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OESTERREICHISCHE NATIONALBANK
EUROSYSTEM

From low to negative rates: an asymmetric dilemma

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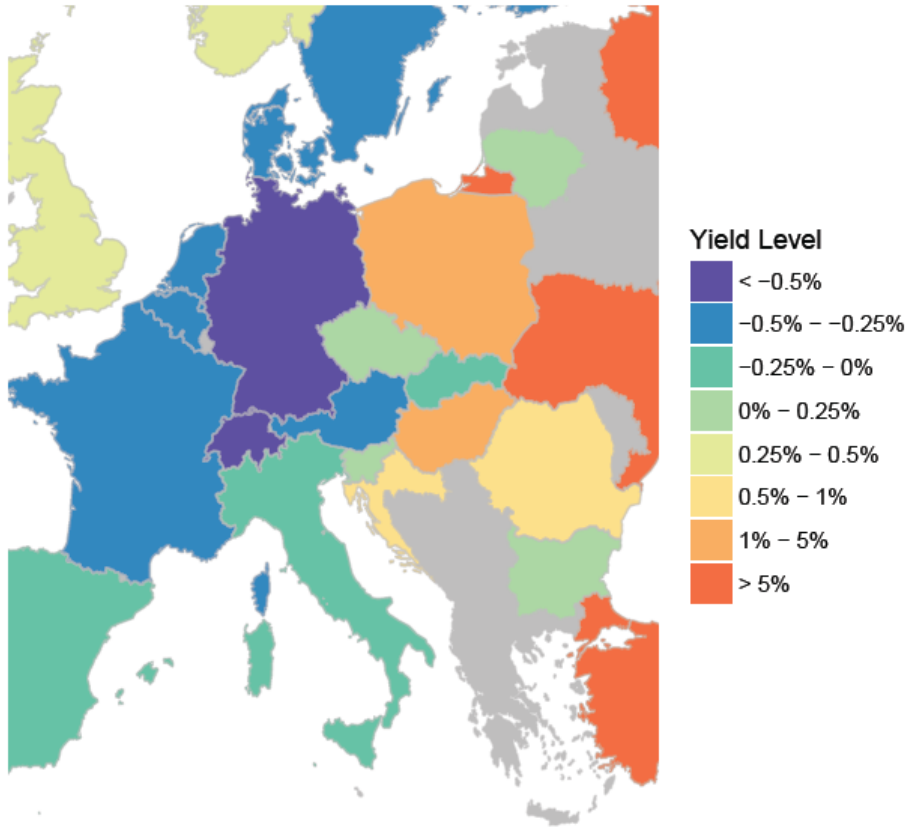
The opinions expressed by the authors of this study do not necessarily reflect the official viewpoints of the Eurosystem or the Oesterreichische Nationalbank.

Motivation



Source: OeNB.

Sovereign bond yields (1y) in Europe April 2016.

Motivation

- Central research question:

  What is the impact of the interest rate level on banks' interest rate margins?

  Does the relation also hold if rates move to negative territory?

- Why is this of interest?

  → Global rates are at record low and negative yield on sovereigns bonds spreads.

  → Net interest income is the central source of income for banks.

  → Financial stability is crucially affected as profits are always first line of defense against losses.

  → All banks are affected by this relationship at the same time, ie. systemic scope.

Motivation – Co-Movement of Interest Income and Expenses

- Negative Interest Rates and Co-Movement?
  - We focus on the situation in Austria where the zero floor on deposits rests on a supreme court decision. ➔ Breakdown of long run relationship (expressed by the Net interest income or net interest margin (NIM)): Loan Rates move, Deposit rates are floored.
  - Even in countries where negative deposit rates are legally possible (e.g. Switzerland), Swiss banks knew that imposing negative interest rates on ordinary retail customers would risk a disastrous bank run.
  - Economics theory would suggest that if banks charged negative deposit rates rational customers would look for alternatives to save their cash. It might go into a safe. Most customers already pay deposit fees (independent of the deposit size), hence additional costs in terms of negative deposit rates would make safes an even better option. In the worst case scenario negative deposit rates could trigger a (gradual) bank run.
- Consequences for modelling interest income?
  - Classical approach: panel estimation/time series analysis of NIM. However, in the past a negative interest rate environment was not observed.
  - Our approach (considered as a first step) is (1) to break down the NIM in its components, (2) model this components with the best fitting ARIMA model, (3) add the results and

A Panel Model Approach

Fixed effects panel model

$$y_{i,t} = \alpha_i + X_{i,t}\beta + Z_t\gamma + e_{i,t}, \quad i = 1, \cdots, N, \quad t = 1, \cdots, T,$$

$y_{i,t}$ Net interest margin of bank i at time t (NIM)

$X_{i,t}$ bank-specific control variables,

Z_t global variables, including the interest rate level (3 month Euribor)

Data:

Quarterly observations from 1998 to 2016 for each bank operating in Austria,

T=73, N=946, unbalanced, ~48,000 observations

Results: Standard NIM model

Key results (other control variables omitted):

	Coefficients	(Standard Errors)
Euribor	0.164	(0.005)***
$Euribor^2$	–0.003	(0.001)**
Term spread	0.115	(0.003)***
Interaction: Euribor x RBD	0.017	(0.003)***
RBD	0.098	(0.010)***

1. Linear effect:

A drop of 100 basis points (bps) in the reference rate is associated with a drop of 16bps in NIM.

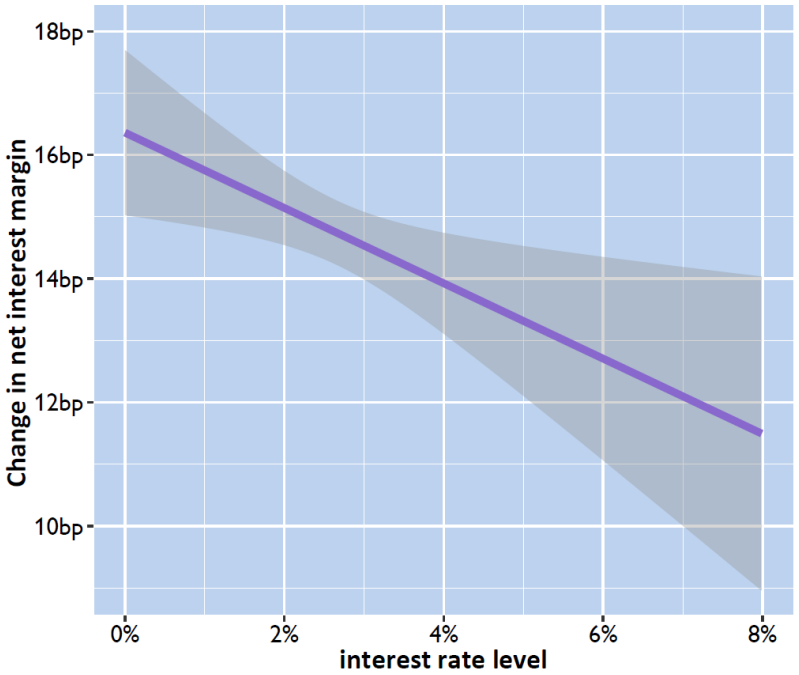
2. Non-linear effect:

The above mentioned effect is smaller the larger the reference rate is.

3. Term spread: As banks lend long and refinance short, a lower term spread also lowers NIM.

4. RBD (regional bank dummy) shows that regional banks have a higher

Results



Estimated effect of a change
NIM (y-axis)

confidence levels
rs.

Similar results found by Busch and Memmel (2015), Borio et al. (2015), Claessens et al. (2016) and Genay and Podjasek (2014).

Does the relation also hold if rates move to negative territory?

The negative interest rate environment

Does the relation also hold if rates move to negative territory?

We are skeptical of this.

A simple credit pricing model:

Refinancing rate, e.g. EURIBOR	+	Add-on to cover operational expenses, risk costs and cost of equity	=	Rate charged on loans e.g. EURIBOR + 80bps

However, as deposits cannot go below zero, the true refinancing rate becomes detached from the reference rate once the reference rates move to negative territory.

E.g. EURIBOR moves form -0.2 to -0.5 but rate on deposits cannot follow: they stick at 0.

→ If market rates drop the asset side potentially follows suit while the bank still pays for its refinancing.

→ A negative interest rate environment causes the reference rate to be unrepresentative of the true refinancing rate of a bank.

→ Banks experience a systemic mispricing of assets, not because the risk has been incorrectly assessed, but because the refinancing rate does not reflect the true conditions the bank faces.

The ARIMA model approach

We estimate a separate ARIMA model for each P&L item of each bank.

$$(1-B^m)^{D_{i,j}}\,(1-B)^{d_{i,j}}(y_{t,i,j}-\mu_{i,j}) = \gamma'_{i,j}\,(Euribor_t\;Exp_{t,i,j}) + \gamma''_{i,j}\,(Euribor_{t-1}\;Exp_{t,i,j}) + \eta_{t,i,j}$$

$$\Phi(B^m)\,\phi(B)\,\eta_{t,i,j} = \Theta(B^m)\,\theta(B)\,\epsilon_{t,i,j}.$$

In words: the approach models each P&L item of each bank as a function of its past and the interest rate level times the exposure to that item.

Once the model is fitted, we can generate forecasts plugin in hypothetical reference rates.

- Importantly, we floor the forecasts at zero for the P&L item „interest expenses on deposits“.
- The order of the polynomials is chosen by following Hyndman and Khandakar (2008)
- We use the model for forecasting **eight quarters** into the future while holding the exposure constant (“constant balance sheet assumption”) but varying the reference rates
- Scenario(–1) assumes a drop in the reference rate to –1%,

The ARIMA model approach: What do we forecast?

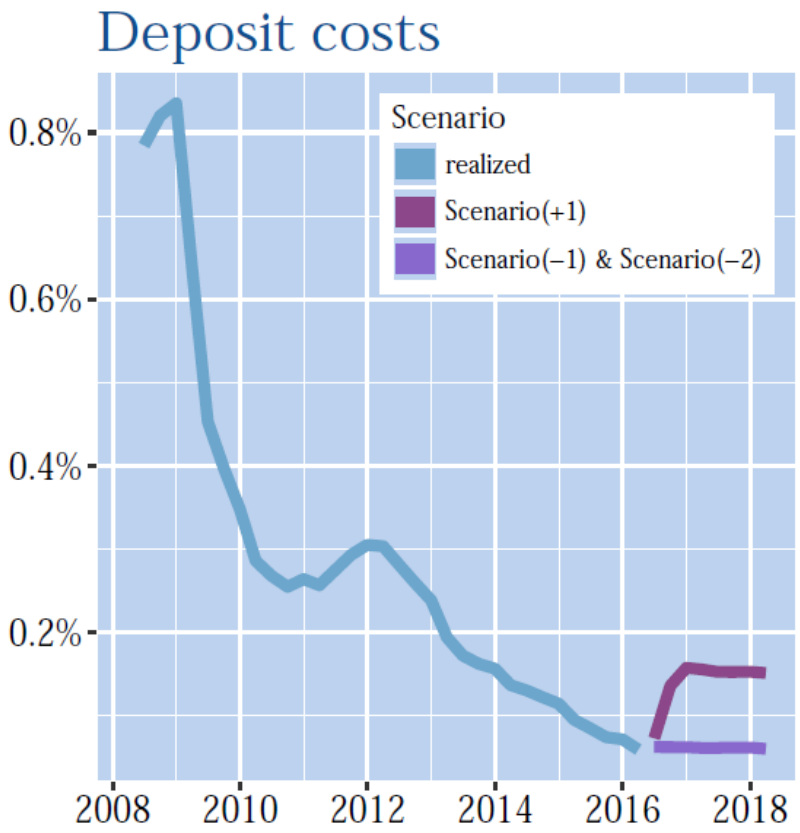
Table 3: Summary of the P&L structure used in the ARIMA approach.

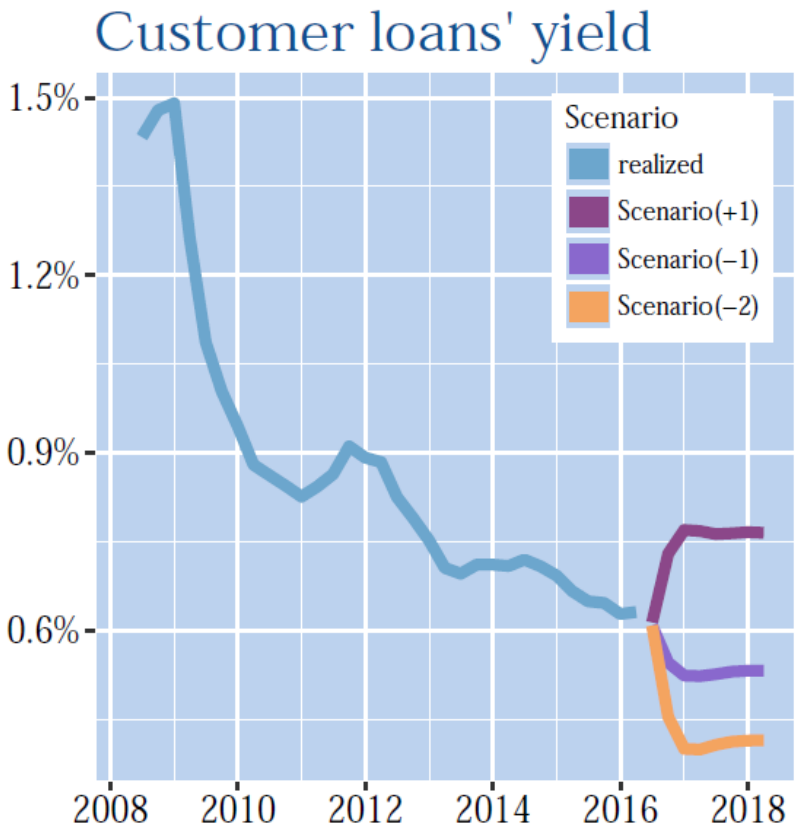
P&L item	Separate ARIMA model	Interest sensitive	Floored at zero
1. Interest income			
Interest income from interbank loans	yes	yes	
Interest income from non-bank cust. loans	yes	yes	
Interest income from bonds	yes	yes	
Interest income from other	yes	yes	
2. Interest expenses			
Interest expenses from interbank loans	yes	yes	
Interest expenses from non-bank cust. deposits	yes	yes	yes
Interest expenses from bonds issued	yes	yes	
Interest expenses from other	yes	yes	
3. Net interest income (1+2)			
4. Income from equity positions	yes	yes	
5. Fee and commission income	yes		
6. Fee and commission expenses	yes		
7. Net income from other financial transactions	yes		
8. Other income	yes		
9. Administrative expenses	yes		
10. Other expenses	yes		
11. Earnings before risk costs and taxes (3+4+5+6+7+8+9+10)			

The ARIMA model approach - Estimation

- We use the auto.arima function in the R package **forecast** (see Hyndman and Khandakar, 2008)
- The specific parameters are the following:
  1. p: Lags of the non-seasonal AR polynomial.
  2. d: Order of first-differencing. Chosen automatically by the KPSS test.
  3. q: Lags of the non-seasonal MA polynomial.
  4. P: Lags of the seasonal AR polynomial.
  5. D: Order of seasonal-differencing. If missing, will choose a value
  6. Q: Lags of the seasonal MA polynomial.
- Before we look at the results, there are some important factors about the Austrian bank market:
  - 70% of all loans are floating rates, so out simple credit price model can be applied (see slide 9)
    ➔ High sensitivity to short term loan rate but low autocorrelation.
  - In some P&L items there is strong seasonality.

Results





As intended, deposits costs cannot go below zero and do not drop further, while yields on assets follow the reference rates.

→ Substantial impact to banks' NIM.

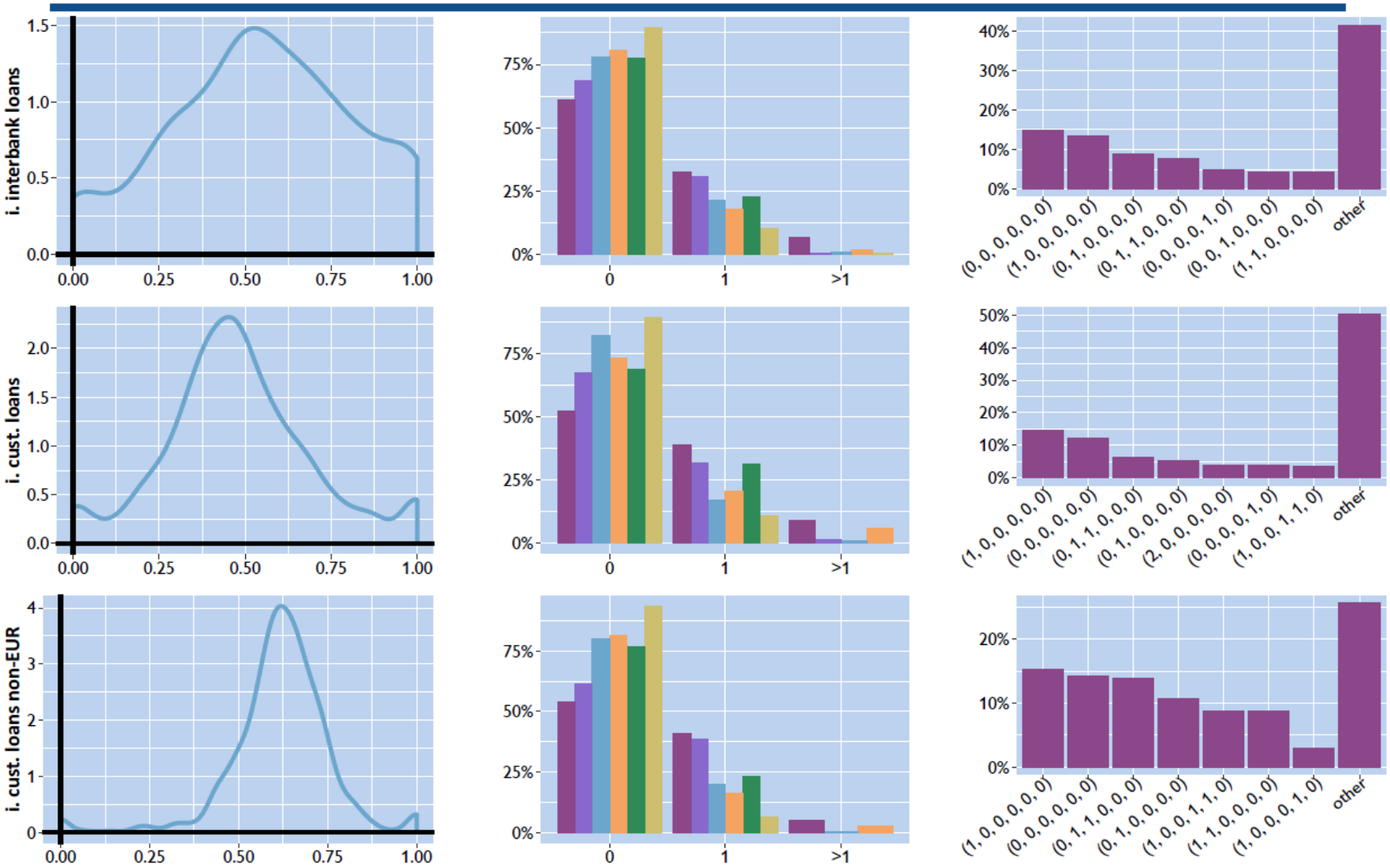
Results NIM of sectors in bps across scenarios

Sector	realized	Scen.(+1)	Scen.(-1)	Scen.(-2)	Δ(+1)	Δ(-1)	Δ(-2)
Volksbanks	176.9	194.3	133.5	86.3	17.4	-43.4	-90.6
Automotive banks	244.9	247.1	212.3	173.9	2.3	-32.6	-71.0
Raiffeisen banks	170.8	189.6	141.0	104.8	18.8	-29.8	-66.0
Sparkassen	161.8	184.8	137.4	99.2	23.0	-24.4	-62.5
Medium universal banks	153.5	151.8	122.2	95.4	-1.7	-31.4	-58.2
Specialized institutions	110.1	103.7	76.5	53.5	-6.4	-33.6	-56.6
Branches	64.5	65.2	26.1	10.7	0.8	-38.4	-53.7
Private stock banks	59.6	110.3	43.4	27.5	50.8	-16.1	-32.0
Building societies and housing finance banks	58.8	54.7	44.5	38.8	-4.1	-14.4	-20.0
Large banks	79.2	113.1	73.4	67.6	33.9	-5.8	-11.6
All banks	165.3	184.5	135.5	98.6	19.2	-29.8	-66.7

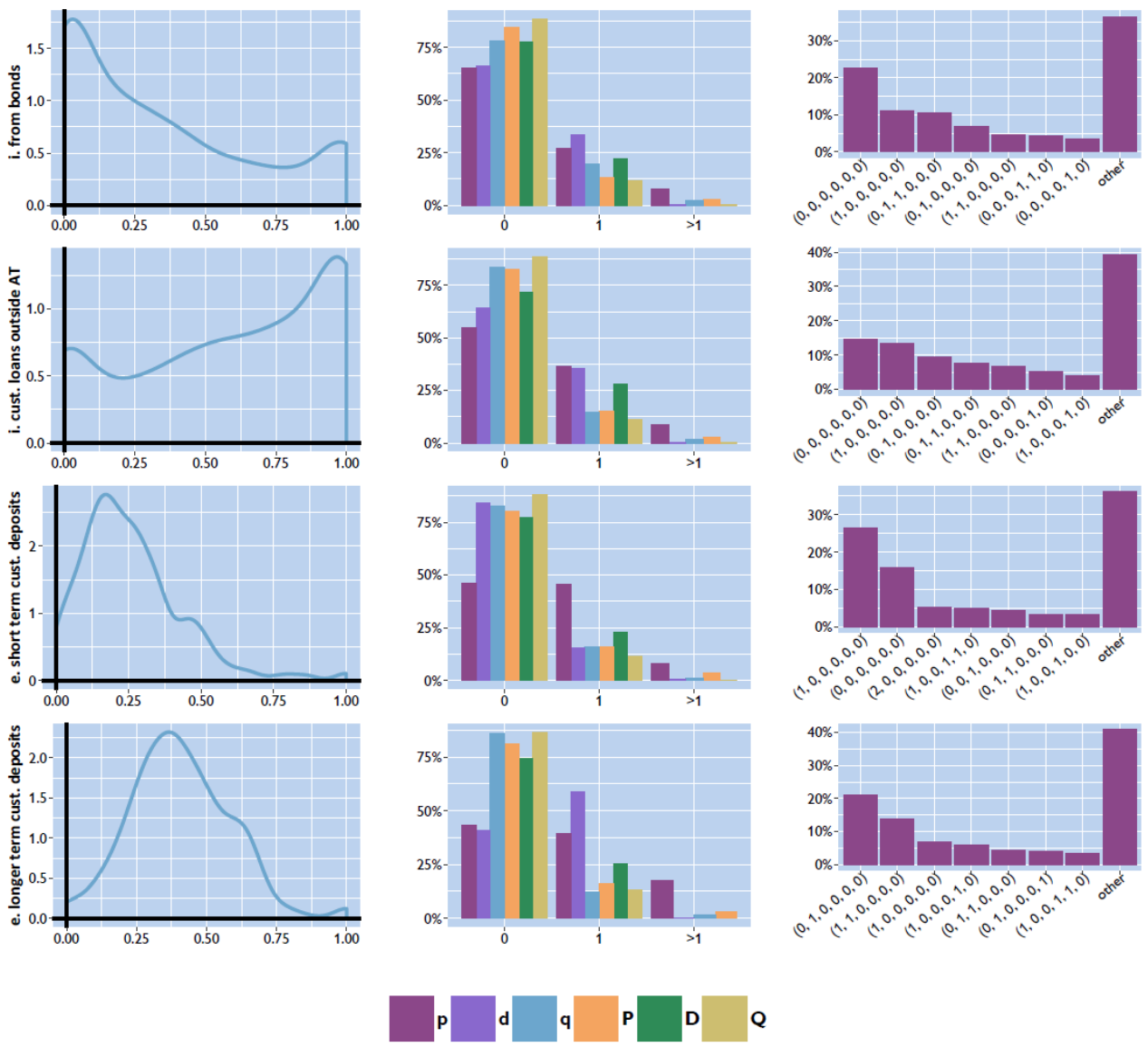
Under a reference rate of –1% impact ranges from (a median of) –43.4 basis points for Volksbank credit cooperatives to –5.8 basis points for large banks.ARIMA approach agrees with panel model approach for positive reference rates but predicts a stronger decline in NIM when reference rates move to negative territory.

→ Zero floor on deposits is important to consider!

Results – Overview of selected ARIMA Models (1)



Results – Overview of selected ARIMA Models (2)



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Conclusions

- We analyze the effects of low and negative rates on the profitability of Austrian banks
- We found that banks' NIM is linked to the interest rate environment. The link is strong when reference rates are close to zero (at around 16bps per 100bps) but due to nonlinearities is subdued in normal times.
- We are skeptical of extrapolating these findings to negative rates
- → We employ an ARIMA estimation approach that is best known for its superior forecasting performance.
- → In the ARIMA approach it is easy to take the asymmetric dilemma into account that deposit rates are legally floored at zero while loan rates directly track reference rates
- Using such an approach, we found that negative rates can create a substantial risk to the profitability of banks
- Smaller deposit-financed banks, in particular, are hit hardest. This finding is important as these banks often do not participate in empirical studies due to a shortage of data (small banks)
- Reference rates that venture close to –2% erode the profits of a large part of the banking system.

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A Dynamic Panel Model Approach

Fixed effects panel model

$$y_{i,t} = \alpha_i + \phi y_{i,t-1} + X_{i,t}\beta + Z_t\gamma + e_{i,t}, \quad i = 1, \cdots, N, \quad t = 1, \cdots, T,$$

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Z_t global variables, including the interest rate level (3 month Euribor)

Data:

Quarterly observations from 1998 to 2016 for each bank operating in Austria,

T=73, N=946, unbalanced, ~48,000 observations

Results

Key results (other control variables omitted):

	Coefficients	(Standard Errors)
NIM(-1)	0.384***	(0.042)
Euribor	0.105***	(0.020)
$Euribor^2$	-0.000	(0.002)
Term spread	0.090***	(0.008)
Interaction: Euribor x RBD	-0.017**	(0.007)
RBD	0.171***	(0.031)

1. Linear effect:

A drop of 100 basis points (bps) in the reference rate is associated with a drop of 11bps in NIM.

2. Non-linear effect:

The above mentioned effect is smaller than in the fixed effects model.

3. Term spread: As banks lend long and refinance short, a lower term spread also lowers NIM.

4. RBD (regional bank dummy) shows that regional banks have a higher