

Modeling Colombian yields with a macro-factor affine term structure model

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Research practise 3: final presentation

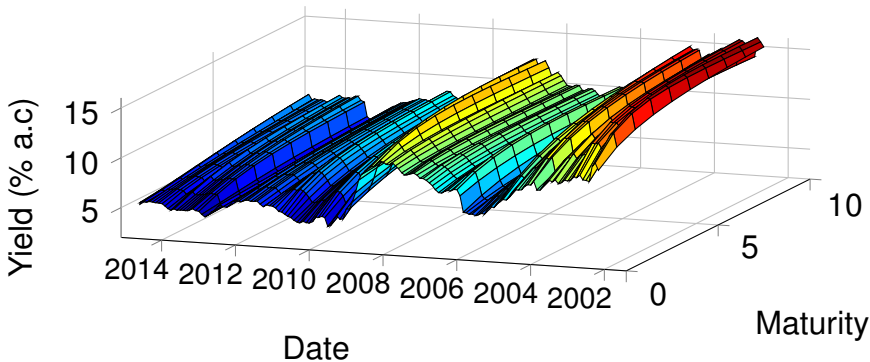
Universidad EAFIT
Medellín, Colombia

June 3rd, 2016



The term structure of interest rates

- Interest rates vary with *time* (t) and *maturity* (τ).
- This relationship is called the term structure (TS).



Importance of the term structure

- It contains expectations about the state of the economy.
- This information can be used for:
 - Pricing assets
 - Informing monetary policy
 - Deciding on consumption or savings

Objectives

To model and forecast the Colombian TS using affine term structure models which include macroeconomic factors.

- Estimate models with different combinations of factors
- Find factors with the best performances
- Analyse the effect of macro-factors on the TS
- Check whether macro-factors improve performance

Affine term structure models

- Introduced by Duffie and Kan [1996]
- Model yields over time and maturity $\gamma_\tau(t)$ as functions of a state vector $X(t)$:

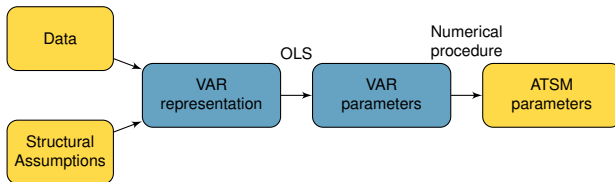
$$\gamma_\tau(t) = A(\tau) + B(\tau)^\top X(t)$$

- $X(t)$ captures changes over **time**
- $A(\tau)$ and $B(\tau)$ change over **maturity**

Estimation

Hamilton and Wu [2012] show that:

- Discrete Gaussian ATSMs can be *mapped* to VAR's.
- You can estimate a VAR and recover the ATSM parameters.



Data - Yields

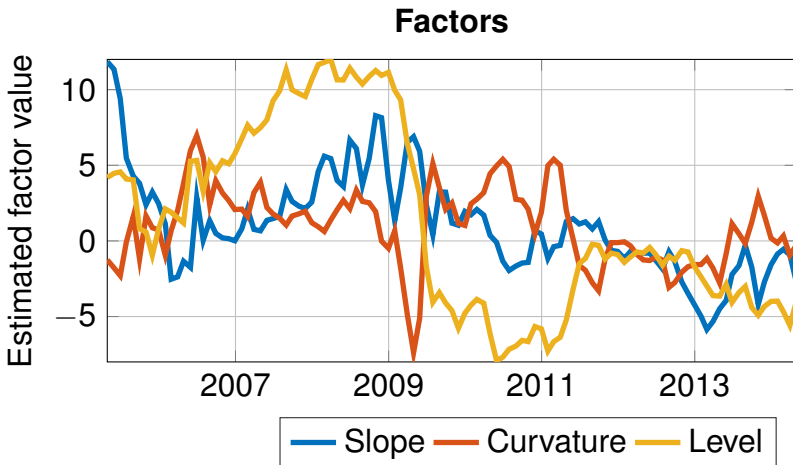
- We use bootstrapped yields from 3 months to 10 years.
- All yields are extracted from Bloomberg.
- We use monthly observations from April 2005 to May 2015.

Data - Macroeconomic factors

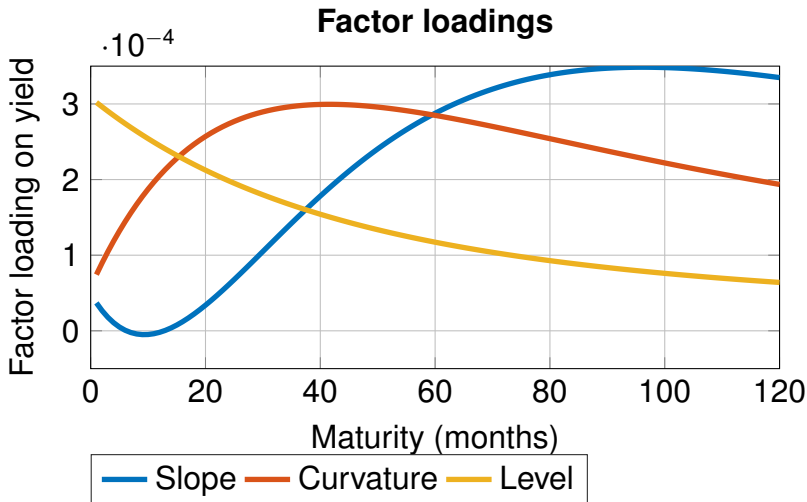
- IMACO
 - IPC
 - USD/COP
 - TIB-IBR
 - CDS 5y
 - VIX
 - Oil price
 - Monetary base
-
- The factors are included by pairs, with three additional latent factors.
 - Data is obtained from Bloomberg and Banco de la República.
 - They are included as standardized monthly variations.

Baseline: latent factor model

We estimate a model with only three latent factors



Latent factor model loadings

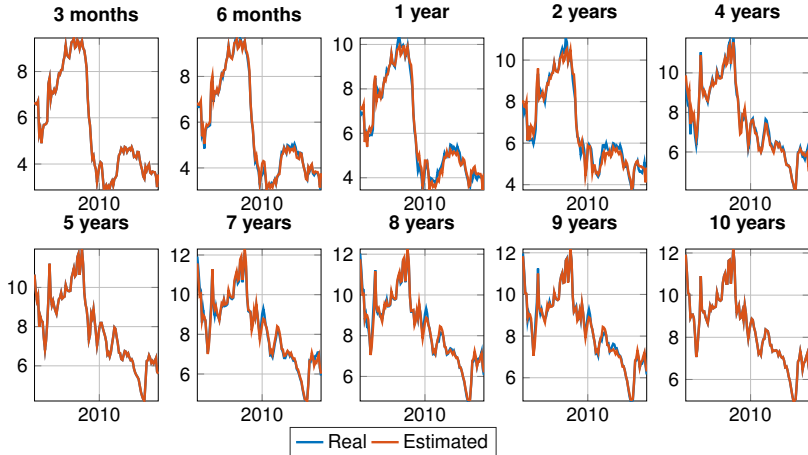


In sample fit: best models

<i>Latent factors model</i>	Yearly RMSEs (basis points)										
	Average	3m*	6m	1y**	2y	4y	5y*	7y	8y	9y	10y*
	21.31	0.00	24.91	52.25	57.62	23.65	0.00	19.06	19.89	15.71	0.00
<i>Macro-Factors models</i>	Average	3m*	6m	1y**	2y	4y**	5y*	7y	8y**	9y	10y*
TIB-IBR - Monetary base	13.16	0.00	11.83	22.46	27.59	20.14	0.00	17.04	17.77	14.82	0.00
Vix - TIB-IBR	13.20	0.00	12.07	22.39	28.05	20.15	0.00	16.94	17.82	14.63	0.00
IMACO - TIB-IBR	13.23	0.00	11.66	21.94	28.28	20.42	0.00	17.15	17.85	14.97	0.00
WTI - TIB-IBR	13.33	0.00	11.86	22.48	27.53	20.61	0.00	17.77	18.29	14.77	0.00
IPC - TIB-IBR	13.68	0.00	12.00	24.90	29.88	20.20	0.00	17.03	18.02	14.72	0.00
WTI - Monetary base	13.84	0.00	12.07	24.00	29.77	21.28	0.00	18.13	18.17	15.03	0.00
IMACO - Monetary base	14.06	0.00	12.71	25.79	30.75	21.47	0.00	17.15	17.86	14.84	0.00
Vix - Monetary base	14.11	0.00	12.17	23.96	30.49	20.68	0.00	19.27	17.75	16.82	0.00
IMACO - Vix	14.12	0.00	12.94	25.75	31.46	21.51	0.00	17.01	17.94	14.61	0.00
IMACO - WTI	14.23	0.00	12.73	25.80	30.92	21.93	0.00	17.78	18.36	14.76	0.00

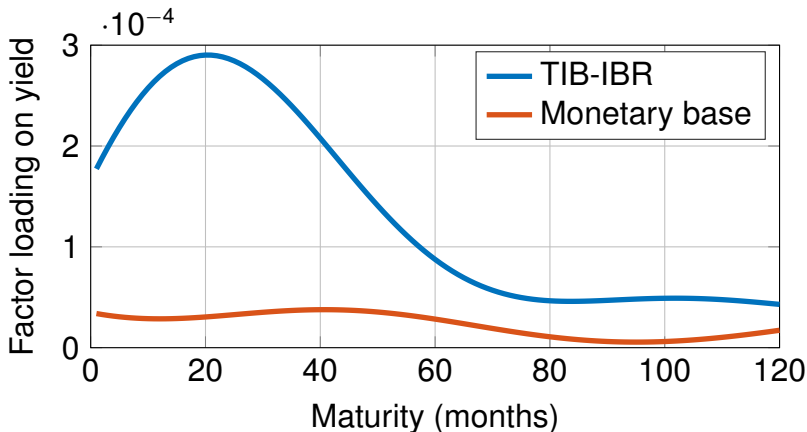
Yields used in estimation are marked with * (observed without errors) and ** (observed with errors). Results are calculated using 108 observations (May 2005 to April 2014).

Best fit: TIB-IBR – Monetary base



Factor loadings: TIB-IBR – Monetary base

Macroeconomic factor loadings

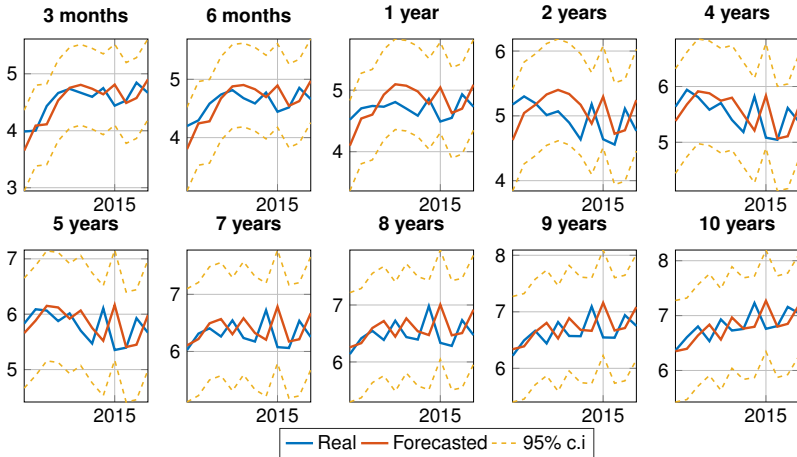


One month forecasts: best models

<i>Latent factors model</i>	Yearly RMSEs (basis points)										
	Average	3m*	6m	1y**	2y	4y	5y*	7y	8y	9y	10y*
	35.90	24.19	33.13	47.93	51.85	38.94	37.56	34.16	33.42	30.27	27.57
<i>Macro factors model</i>	Average	3m*	6m	1y**	2y	4y**	5y*	7y	8y**	9y	10y*
IMACO - Monetary base	31.83	21.57	24.66	30.87	40.25	38.38	37.53	33.88	33.33	30.18	27.69
IMACO - Vix	31.99	21.72	24.45	30.81	42.36	39.27	37.45	33.28	32.86	30.02	27.68
Vix - Monetary base	32.01	21.35	24.08	30.79	42.60	39.07	37.43	34.07	32.73	30.70	27.31
WTI - Monetary base	32.02	21.57	24.69	31.21	40.37	37.46	37.64	35.62	34.01	30.03	27.61
IMACO - WTI	32.06	21.92	25.25	31.20	39.31	37.58	37.62	35.13	34.27	30.72	27.64
USDCOP - Monetary base	32.19	27.32	29.03	26.66	37.01	39.28	37.39	34.60	33.42	29.50	27.70
CDS 5y - Monetary base	32.39	21.24	23.74	30.38	42.88	39.51	37.40	35.28	34.18	32.08	27.18
IMACO - IPC	32.92	22.11	26.07	34.56	44.00	38.85	37.54	34.31	33.64	30.44	27.65
CDS 5y - WTI	32.99	21.32	24.74	30.87	39.18	40.38	37.26	42.92	34.24	31.15	27.78
IPC - WTI	32.99	22.15	26.15	34.60	43.20	38.12	37.62	35.36	34.37	30.73	27.63

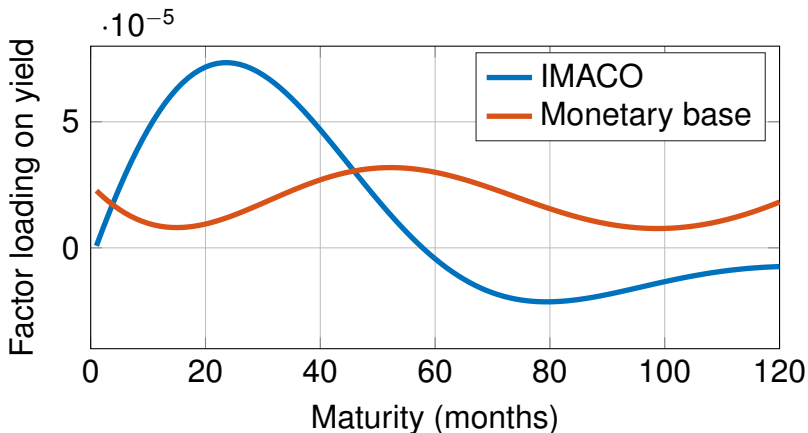
Yields used in estimation are marked with * (observed without errors) and ** (observed with errors). Results are calculated using 12 observations (May 2014 to April 2015).

Best forecasts: IMACO – Monetary base



Factor loadings: IMACO – Monetary base

Macroeconomic factor loadings



Conclusions

- Macroeconomic factors improve in-sample fit and out-sample forecasts in the short end of the curve.
- The inter-bank rate is effective for in-sample modelling but not for forecasting.
- Economic activity has a flattening effect and is good for forecasting.
- Short yields from as reactions to economic conditions while long yields can mostly be explained by short yields.

Future work

- Conduct robustness tests with a bigger dataset
- Extend our study to other Latin American countries
- Publish our work

References

- Darrell Duffie and Rui Kan. A yield-factor model of interest rates. *Mathematical Finance*, 6(4): 379–406, 1996.
- James D Hamilton and Jing Cynthia Wu. Identification and estimation of gaussian affine term structure models. *Journal of Econometrics*, 168(2):315–331, 2012.

Thanks for your attention!