DEUTSCHE BUNDESBANK EUROSYSTEM

Banks' Net Interest Margin and Changes in the Term Structure

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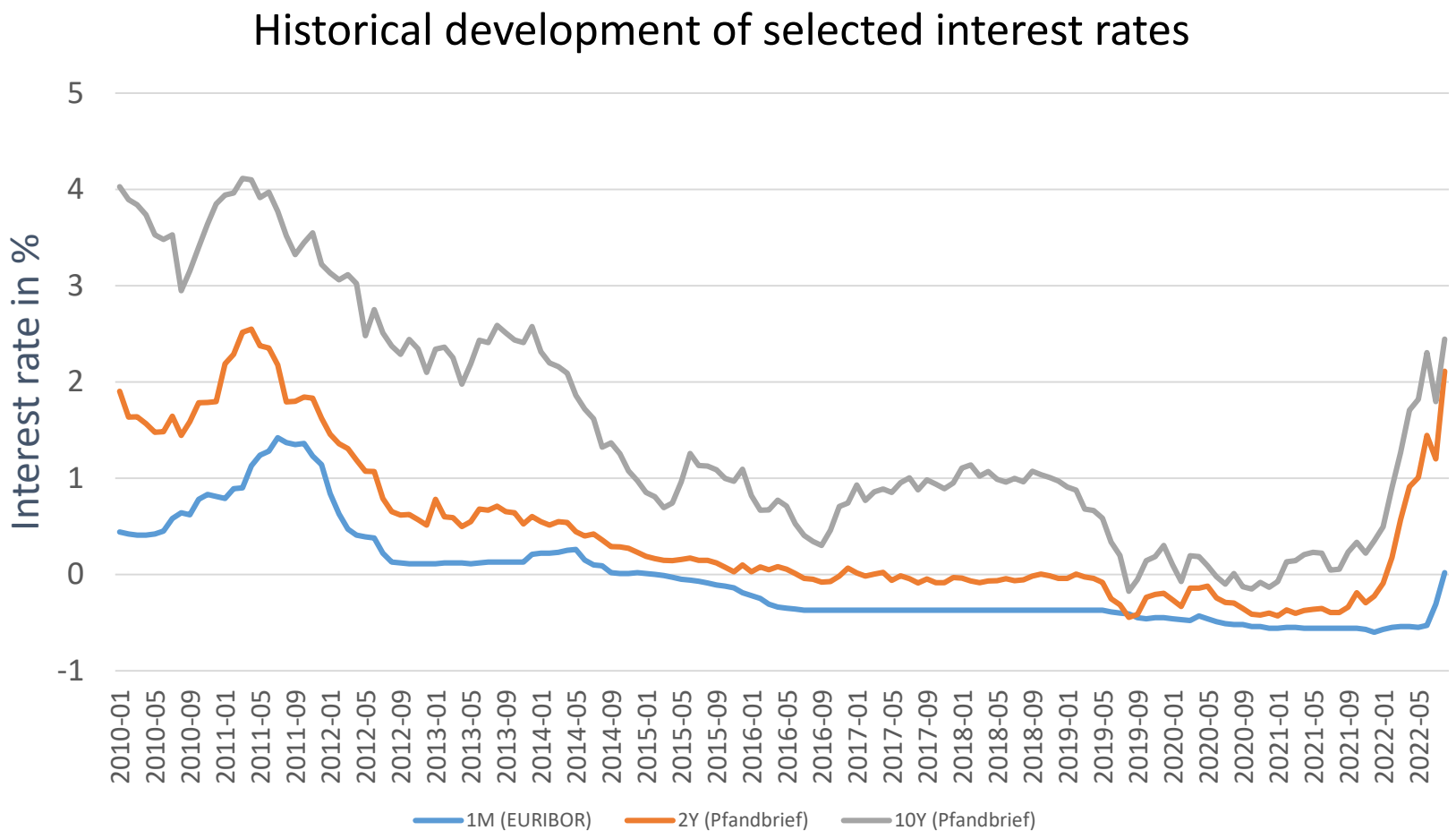
Agenda

- Motivation
- Part A: Modelling of the Term Structure
- Part B: Modelling of Banks’ NIM
- Conclusion

Motivation


Historical development of selected interest rates
Interest rate in %
5
4
3
2
1
0
-1
2010-01
2010-05
2010-09
2011-01
2011-05
2011-09
2012-01
2012-05
2012-09
2013-01
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2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
2021-09
2022-01
2022-05
1M (EURIBOR)
2Y (Pfandbrief)
10Y (Pfandbrief)

Motivation

Topics:

A

A) Modelling of changes in the term structure

- Necessary number of parameters to adequately describe the term structure

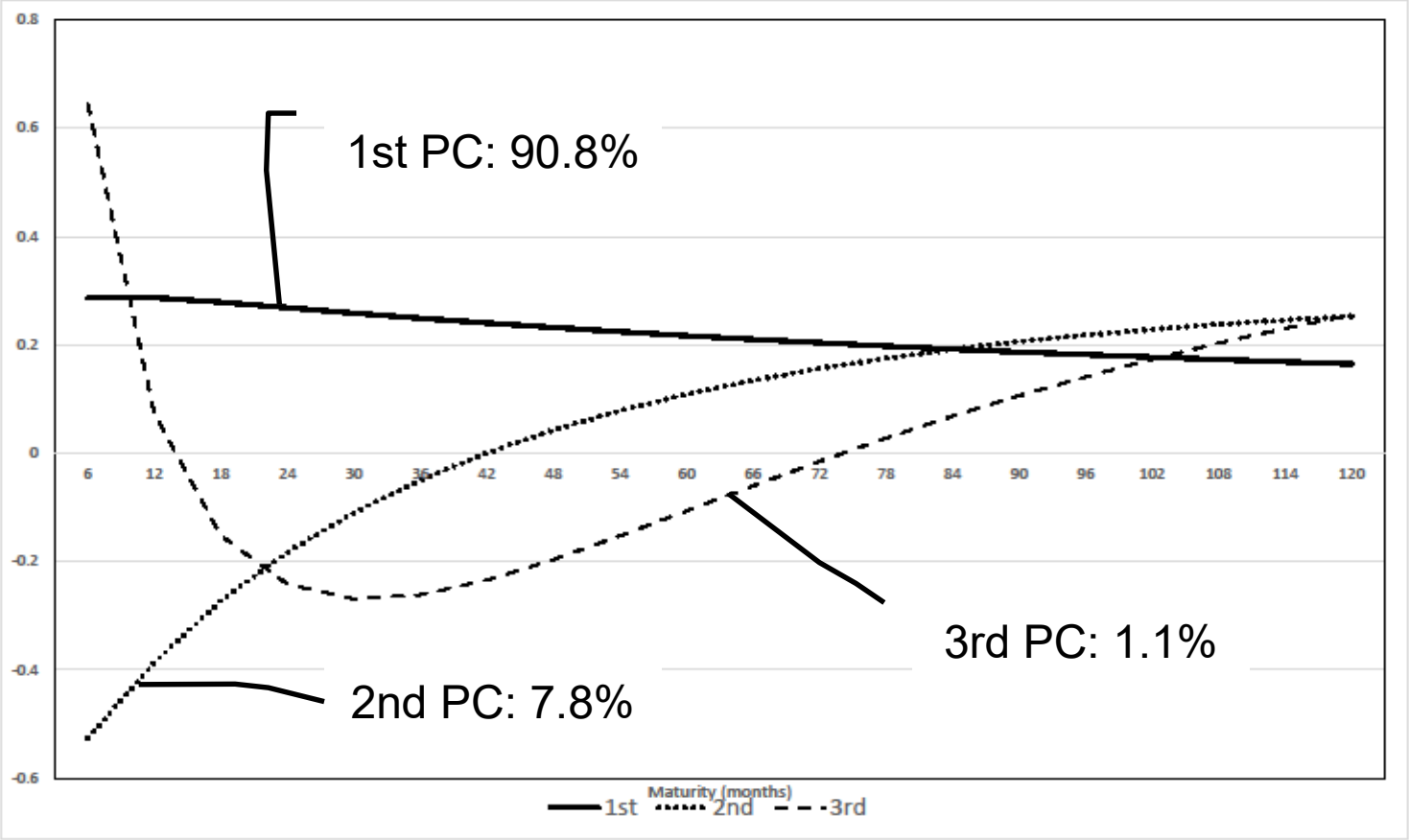
B

B) Parsimonious model of banks‘ interest business (net interest margin):
Model should be able to reproduce empirical features, for instance

- Term transformation,
- Contribution to the net interest income due to level and steepness of the term structure,
- Risks related to changes in the term structure

PCA of yearly Interest Rate changes

A



German government bonds (6M-10Y), data from 1975 until 2021, 1 year changes

Data: Term Structure

A

Underlying data: Yields of German government bonds (Svensson method)

- Maturities: 6, 12, …, 120 months
- Period: Jan. 1975 – Dec. 2021 (monthly data)

Summary statistics:

Interest rates	**Model parameters**	**Mean**	**1st Perc.**	**99th Perc.**
Level	Short-term level (in bp)	375	-99	1165
	Steepness (in bp per year)	14	-91	78
Change (1 year)	Short-term level (in bp)	-22	-390	392
	Steepness (in bp per year)	0	-33	31

Model/Results: Term Structure

A

We analyze three models:

- Parallel Shift: $\Delta r_t = \beta_{0,t}$
- Two Factors: $\Delta r_t = \beta_{0,t} + \beta_{1,t} m$
- Three Factors: $\Delta r_t = \beta_{0,t} + \beta_{1,t} f_1(m) + \beta_{2,t} f_2(m)$

Coefficient of determination for different term structure models:

Model	Change horizon		
	1 month	3 months	12 months
Parallel Shift	81.47%	86.73%	88.14%
Two Factors	90.61%	95.49%	97.47%
Three Factors	97.13%	97.80%	98.35%

Akaike Information Criterion:
Two Factors better than Three Factors for longer change horizon (greater or equal 1 year)

Empirical Model: Banks‘ Interest Business I

B

Model assumptions:

i) Asset side:

- Loans with maturity M_A, granted in a revolving manner; share: ϕ_A
- Cash; share: $1 - \phi_A$

ii) Liability side:

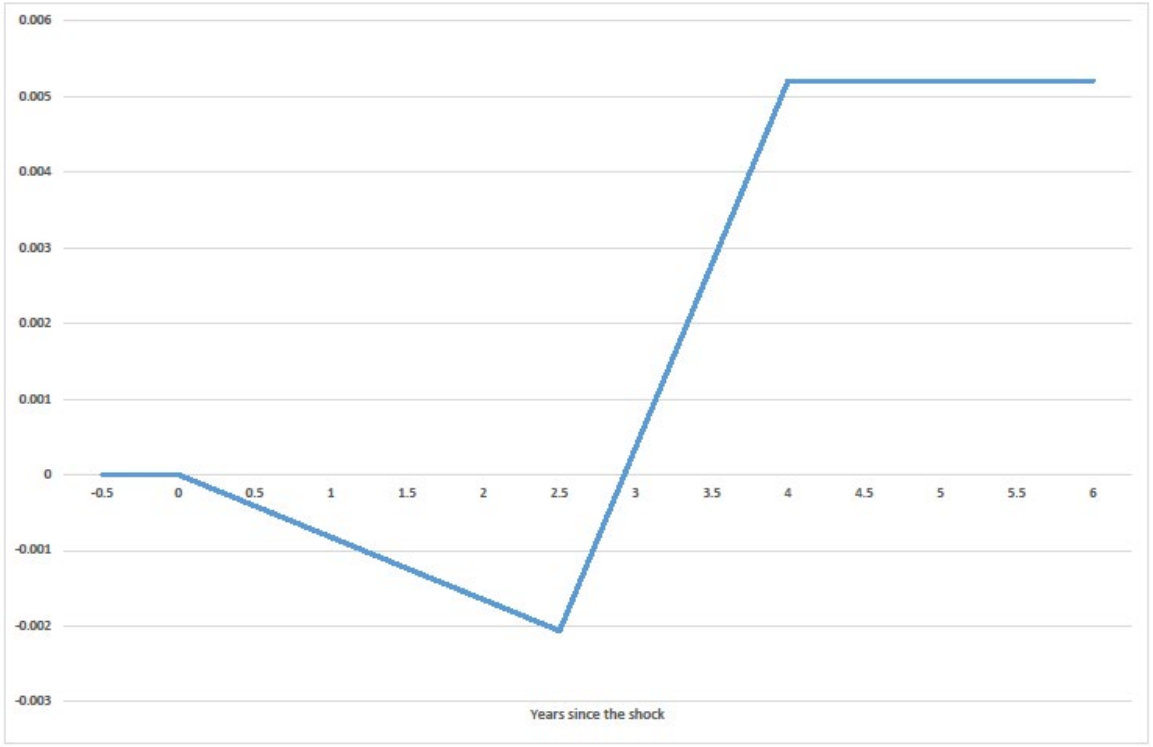
- Issued bonds with maturity M_L(in a revolving manner); share: ϕ_L
- Non-remunerated deposits; share: $1 - \phi_L$

iii) Additional assumptions:

- Two-Factor-Model for the term structure (level + slope) (see part A)
- Low interest level
- No defaults
- Static balance sheet
- Pass-through on loans/bonds: 100 %

Empirical Model: Banks‘ Interest Business II

B



Example for illustration:

Consider a bank with $M_A = 4, M_L = 2.5,\ \phi_A = 0.95, \phi_L = 0.7$

Assume a change in term structure: positive shift + increase in steepness

→ Change in C.NIM is initially negative, turns positive after 3 years and stabilizes after 4 years

Empirical Model: Banks‘ Interest Business III

B

Examples of stylized types of banks in this model:

No.	Bank charactistic				Term structure	C.NIM	
	$\phi_A - \phi_L$	$\frac{\phi_A}{M_A} - \frac{\phi_L}{M_L}$	$M_A \cdot \phi_A - M_L \cdot \phi_L$	Example		Short-term	Long-term
1	1	n.a.	0	Simplified central bank	pos. shift	n.a.	pos.
2	0	neg.	(pos.)	Commercial bank	pos. shift	neg.	0
					pos. shift + inc. in steep.	neg.	pos.
					neg. shift + inc. in steep.	pos.	pos.
3	pos.	neg.	(pos.)	Traditional bank	pos. shift	neg.	pos.
					Pos. shift + inc. in steep.	?	pos.
					Neg. shift + inc. in steep.	pos.	?

Empirical Model: Banks‘ Interest Business IV

B

Model parsimonious, but can reproduce empirical features:

Changing effect of an interest rate shock on the NIM (net interest margin)

$$C.NIM^{t} = NIM_{t,IR\ Scenario} - NIM_{t,const\ IR}$$

Can be linked to

i) Short term: $C.NIM^{Short\ term} \propto (\frac{\phi_A}{M_A} - \frac{\phi_L}{M_L})$

ii) Long term: $C.NIM^{Long\ term} \propto \phi_A - \phi_L$

iv) Market power:

$$\phi_L \ll 1 \Rightarrow \text{ Market power}$$

Model equation: Deviation (long term) of the net interest margin (C.NIM)

$$C.NIM = level\_change \cdot (\phi_A - \phi_L) + slope\_change \cdot (\phi_A \cdot M_A - \phi_L \cdot M_L)$$

→ Will be checked on empirical data

Data: Banks‘ Interest Business I

B

Underlying data: Quantitative survey among German small and medium-sized banks (LIRES / German: “NZU-Umfrage” or “LSI-Stresstest”)

- Different interest rate scenarios (overnight shock)
- Forecast of P&L-components for the next five years
- Carried out every two years (in this paper: waves 2017 and 2019; wave 2021 postponed to 2022)

Overview over scenarios:

Scenario	Description	Level	Slope
Baseline	Term structure remains constant	0	0
Turn	Term structure flattens	+125	-11
Pos. shift	All interest rates increase by 200 bp	+200	0
Neg. shift	All interest rates decrease by 100 bp	-100	0

→ Data on C.NIM for different interest rate scenarios

Data: Banks‘ Interest Business II

B

Summary statistics for different years (1 and 5), and different waves of the LIRES (2017 and 2019) for the positive shift scenario:

Variable (year)	Scenario	Wave	Mean (in bp)	StDev. (in bp)	Share >0 (in %)	Nobs
C.NIM(1)	Pos. shift	2017	-10.10	27.93	25.65	1419
C.NIM(1)	Pos. shift	2019	-9.93	26.17	27.26	1383
C.NIM(5)	Pos. shift	2017	29.08	29.63	90.77	1419
C.NIM(5)	Pos. shift	2019	29.32	31.98	88.36	1383

Data: Banks‘ Interest Business III

B

Summary statistics for the relevant variables for the times of different waves of the LIRES (2017 and 2019):

Variable	Year	Unit	Mean	StandardDev.	1st perc.	Median	99th perc.	Nobs
$\phi_A \cdot M_A - \phi_L \cdot M_L$	2016	-% per TA	1.96	1.03	-0.54	1.99	4.64	1419
$\phi_A \cdot M_A - \phi_L \cdot M_L$	2018	-% per TA	1.93	1.07	-0.77	1.96	4.76	1383
$\phi_A - \phi_L$	2016	% per TA	25.05	11.85	-11.86	26.43	49.13	1419
$\phi_A - \phi_L$	2018	% per TA	26.07	11.74	-12.67	27.71	48.71	1383

Results: Banks‘ Interest Business I

B

$$C.NIM = level\_change \cdot (\phi_A - \phi_L) + slope\_change \cdot (\phi_A \cdot M_A - \phi_L \cdot M_L)$$

Regression coefficients for different scenarios and waves:

Scenario	Wave	$\phi_A - \phi_L$	$\phi_A \cdot M_A - \phi_L \cdot M_L$	R^2	Nobs
Turn	2017	17.40***	-8.46***	13.05	1351
Pos. shift	2017	85.53***	-7.12***	17.34	1350
Neg. shift	2017	-22.84***	-1.85***	2.72	1346
Turn	2019	23.65***	-10.95***	17.67	1318
Pos. shift	2019	112.27***	-8.99***	22.72	1317
Neg. shift	2019	-36.91***	-1.10*	4.56	1312

Results: Banks‘ Interest Business II

B

- Coefficient in front of $\phi_A - \phi_L$ always with the right sign, but smaller than theory predicts => possible explanation: attenuation bias

- Coefficient in front of $\phi_A \cdot M_A - \phi_L \cdot M_L$ significant in the „Turn“ scenarios, but also in the „Shift“ scenarios => possible explanation: new equilibrium not yet reached at the forecast horizon

- $\phi_A \cdot M_A - \phi_L \cdot M_L$ can be (nearly) directly taken from banks‘ regular reporting. Components of $\phi_A - \phi_L$ determined from banks‘ reporting; results robust if determined differently.

Conclusion

Term structure:

A

- Model with level and slope: Good fit
- Taking account of the slope adds value (level alone explains about 90% of the variation)

Banks‘ interest business:

B

- Parsimonious model, but able to reproduce empirical features
- Mostly in line with the results of a quantitative survey (LIRES)
- Change of NIM due to interest rate shock - relevant for stress tests

Appendix

Results: Term Structure II

A

- Our results close to the theoretical values (shown in the paper)

- Model for the term structure chosen: two factors (level + steepness), change horizon: one year
  - Close to complete explanation (97.47%)
  - Still analytically tractable (shown in the paper)
  - Third factor would add little (at a change horizon of one year)
  - One year: relevant horizon for small and medium-sized banks

Information criterion

A

Table 8: Information criterion AIC

Model for the Term Structure	Change horizon			
	1 month	3 months	12 months	24 months
Parallel shift (see Eq. (29))	0.5%	0.7%	0.7%	0.4%
Two factors (see Eq.(30))	39.7%	44.5%	49.6%	57.8%
Three factors (see Eq. (31))	59.8%	54.8%	49.6%	41.8%

This table shows how often the respective factor model for the term structure is the best one according to the information criterion AIC (the results for the information criterion BIC are available on request).

Empirical Model: Banks‘ Interest Business V

B

Overview of results on the effects of term transformation:

Study on term transformation	Share of NIM	Earnings [in bp per assets]	Sample
Memmel (2011)	12.3%	26.3	German banks, 2005-2009
Busch/Memmel (2016)	33.6%	73.3	German banks, 2012
Chaudron et al. (2022)	8.3%	11.4	Dutch banks, 2008Q1-2020Q4
Study in this paper	10.1%	18.7	German banks, 2014-2020