	35,1	91,4	56,7	10,1

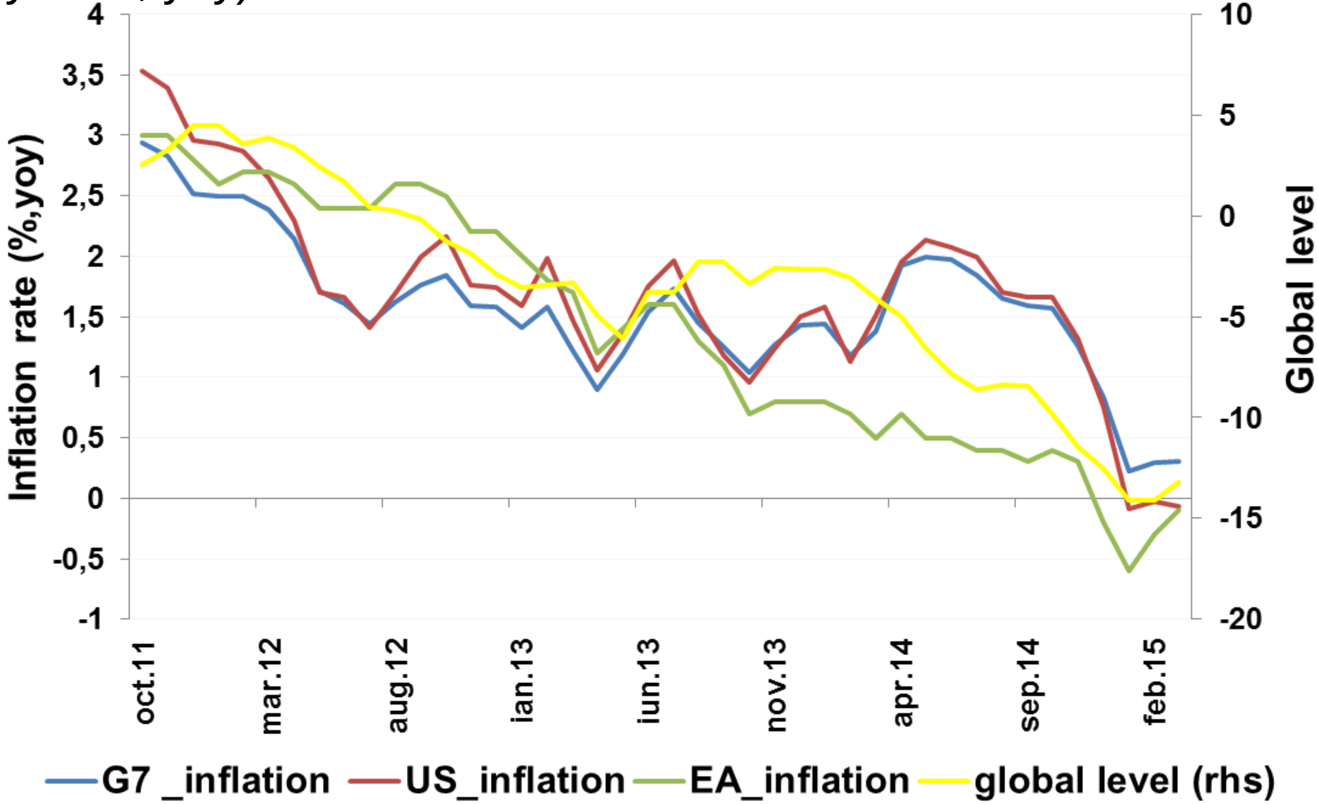
Variance decomposition (%)	RO	HU	PL	JP	GE	US
Cglobal	61,5	87,5	42,5	44,8	39,8	39,7
Clocal	38,5	12,6	57,5	55,2	60,2	60,3

- Also fitting the yield curve using the estimated factors highlight the fact that “global yield” explains a lower proportion (60%) for very short maturities => this segment is correlated with money market conditions

(IV.2)What drives the global factors?
(a) Global Level

➡ strongly correlated (ρ) with EA inflation rate

(monthly data, yoy)



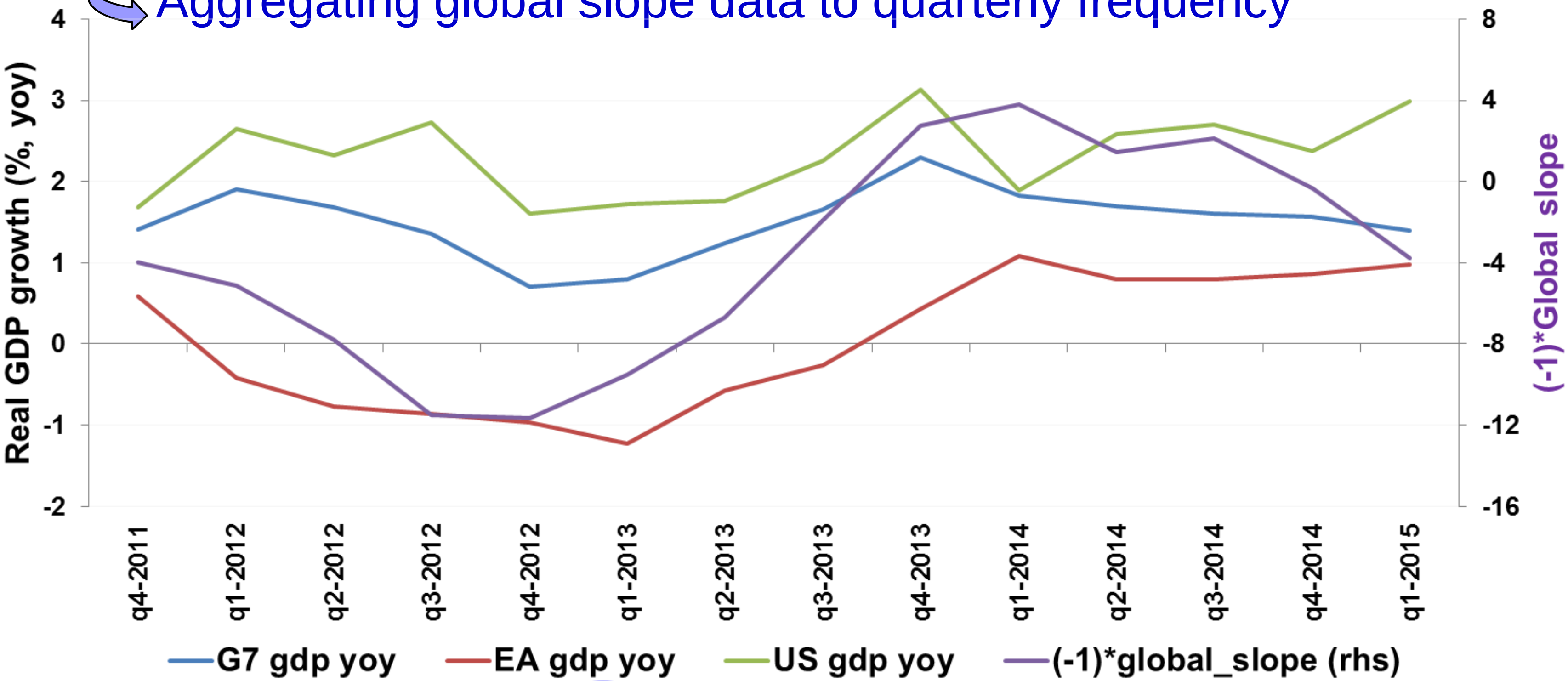
ρ=0.74 ρ=0.74 ρ=0.9

What drives the global factors?

(b) Global Slope

- correlated with real sector activity

Aggregating global slope data to quarterly frequency



ρ=0.7 ρ=0.85 ρ=0.4

high correlation with real GDP growth (yoy) in Eurozone

What drives the global factors?

(c) Global Curvature

- No macroeconomic factors found to have a significant linear correlation with global curvature dynamics
- The question that arises is if there could be a nonlinear connection between macroeconomic indicators and the global curvature?

➡ neural networks might answer to this question

- However, due to a limited set of data

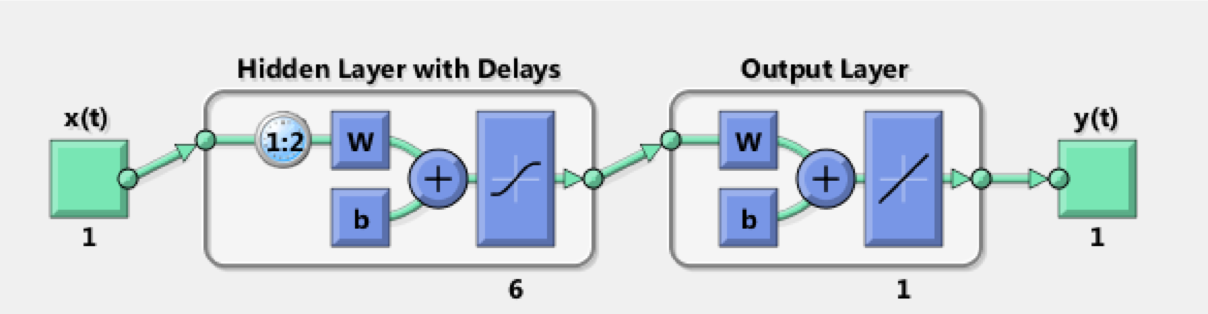
  over-fitting /overlearning problem has a very high likelihood

What drives the global factors?

(c) Global Curvature

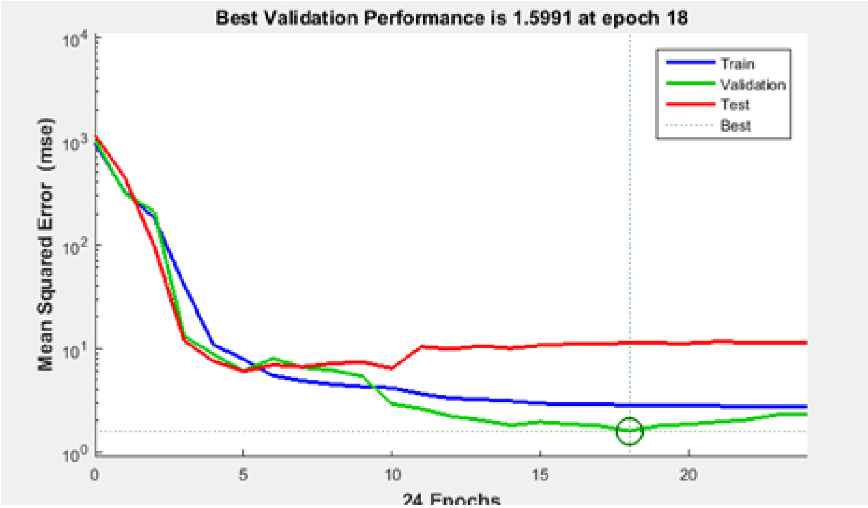
Modeling with Neural networks (1)

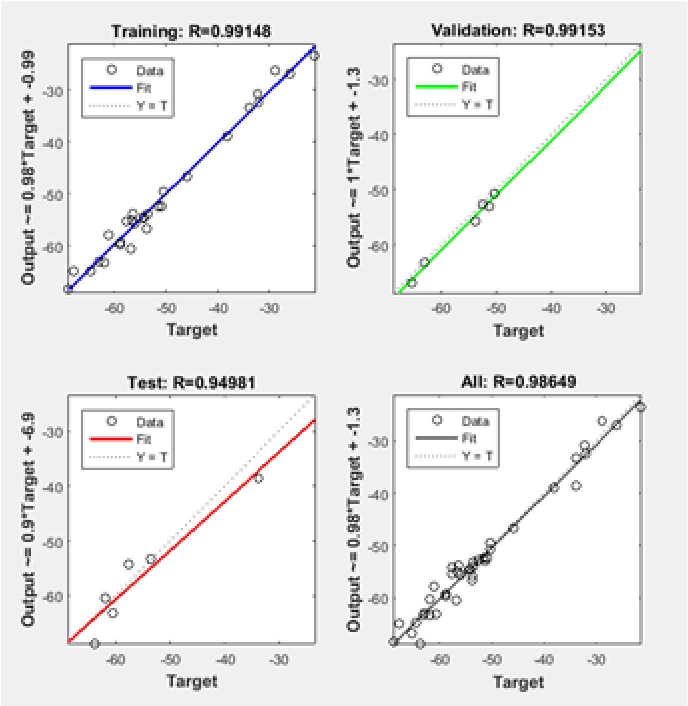
- VIX index, NASDAQ index, S&P index, PMI Eurozone taken as inputs for global curvature



- Network architecture : a hidden layers of 10 units, including 2 delays

What drives the global factors?
(c) Global Curvature
Modeling with Neural networks (2)

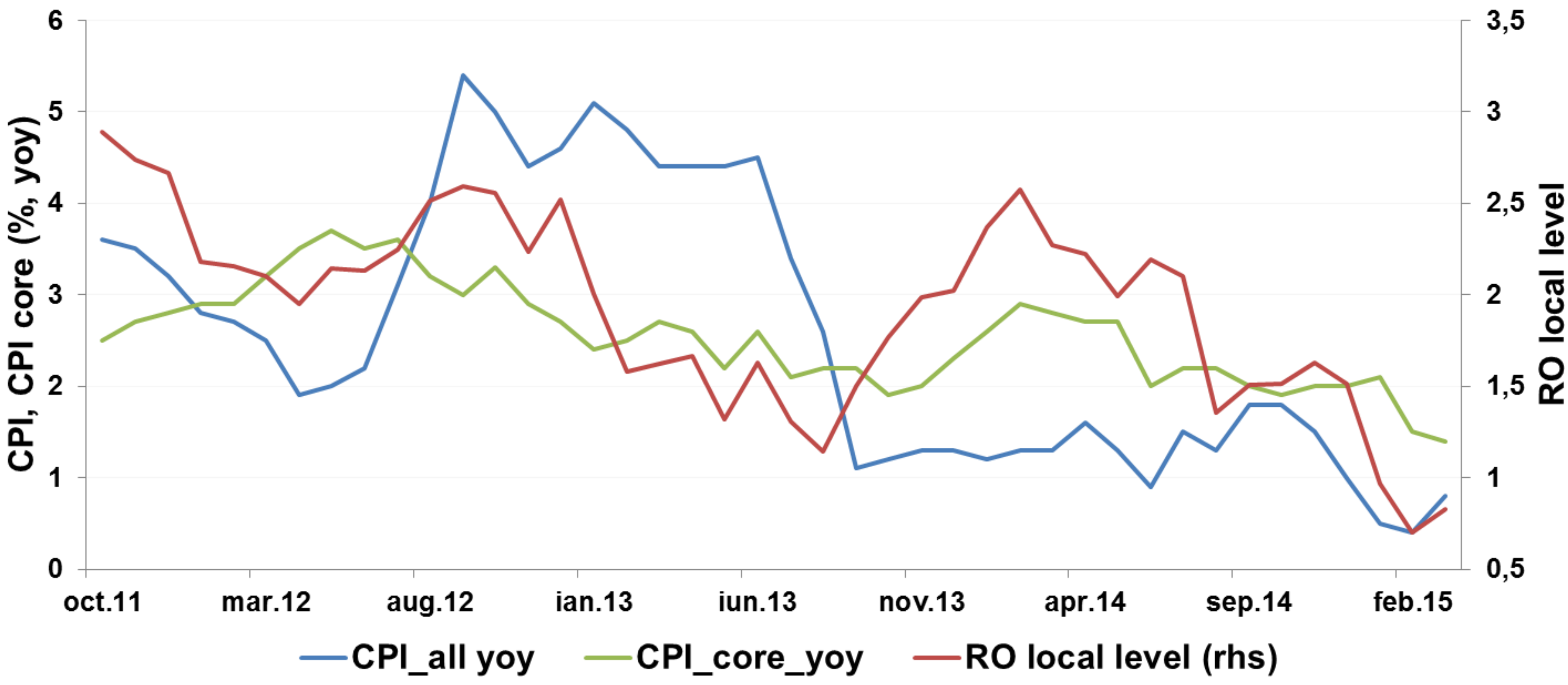




!!! Over-fitting problem is conspicuous

What drives the local factors in RO?
(a) Local Level (1)

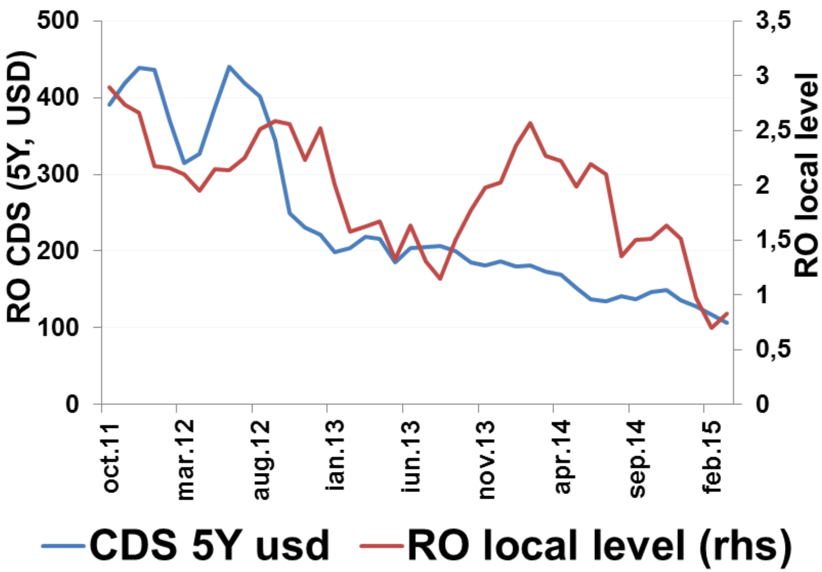
- Correlated with core inflation, yoy (ρ=0.65)



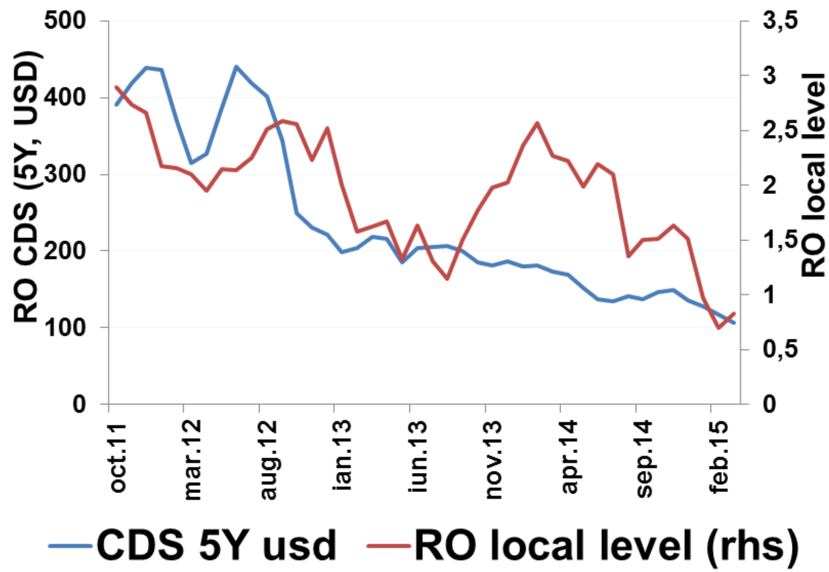
- Correlation with headline inflation rate (yoy) much weaker (0.35)

What drives the local factors in RO?
(a) Local Level (2)

- Also correlated with RO CDS (5 years, USD) and ROBOR 6M-key rate



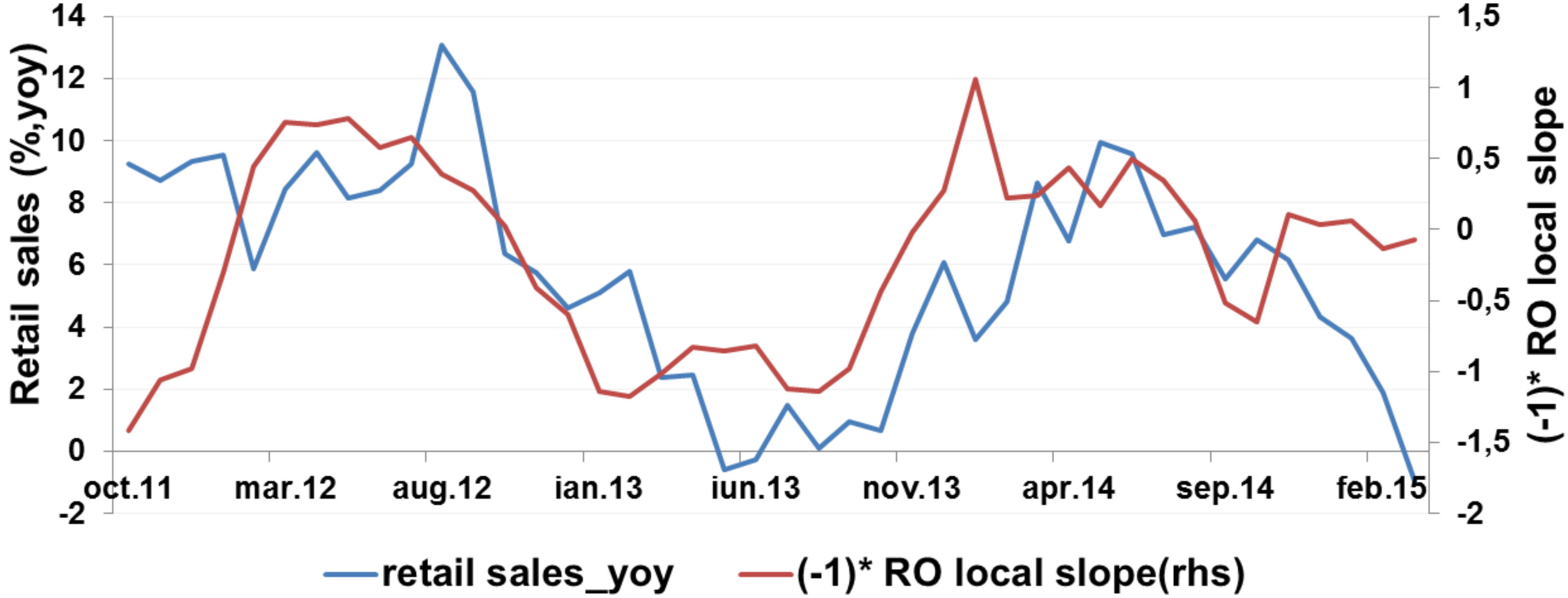
ρ=0.6



ρ=0.5

What drives the local factors in RO?
(b) Local Slope

- Correlation with retail sales (ρ=0.4), proxy for private consumption



What drives the local factors in RO?
(c) Local Curvature

- No significant linear correlation with macroeconomic indicators
- Most likely, there are not macro fundamentals to explain the dynamics of (local) curvature
- Local curvature might be linked with:

  impossible to exactly quantify factors

(e.g investors' sentiment / risk aversion)

Conclusion & further research (1)

- **Global factors** exist and explain more than 90% of yields variation(**<** impact for <=1Y tenors)
- Regional factor -> not significant at monthly frequency
- **Level** <-> **inflation**, **slope** <-> **real sector**
- **Curvature** ->no linkage with macro factors
- Obtained results are very useful for banks (that hold T-bonds portfolios) when conducting **stress- test scenarios**

Conclusion & further research (2)

- Having in mind the macro-fundamentals that drive the Romanian yield curve, next step would be to develop **a daily frequency model which would be useful for T-bond traders**
- Another interesting subject would be to assess to what extent **the divergent monetary policies of US Fed** (when starting to hike interest rate, most likely in Q4 2015) **and ECB** (will continue with QE until 2016) **will affect Romanian T-bond yields dynamics.**

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Thank you for your attention!