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Forecasting the term structure of interest rates in Slovakia

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Motivation

- **Q:** Can we predict yields on Slovak government bonds better than a naive benchmark out-of-sample?
- Why is this an important question?
  1. Assess the role of active government debt management
  2. Slovak bonds are different from other major government bond markets (U.S., U.K.) due to credit and liquidity premiums, and lack of domestic monetary policy tools
- Focus on a small number of forecasting models and longer horizons (e.g. one to three years)

This paper

- ⋆ We split the forecasting exercise into two parts:
  1. Forecasting of German government bond yields
  2. Forecasting of the spread of Slovak to German government bonds
- ⋆ The sum-of-the-parts forecasting model delivers better forecasting performance than the random walk, especially at long horizons
- ⋆ Source of improvement is the negative correlation between spread forecast errors and forecast errors on German government bonds

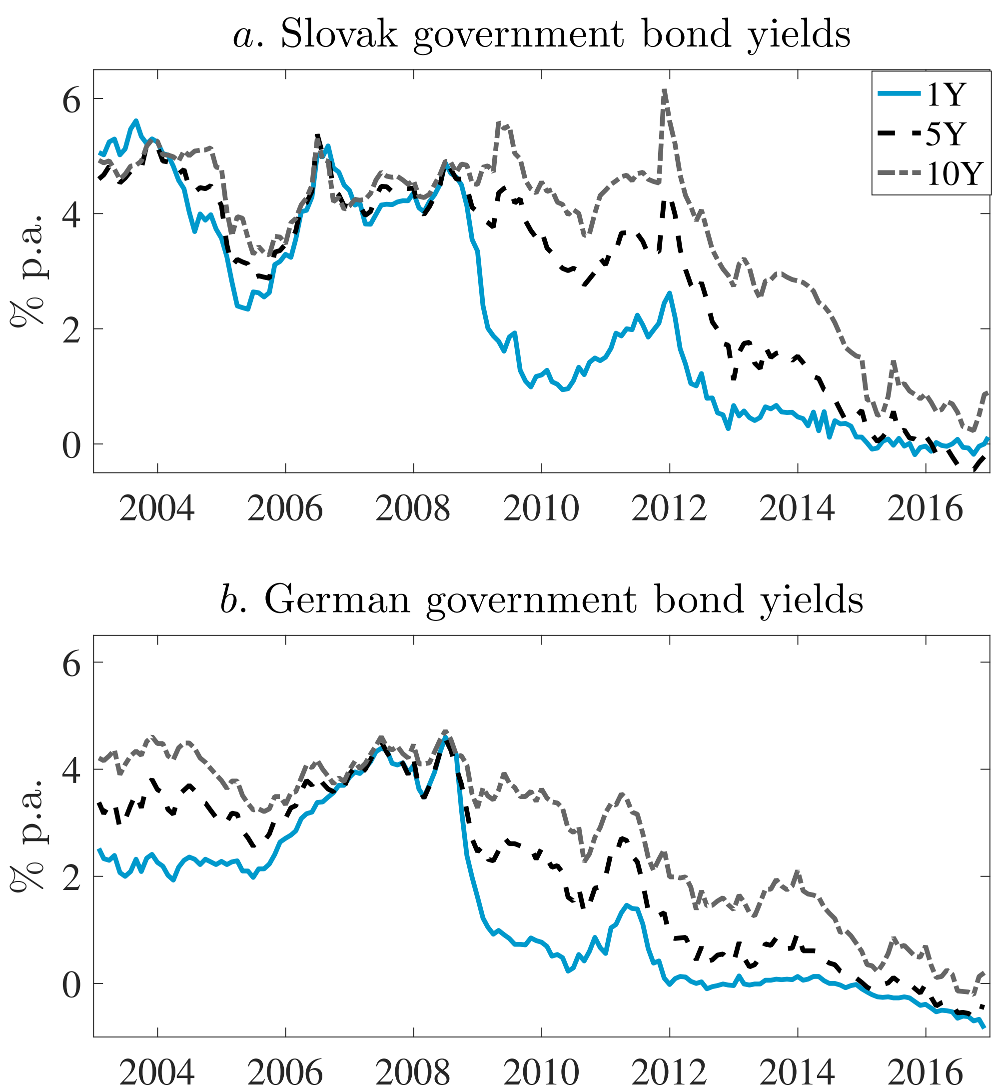
Related literature

Expectations hypothesis. Fama & Bliss (1987), Campbell & Shiller (1991), [regressions on yield curve slope]; Cieslak & Povala (2015) [yield curve decomposition into short rate expectations and term premium];

Statistical models Diebold & Li (2006) [dynamic Nelson-Siegel]; Ang & Piazzesi (2003) [add macro factors to a reduced-form no-arbitrage term structure model]; de Pooter & Ravazzolo & van Dick (2010) [adding macro factors improves forecasting performance in recessions];

Forecasting credit spreads. Amstad & Remolona & Shek (2016), Cornelli (2012) [relative importance of country fundamentals vs. global financial variables, e.g. VIX]; Ejsing & Grothe & Grothe (2015) [credit and liquidity spreads during the eurozone sovereign debt crisis].

Key objects

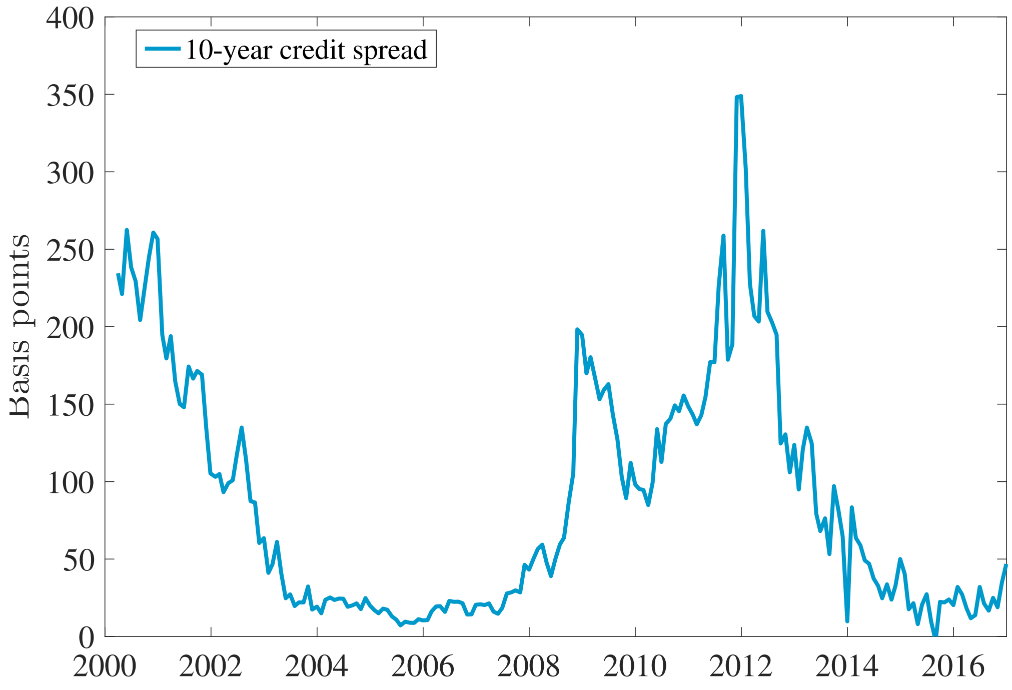


- Sample period January 2003–December 2016

- Estimated zero-coupon yields on Slovak government bonds available on the National Bank of Slovakia website

- Number of regime changes (i) euro adoption, (ii) two financial crises, and (iii) non-conventional monetary policy $\longrightarrow$ complicates forecasting

Key objects (cont'd)



- Credit spread is an important driver of yields ⟶ in the post-2011 period the main source of variation in yields
- Eurozone crisis in 2011-2012 more severe than the Great Recesssion in 2008
- Currently low spreads not unique

*Credit spread before 2009 is obtained from international EUR-denominated bonds.

Framework

- ⋆ Term structure of interest rates: **market expectations about future policy rates + risk premiums**
- ⋆ Key components of the Slovak yield curve:
  1. Expectations about the ECB policy rate
  2. Term premium
  3. Sovereign credit risk premium
  4. Liquidity risk premium
- ⋆ Need a forecasting model that takes the economic decomposition of the yield curve into account

Models

- Decompose the term structure of German yields into inflation π_t, real rate r_t and term premium $tp_t^{(n)}$:

$$y_t^{(n)} = \underbrace{\frac{1}{n}\sum_{i=0}^{n-1} E_t r_{t+i} + \frac{1}{n}\sum_{i=1}^{n} E_t \pi_{t+1}}_{\text{expectation hypothesis term}} + \underbrace{tp_t^{(n)}}_{\text{term premium}} .$$

- Approximate inflation expectations with a discounted moving average of past inflation:

$$\tau_t^{CPI} = (1-\nu)\sum_{i=0}^{t-1} \nu^i \pi_{t-i}$$

- Use one-period yield to extract the real rate (no term premium)
- Term premium is a residual from regressing long-term yield on inflation expectations and the real rate

Models (cont'd)

⋆ Forecasting the three components:

1. Inflation expectations τ_t^{CPI}: assume random walk
2. Real rate: assume AR(1) process
3. Term premium: assume AR(1) process

□ Compare the forecast to the dynamic Nelson-Siegel model widely used in the literature

□ Consider three models for forecasting spreads:

1. Random walk
2. AR(1) model
3. "Extended" model: lagged spread, slope of German curve, VIX

Forecasting setup

- ⋆ Forecasting horizons: one, six, 12, 24, and 36 months
- ⋆ Benchmark forecast: random walk $\hat{y}^{(\tau)}_{t+h|t,rw} = y^{(\tau)}_t$
- ⋆ Metric: ratio of Root Mean Squared Forecast Errors (RMSFE) to random walk RMSFE
- ⋆ Use Diebold-Mariano test to evaluate the significance
- ⋆ Out-of-sample period: January 2009 through December 2016

Dynamic Nelson-Siegel model (DNS)

DNS German yields					
	1-month	6-month	12-month	24-month	36-month
1Y	1.27*	1.41	1.79	2.59	3.19
2Y	1.05	1.23	1.61	2.23	2.47
3Y	1.02	1.25	1.57*	2.03	2.13*
4Y	1.11*	1.30*	1.57*	1.90	1.94*
5Y	1.22*	1.32*	1.54*	1.79*	1.80*
6Y	1.23**	1.31*	1.49*	1.69*	1.69*
7Y	1.16*	1.26*	1.43*	1.59*	1.60*
8Y	1.06*	1.20*	1.35*	1.49*	1.51*
9Y	1.00	1.13*	1.26*	1.40*	1.43*
10Y	1.01	1.06	1.18	1.32	1.36*

* indicates that the difference is statistically significant as indicated by Diebold-Mariano test.

- ⋆ DNS model significantly under-performs the naive benchmark
- ⋆ Deterioration in performance mainly due to zero lower bound

Forecasting the short rate and the risk premium, restr. version

Restr. cycles (German bonds)					
	1-month	6-month	12-month	24-month	36-month
1Y	0.99	0.99	1.11	1.98*	2.37*
2Y	0.99	1.02	1.14	1.66*	1.73*
3Y	1.00	1.03	1.11	1.41	1.37
4Y	1.00	1.03	1.07	1.22	1.15
5Y	1.00	1.02	1.04	1.09	1.01
6Y	1.00	1.01	1.00	1.00	0.91
7Y	1.00	1.00	0.98	0.93	0.83*
8Y	1.00	0.99	0.95	0.87	0.78*
9Y	1.00	0.99	0.94	0.83*	0.73*
10Y	1.00	0.98	0.92	0.79*	0.70*

- ⋆ Modeling components of the yield curve improves forecasting performance
- ⋆ Best model restricts term premium component to be zero, i.e. forecast real rate

Predictability of Slovak government bond yields

	Restr. cycles (German bonds) + RW (spreads)				
	1-month	6-month	12-month	24-month	36-month
1Y	0.66	0.70	0.86	1.18*	1.58*
2Y	0.69	0.74	0.89	1.13*	1.25*
3Y	0.70	0.75	0.87	1.02*	1.07*
4Y	0.71	0.74	0.84	0.92*	0.95
5Y	0.71	0.74	0.81	0.84	0.87
6Y	0.72	0.74	0.79	0.79	0.81
7Y	0.73	0.74	0.77	0.74	0.77*
8Y	0.73	0.74	0.76	0.71	0.73*
9Y	0.74	0.74	0.76	0.69	0.71*
10Y	0.75	0.75	0.75	0.67	0.69*

- ⋆ Any of forecasting model of spreads produces significantly lower forecasting errors than a naive forecast
- ⋆ Interaction of credit spread and German government bond yield forecast errors improves the forecasting performance

Conclusions

- ⋆ Yields on Slovak government bonds are predictable out-of-sample
- ⋆ The key to this result is an economically-motivated decomposition of yields
- ⋆ Source of predictability is the negative correlation of forecast errors

Appendix

Data, Robustness

Data

- Zero-coupon yield curve extracted from Slovak government bonds, monthly frequency, 2003-2016, from the National Bank of Slovakia
- German zero-coupon yield curve, monthly frequency, 1991-2016, from the Bundesbank