

Are low interest rates firing back? Interest rate risk in the banking book and bank lending in a rising interest rate environment

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Focus of the paper

- | **Descriptively show banks' build up of interest rate risk**
 - Low for long interest rate environment altered the duration of bank balance sheets
 - Unexpected pace of the MP tightening lead to materialization of interest rate risk

- | **Look at the implications for bank lending supply in a rising interest rate environment**
 - Lending contraction
 - Lending portfolio reshuffling

- | **Identify borrowers affected by the contraction/reshuffling in lending supply**
 - MSMEs
 - No substitution effects

Overview of the literature

- | **Bank maturity transformation and monetary policy** (Drechsler et al., 2017, Drechsler et al., 2021, Greenwald et al., 2023)
- | **Bank lending channel** (e.g., Kashyap and Stein, 1995, Jiménez et al., 2012, Gambacorta and Shin, 2018)
- | **Interest rate risk, monetary policy and lending**
 - Beutler et al., 2020: banks with a larger *duration gap* reduce lending more when interest rates rise to remain in compliance with capital requirements (Swiss bank-level data, 2001Q2-2013Q3)
 - Gomez et al., 2021: banks with a larger *income gap* reduce lending less when interest rates increase because of increased net interest income (US bank and bank-firm level data, 1986Q1-2013Q4)

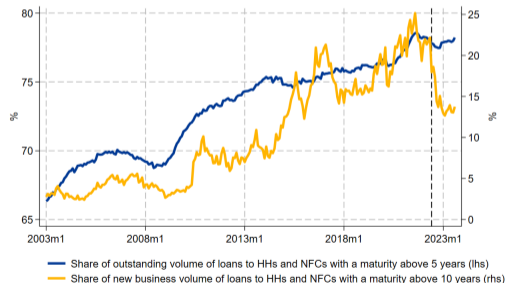
Contribution to the literature

Our contribution:

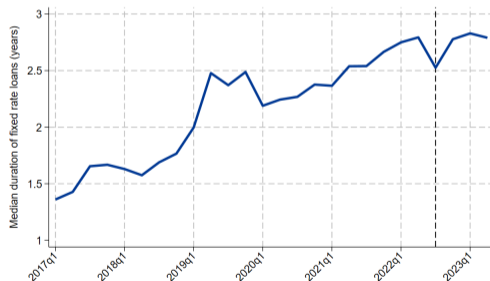
- | Detailed and extensive loan-level credit registry data for the euro area (*AnaCredit*)
- | Unique supervisory dataset to capture the *behavioral* maturity mismatch across the whole maturity/repricing structure of the balance sheet, including information on hedging
- | Evaluating the effects of banks' exposure to interest rate risk on lending after a monetary tightening subsequent to a prolonged period of low interest rates

What happened during the low interest rate environment?

- └ Banks issued more fixed rate loans with a large maturity to compensate for compressed margins
- └ This increased the duration of banks' asset-side



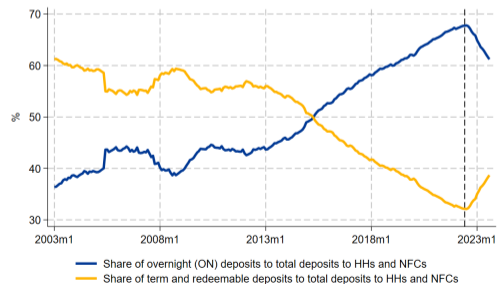
(a) Share of loans with a large maturity (%), Jan 2003 - July 2023. Source(s): ECB Balance Sheet Items and MFI Interest Rate Statistics.



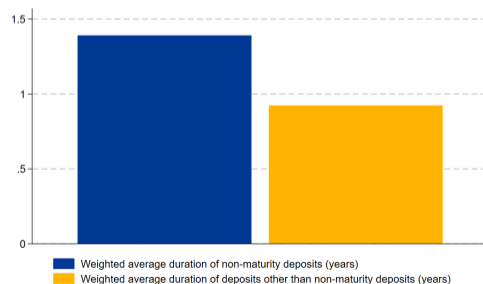
(b) Duration of fixed rate loans (years), 2017Q1-2023Q2. Source(s): ECB Supervisory data.

What happened during the low interest rate environment?

- | There was a large inflow of sticky overnight deposits, which behaviourally have a larger duration than term and redeemable deposits
- | This increased the duration of banks' liabilities, counterbalancing the increase in the duration of the assets



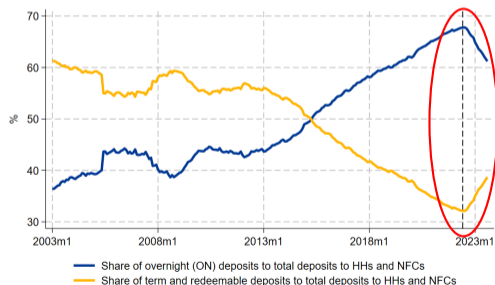
(a) Share of deposit types in total deposits to HHs and NFCs (%), Jan 2003 - July 2023. Source(s): ECB Balance Sheet Items.



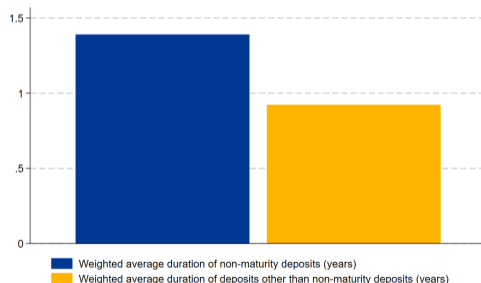
(b) Duration of deposit types (years), Median 2022Q2. Source(s): ECB Supervisory data.

What happened since interest rates started to increase?

- | There has been a material shift from overnight to term and redeemable deposits, reducing the duration of banks' liability-side
- | **Materialisation of interest rate risk (net duration risk)!**



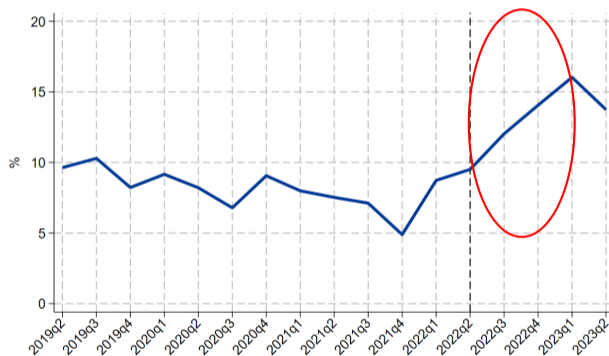
(a) Share of deposit types in total deposits to HHs and NFCs (%), Jan 2003 - July 2023. Source(s): ECB Balance Sheet Items.



(b) Duration of deposits types (years), Median 2022Q2. Source(s): ECB Supervisory data.

What happened since interest rates started to increase?

┆ Materialisation of interest rate risk (net duration risk)!



Duration gap (scaled by total assets) of euro area banks (%), 2019Q2-2023Q2. Source(s): ECB Supervisory data.

Measuring interest rate risk

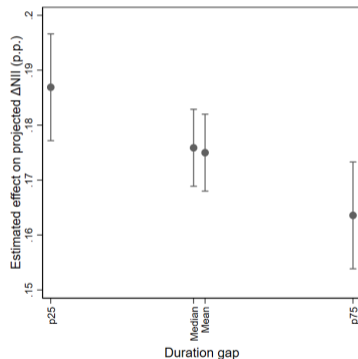
$$DurationGap = \sum_{j=1}^{14} \frac{DUR_j}{1+i} \left(\frac{A^j - L^j}{Z} \right) \quad (1)$$

Where j represent the maturity buckets and Z represents total assets

- | Based on bank-level supervisory data on **cash-flows for each repricing/maturity bucket**
- | = Time to receive the cash-flows from the assets side – time to receive cash-flows from the liability side (weighted by their present value)
- | **Positive** duration gap signals **losses** in economic value of equity when interest rates increase
- | Takes into account **behavioural assumptions** and **hedging**

Why should interest rate risk matter for bank lending?

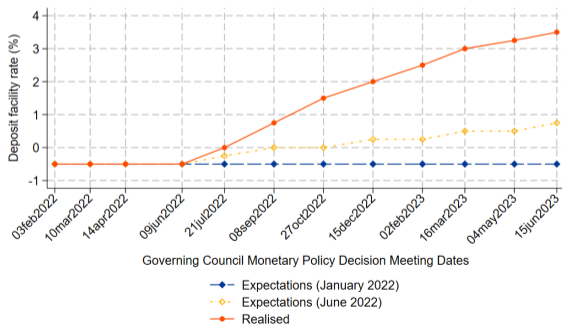
- | Banks try to have stable duration gap over time (Drechsler et al., 2021) or to **match the duration of assets and liabilities** (Kirti, 2020) to lock in long-term profits with stable funding
- | Net duration risk entails **lower expected profitability** (English et al., 2018) and, consequently, **capital accumulation** in the medium run
- | Banks want to **avoid supervisory scrutiny** and capital surcharges in the form of P2R and P2G



Impact of duration gap on 12 month projected ΔNII (p.p.), coefficients and 95% confidence bands. Source(s): ECB Supervisory data.

Empirical challenges

- | **Controlling for credit demand** by using firm-time or industry-location-size-time fixed effects
- | **Controlling for interest rate type** by using interest rate type fixed effects
- | **Controlling for positive impact of MP tightening on bank profits in the short-term** by controlling the heterogeneous impact of NII on lending after MP tightening
- | **Exogeneity of monetary policy?**



Empirical strategy

Bank-firm-quarter level estimations:

$$\begin{aligned} \Delta \log(\text{loans})_{c,b,f,t} = & \gamma \text{DurationGap}_{c,b,t-1} + \beta (\text{DurationGap}_{c,b,t-1} * \Delta \text{PolicyRate}_t) \\ & + \kappa \tilde{X}_{c,b,t-1} + \lambda (\tilde{X}_{c,b,t-1} * \Delta \text{PolicyRate}_t) + \eta_{f,t,i} + [\alpha_{c,t}] + \epsilon_{b,f,t} \end{aligned} \quad (2)$$

- | Bank-firm-quarter level data on firm lending from *AnaCredit* combined with bank-level characteristics (bank size, profitability, income gap, funding structure, capitalization, liquidity, NPL)
- | Time frame: 2021Q1-2023Q2
- | 73 significant institutions
- | > 2 million observations [Go to descriptives](#)

Intensive margin results

	Dependent variable: $\Delta \text{Log}(\text{loans})$			
	(1)	(2)	(3)	(4)
Duration gap/TA (lag)	0.000144 (1.34)	0.000193* (1.75)	0.000144 (1.33)	0.000194* (1.72)
Duration gap/TA (lag) \times Δ policy rate	-0.0292** (-2.26)	-0.0300*** (-3.04)	-0.0294** (-2.25)	-0.0302*** (-3.00)
Observations	2028673	2013105	2028661	2013091
Control variables \times Δ policy rate	No	Yes	No	Yes
Borrower \times Time \times Interest rate type FE	Yes	Yes	Yes	Yes
Country \times Time FE	No	No	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

- | When interest rates increase by 100 bps, a bank with a duration gap at the 75th percentile **reduces lending by around 90 bps more** than a bank at the 25th percentile
- | Similar results on the probability of issuing a new loan [More results](#)
- | = **deleveraging!**

Portfolio reshuffling

	Short-term loans (maturity ≤ 2 years)				Long-term loans (maturity > 2 years)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Duration gap/TA (lag)	0.000182 (0.42)	0.000235 (0.59)	0.000113 (0.25)	0.000164 (0.41)	0.000227 (1.52)	0.000277 (1.65)	0.000223 (1.49)	0.000276 (1.61)
Duration gap/TA (lag) $\times \Delta$ policy rate	-0.00230 (-0.05)	0.0222 (0.48)	0.00615 (0.12)	0.0350 (0.74)	-0.0607*** (-2.82)	-0.0557*** (-3.08)	-0.0610*** (-2.79)	-0.0561*** (-3.04)
Observations	43873	43178	43847	43158	1781033	1767958	1781017	1767942
Control variables $\times \Delta$ policy rate	No	Yes	No	Yes	No	Yes	No	Yes
Borrower \times Time \times Interest rate type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country \times Time FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

- | Banks with a high duration gap especially reduce their **long-term lending** to reduce their exposure to duration risk and avoid supervisory scrutiny when interest rates increase
- | Similar results on the probability of issuing a new loan [More results](#)

Portfolio reshuffling

	Dependent variable: $\Delta \text{Log}(\text{loans})$			
	(1)	(2)	(3)	(4)
Duration gap/TA (lag)	0.000197*	0.000243**	0.000197*	0.000240**
	(1.80)	(2.11)	(1.80)	(2.07)
Duration gap/TA (lag) \times Δ policy rate	-0.0249*	-0.0272**	-0.0248*	-0.0268**
	(-1.76)	(-2.58)	(-1.75)	(-2.53)
Duration gap/TA (pre/lag) \times Δ policy rate \times Floating	-0.00361	0.00458	-0.00394	0.00410
	(-0.19)	(0.29)	(-0.21)	(0.25)
F-test floating rate loans	-0.0285	-0.0226*	-0.0288	-0.0227
	(-1.66)	(-1.77)	(1.62)	(-1.67)
Observations	2803531	2780145	2803522	2780140
Control variables \times Δ policy rate	No	Yes	No	Yes
Double interactions	Yes	Yes	Yes	Yes
Borrower \times Time	Yes	Yes	Yes	Yes
Country \times Time FE	No	No	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

- | Estimations without interest rate type fixed effects
- | Banks with a high duration gap especially reduce their **fixed rate lending** to reduce their exposure to duration risk and avoid supervisory scrutiny when interest rates increase
- | Similar results on the probability of issuing a new loan [More results](#)

Which borrowers are more affected? Firm-size

	Dependent variable: $\Delta \text{Log (loans)}$			
	(1)	(2)	(3)	(4)
Duration gap/TA (lag)	0.0000182 (0.16)	0.0000170 (0.18)	0.0000154 (0.13)	0.0000187 (0.19)
Duration gap/TA (lag) \times Δ policy rate	-0.00443 (-0.35)	-0.00233 (-0.22)	-0.00475 (-0.36)	-0.00316 (-0.28)
Medium-sized firm \times Duration gap/TA (lag) \times Δ policy rate	-0.0210* (-1.95)	-0.0222** (-2.09)	-0.0205* (-1.90)	-0.0210* (-1.97)
Small-sized firm \times Duration gap/TA (lag) \times Δ policy rate	-0.0461*** (-4.03)	-0.0491*** (-4.56)	-0.0456*** (-3.92)	-0.0479*** (-4.38)
Micro-sized firm \times Duration gap/TA (lag) \times Δ policy rate	-0.0214** (-2.61)	-0.0281** (-2.55)	-0.0211** (-2.42)	-0.0271** (-2.36)
Observations	1981398	1966119	1981386	1966105
Control variables \times Δ policy rate	No	Yes	No	Yes
Double interactions	Yes	Yes	Yes	Yes
Borrower \times Time \times Interest rate type FE	Yes	Yes	Yes	Yes
Country \times Time FE	No	No	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

- ┌ Banks with a larger duration gap do not significantly reduce lending to large firms when interest rates increase
- ┌ When interest rates increase by 100 bps, a bank with a duration gap at the 75th percentile reduces lending by **90-97 bps** more to small firms, while this is between **40-56 bps** for micro- and medium-sized firms

Which borrowers are more affected? Substitution effects

	<i>Dependent variable: $\Delta \text{Log}(\text{borrowing})$</i>	
	(1)	(2)
High exposure	0.0152*** (24.61)	0.0168*** (21.67)
High exposure $\times \Delta \text{policy rate}$	-0.750*** (-9.17)	-0.744*** (-7.13)
Observations	6400463	6375657
Bank-level control variables $\times \Delta \text{policy rate}$	No	Yes
ILS \times Time \times Interest rate type FE	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Clustered standard errors at the firm level are reported in parenthesis.

- | Firm-quarter-level analysis
- | When interest rates increase by 100 bps, firms exposed to banks with a higher duration gap exhibit **around 75 bps lower borrowing** in relative terms
- | Firms cannot (fully) substitute the contraction in borrowing coming from high-duration gap banks

Robustness checks

- | Including single bank-firm relationships [Go to results](#)
- | Pre-determined duration gap (2) [Go to results](#)
- | Controlling for overnight deposits composition [Go to results](#)
- | Generalised propensity score weighting [Go to results](#)
- | Extensive margin analysis [Go to results](#)
- | Non-linearities [Go to results](#)
- | Excluding mixed rate loans [Go to results](#)
- | Different thresholds for short- vs long-term lending
- | Additional control variables
- | Different clustering of standard errors

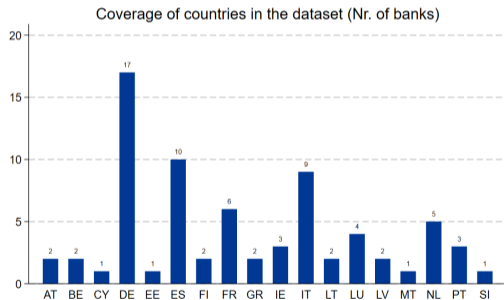
Conclusions

- | Banks with a larger duration gap (i.e., higher interest rate risk exposure) **deleverage and reduce long-term and fixed-rate lending more compared to their peers** when interest rates increase to reduce their duration gap and avoid supervisory scrutiny
- | **Small firms** are most affected by this deleveraging and affected firms **cannot fully substitute** the contraction in lending
- | Important **policy implications**
 - Heterogeneity in the transmission of monetary policy
 - (Long-term) lending contraction can exacerbate economic downturn, with most pronounced effects for MSMEs

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Sample coverage and descriptives [Back](#)



	N	Mean	Std.dev.	p25	p75	Min.	Max.
Endogeneous variables:							
$\Delta \text{Log}(\text{loans})$ (%)	14,582,455	-2.407	25.415	-6.558	0	-100.606	119.647
Variable of interest:							
Duration gap/TA (%)	17,167,090	4.119	26.366	-11.335	19.791	-62.315	80.843
Bank control variables:							
Income gap/TA (%)	17,167,090	4.090	7.276	-1.152	9.776	-53.903	39.449
Log TA	17,167,090	12.909	1.183	11.896	13.671	8.057	14.718
Cash/TA (%)	17,167,090	14.599	4.461	11.800	17.376	1.025	36.560
ROA (%)	17,167,090	0.491	0.385	0.286	0.648	-0.907	1.941
Debt securities/TA (%)	17,129,892	10.554	6.403	7.971	11.139	0	37.618
NPL ratio (%)	17,167,052	3.534	1.422	2.769	4.197	0.465	13.303
Distance to MDA (%)	17,167,090	4.615	2.663	3.189	5.403	0.420	26.085

Descriptives for the period 2021Q1-2023Q2.

Probability of issuing a new loan [Back](#)

	<i>Dependent variable: new loan</i>			
	(1)	(2)	(3)	(4)
Duration gap/TA (lag)	0.000369*** (2.66)	0.000380** (2.42)	0.000375*** (2.68)	0.000388** (2.41)
Duration gap/TA (lag) \times Δ policy rate	-0.0503** (-2.23)	-0.0603*** (-3.59)	-0.0504** (-2.19)	-0.0607*** (-3.53)
Observations	2028673	2013105	2028661	2013091
Control variables \times Δ policy rate Borrower/ILS \times Time \times Interest rate type FE	Borr	Borr	Borr	Borr
Country \times Time FE	No	No	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

Probability of issuing a new loan (portfolio reshuffling)

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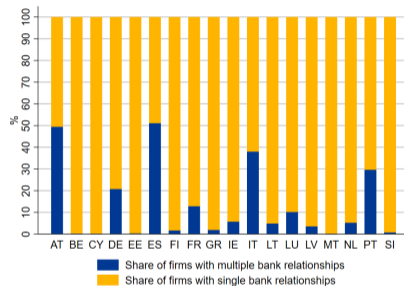
	New loan (maturity \leq 2 years)				New loan (maturity $>$ 2 years)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Duration gap/TA (lag)	0.0000188 (0.07)	-0.0000506 (-0.18)	-0.00000241 (-0.01)	-0.0000898 (-0.31)	0.000392*** (3.08)	0.000415*** (3.02)	0.000397*** (3.10)	0.000421*** (2.97)
Duration gap/TA (lag) \times Δ policy rate	0.0460 (1.60)	0.0630* (1.75)	0.0503* (1.73)	0.0676* (1.85)	-0.0611*** (-3.26)	-0.0649*** (-4.40)	-0.0616*** (-3.24)	-0.0654*** (-4.33)
Observations	43873	43178	43847	43158	1781033	1767958	1781017	1767942
Control variables \times Δ policy rate	No	Yes	No	Yes				
Borrower*Time*Interest rate type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country*Time FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: ***, 0.01, **, 0.05, *, 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

	Dependent variable: new loan			
	(5)	(6)	(7)	(8)
Duration gap/TA (lag)	0.000287* (1.94)	0.000251 (1.44)	0.000292* (1.96)	0.000252 (1.43)
Duration gap/TA (lag) \times Δ policy rate	-0.0299 (-1.06)	-0.0394* (-1.88)	-0.0304 (-1.07)	-0.0395* (-1.89)
Duration gap/TA (pre/lag) \times Δ policy rate \times Floating	-0.0124 (-0.32)	-0.0233 (-0.65)	-0.0114 (-0.29)	-0.0234 (-0.65)
F-test floating rate loans	-0.0424 (-1.37)	-0.0627** (2.16)	-0.0417 (-1.32)	-0.0629** (-2.06)
Observations	2803531	2780145	2803522	2780140
Control variables \times Δ policy rate	No	Yes	No	Yes
Double interactions	Yes	Yes	Yes	Yes
Borrower \times Time	Yes	Yes	Yes	Yes
Country \times Time FE	No	No	Yes	Yes

Note: ***, 0.01, **, 0.05, *, 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

Including single bank-firm relationships Back

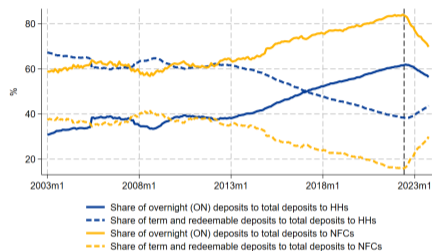


	Dependent variable: $\Delta \text{Log}(\text{loans})$				Dependent variable: $\Delta \text{Log}(\text{loans})$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Duration gap/TA (lag)	0.000212* (1.70)	0.000267** (2.27)	0.000237* (1.83)	0.000289** (2.35)	0.000232** (2.23)	0.000292*** (2.77)	0.000268** (2.43)	0.000319*** (2.88)
Duration gap/TA (lag) \times Δ policy rate	-0.0338* (-1.82)	-0.0359*** (-3.07)	-0.0349* (-1.84)	-0.0352*** (-3.08)	-0.0334* (-1.89)	-0.0357*** (-3.12)	-0.0349* (-1.91)	-0.0335*** (-3.07)
Observations	8511563	8437194	8511563	8437194	6463860	6405467	6463868	6405479
Control variables \times Δ policy rate	No	Yes	No	Yes	No	Yes	No	Yes
ILS \times Time \times Interest rate type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country \times Time FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: ***, 0.01, **, 0.05, *, 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

Robustness checks

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	Dependent variable: $\Delta \text{Log}(\text{loans})$							
	Collapsed regressions		Pre-determined duration gap		Excluding mixed rate loans		Overnight deposit composition	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Duration gap/TA (pre/lag)	-0.00103*	-0.00108	0.000223**	0.000240**	0.000194*	0.000195*	0.000230**	0.000234**
	(-1.68)	(-1.66)	(2.41)	(2.43)	(1.75)	(1.73)	(2.08)	(2.06)
Duration gap/TA (pre/lag) \times Δ policy rate			-0.0202**	-0.0215*	-0.0304***	-0.0305***	-0.0306***	-0.0308***
			(-2.01)	(-1.99)	(-3.08)	(-3.03)	(-3.32)	(-3.27)
Share OV deposits to HH (lag)							0.000561***	0.000574***
							(3.83)	(3.77)
Share OV deposits to HH (lag) \times Δ policy rate							-0.0174	-0.0174
							(-1.04)	(-0.99)
Observations	187845	187845	2013105	2013091	2010213	2010199	2012319	2012305
Control variables \times Δ policy rate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Borrower \times Interest rate type FE	Yes	Yes	-	-	-	-	-	-
Country FE	No	Yes	-	-	-	-	-	-
Borrower \times Time \times Interest rate type FE	-	-	Yes	Yes	Yes	Yes	Yes	Yes
Country \times Time FE	-	-	No	Yes	No	Yes	No	Yes

Generalised propensity score weighting [Back](#)

	<i>Dependent variable: $\Delta \text{Log}(\text{loans})$</i>			
	(1)	(2)	(3)	(4)
Duration gap/TA (lag)	0.000178 (1.62)	0.000226** (2.02)	0.000178 (1.61)	0.000228* (2.00)
Duration gap/TA (lag) \times Δ policy rate	-0.0326** (-2.50)	-0.0330*** (-3.32)	-0.0328** (-2.49)	-0.0333*** (-3.27)
Observations	2028673	2013105	2028661	2013091
Control variables \times Δ policy rate	No	Yes	No	Yes
Borrower*Time*Interest rate type FE	Yes	Yes	Yes	Yes
Country*Time FE	No	No	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

Extensive margin: exit and entry dummy Back

	<i>Dependent variable: Exit dummy</i>				<i>Dependent variable: Entry dummy</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Duration gap/TA (pre)	0.000432 (0.36)	0.000551 (0.66)	0.000359 (0.28)	0.000149 (0.17)	-0.000936** (-2.15)	-0.000862*** (-2.67)	-0.000990** (-2.22)	-0.000993*** (-3.06)
Observations	1027663	1024987	1027663	1024987	925652	923053	925652	923053
Predetermined control variables	No	Yes	No	Yes	No	Yes	No	Yes
Borrower × Interest rate type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: ***: 0.01, **: 0.05, *: 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.

Non-linearities and PSM Back

	<i>Unmatched sample</i>				<i>Matched sample</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Positive duration gap (lag)	0.00636** (2.07)	0.00473 (1.54)	0.00629** (2.04)	0.00464 (1.50)	0.00826** (2.03)	0.00373 (0.70)	0.00824** (2.01)	0.00367 (0.67)
Positive duration gap (lag) \times Δ policy rate	-2.189*** (-4.85)	-1.859*** (-5.04)	-2.187*** (-4.84)	-1.839*** (-4.99)	-1.968*** (-3.63)	-1.512*** (-3.53)	-1.969*** (-3.61)	-1.494*** (-3.44)
Observations	2028673	2013105	2028661	2013091	1613866	1613827	1613856	1613813
Control variables \times Δ policy rate	No	Yes	No	Yes	No	Yes	No	Yes
Borrower \times Time \times Interest rate type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country \times Time FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: ***, 0.01, **, 0.05, *, 0.1. Two-way clustered standard errors at both bank and firm level are reported in parenthesis.