Banks' interest rate pass-through: Frictions and Heterogeneity*

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Abstract

Understanding the impact of changing central bank rates on banks' lending and deposit conditions is important for central bankers for an effective monetary policy, but also for analysts and market participants. We analyse how banks' interest rates change with changing macroeconomic and interest rate environment. By using a unique data set of German banks, we bring together several aspects: How do banks intend a priori to set their rates in a shock scenario? How do interbank, loan and deposit rates change in reality with changing central bank rates? Overall, we provide a comprehensive view on frictions and heterogeneity of banks' interest rate pass-through.

Keywords: interest rate pass-through, monetary policy

JEL classification: E31, G21.

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1 Introduction

Understanding banks' pass-through of (central bank or money market) interest rates to (financial, corporate or private) customers is very relevant for various stakeholders. Central banks and policy makers need to understand how monetary policy transmits into the real economy to establish a targeted and efficient monetary policy and decide upon potential measures. Analysts and investors need models to understand and predict market conditions and it is also relevant for market participants to understand the interest rate environment to make informed decisions about investments. Furthermore, understanding how monetary policy transmits into banks' effective interest rates is key in the area of stress testing.

After a long period of low interest rates, starting from mid-2022, the ECB increased the central bank rates subsequently in ten steps. Against this background of increasing interest rates, it was observed that banks' interest rates adjust at a much smaller pace than the corresponding reference rates, especially for sight deposits which mature daily. This is not only true for household deposits but also for sight deposits to corporates where more pressure on the banks to adjust interest rates could be expected. Moreover, a substantial heterogeneity across banks was observed. Regarding loans, a more pronounced rise was observed (notably the interest rates for loans for real estate were reported regularly in the news), but also not a one-to-one transmission of the central bank rates. This gives rise to the question: How are central bank rates translated into market or interbank rates and how do they translate into loan or deposit rates, i.e. what do we know about the interest rate *pass-through* of markets and banks?

There is a wide literature about estimating banks' interest rate pass-through for different portfolios. In the following, we briefly discuss the most relevant European studies as well as studies with a focus on German banks.

As one of the first studies, Mojon (2000) analyses European retail banks for the time span 1997-1999. The author finds that the pass-through varies across countries and markets and that it is in general higher and faster for short-term credit rates than for mortgages or deposits. He provides evidence that the pass-through increases with the level of competition a bank faces.

Another early study (Bondt (2005)) also focuses on retail rates and the years 1996-2001 in the Euro area. The author comes to the conclusion that short-term deposits (overnight or redeemable at notice of up to 3 months) adjust at a much slower pace compared to retail bank interest rates. The author estimates the immediate pass-through for short-term (and sight) deposits to about 5 percent in the Euro area. For longer maturities, the immediate pass-through is estimated to about 35 percent. In the long run, the average pass-through for short-term deposits is found to be 40 percent at most. Moreover, the study claims that the pass-through process has accelerated since the introduction of the Euro.

In their study on European retail banks (1993-2002) Sander and Kleimeier (2004) find that pass-through rates are mainly affected by competition and stable monetary policy.

Similarly, Kok and Werner (2006) analyse European retail banks (1999-2004) and discuss the difference between speed and extent of the pass-through. They provide evidence that both current account deposits and consumer loans have a very low relative adaptation of interest rates.

Gropp, Kok, and Lichtenberger (2007) analyse the impact of financial innovation on the pass-through of interest rates for European retail banks (1994-2004). The authors again find that competition strongly influences interest rate pass-through. Furthermore, financial innovation seems to increase the speed of pass-through for products related to the innovation.

Based on more recent data, European Central Bank (2009) find that long-run pass-through is not complete as regards overnight and savings deposits and rates on loans to households for consumer credit. This study also confirms that pass-through rates vary drastically depending on the bank product and the country where the given bank is located.

More specifically, there are several country-specific studies based on more granular data that aim at explaining the phenomenon of slow interest-rate pass through. Focusing on Germany, e.g. Sopp (2018) analyses German banks (2003-2016) and hypothesize that banks' profit smoothing could explain incomplete pass-through of market rates.

Heckmann-Draisbach and Moertel (2020) analyse the impact of competition on the pass-through of loan and deposit rates for German banks. They find that credit supply is a major driver of hampered interest rate pass-through and find that monopolistic banks adjust their rates less both on loans and deposits.

In addition, Busch and Memmel (2017) establish average long-term pass-throughs for German commercial banks (based on data 2003-2008). They find that the pass-through for sight deposits is at about 36 percent, for short term savings accounts (with period of notice up to 3 months) at about 53 percent. For short-term deposits (up to 1 year) and medium-term deposits (more than 1, less than 2 years), the long-term pass-through amounts to 98 percent.

In an analysis of German universal banks (2003-2018) Busch and Memmel (2021) find that the pass-through is lower for banks in rural areas, experiencing less competition and offering rather broad services.

After the long period of very low interest rates and especially with the changing interest rate environment, the topic has recently gained more attention.

Based on data 2003-2022, Kho (2023) analyses monetary policy transmission across the Euro area and suggests that the concentration of the banking sector plays an important role for the development of deposit rates. The author investigates differences in deposit rate transmission among thirteen euro area member states and finds that transmission in more concentrated banking sectors is slower when deposit rates increase and faster when they decline. We expand on this finding by focusing on Germany in order to shed light on differences across individual banks.

One step back, Fungáčová, Kerola, and Laine (2023) focus on the monetary policy transmission between 2010-2020, the period of low interest rates. They highlight that transmission has been less efficient during that time.

Against this background, we contribute to the literature by exploring the heterogeneity across portfolios and individual banks, and by investigating hypothetical and actual pass-through rates. We take advantage of information on market rates and very granular bank-specific data taken from the German LSI stress test and the MFI interest rate statistics, and thus, provide a unique view on this topic: First, market rates allow us to analyse the transmission of monetary policy decisions into market and interbank rates. Second, especially the LSI stress test waves in the years 2015 and 2017, which included detailed information on the hypothetical pass-through, provide a useful starting point to analyse banks' intentions under hypothetical interest rate scenarios. Third, the granular data on banks interest rates allows to shed light on the dynamics of interest rate changes when banks actually faced increasing interest rates in 2022 and 2023. In this context, we investigate differences across individual banks.

The remainder of the paper is structured as follows: In section 2, we explain our research design and main equations. In section 3, we give information on the data used and summary statistics. We then show our results in section 4, before we discuss them in section 5. Section 6 concludes.

2 Research Design

In this section, we introduce the relevant concepts, explain our research design and introduce our research questions. Interest rates have changed dramatically in 2022 and 2023. Hence, the changing interest rate environment provides an interesting setting to investigate monetary policy transmission to the markets and also through banks. Furthermore, we enrich this analysis by findings on hypothetical interest rates set by banks in a certain scenario. Our analysis thus has multiple components as explained in the following:

2.1 Changes in the interest rate environment and pass-through by banks

In the first part of the analysis, we try to pin down at which points in time the changes of interest rates manifested themselves. To do so, we analyse the points in time when significant changes were announced and/or implemented. We then analyse market rates (EURIBOR with maturity of 1 week to 12 months) and quantify the "delay" until the monetary policy rate increases has manifested in the respective rate. Thereby, we can analyse the dynamics of the pass-through and shed light onto the impact of the maturity onto the pass-through.

2.2 Pass-through of changes by banks

In a second step, we analyse how banks transmit changes in the interest rate environment to changes in their loan and deposit rates. In this context, we first discuss the **hypothetical pass-through**, namely how banks planned to pass-through interest rate hikes to customers, when they were asked before the interest rate environment actually changed. This is done for several portfolios.

Then, we analyse the **actual pass-through** in the past and compare it to the event of the actual interest rate rise observed in 2022/2023. Comparing actual changes to the hypothetical predictions helps to reveal differences across individual banks and portfolios. Furthermore, we analyse the cross-section in further detail to explain differences in the pass-through between banks. One key question in this context is what characterizes banks with a large/small pass-through. To understand this relationship is particularly relevant in bank interest rate stress testing when modelling the development of interest rates.

Technically, we use a panel regression. For bank i and portfolio j at time t, we denote with $EIR_{i,j,t}$ the effective interest rate. We furthermore use the reference rate $RR_{j,t}$ which is the corresponding EURIBOR rate We then estimate the following equation in levels:

$$EIR_{i,j,t} = \alpha RR_{t,j} + \beta X_i + \gamma Y_t + \epsilon \tag{1}$$

X_i are bank-specific control variables (logarithmic total assets, deposit strength, liquidity, credit relationship, volume change of the specific portfolio). Y_t are macroeconomic variables (GDP or unemployment rate). We use individual bank and time-fixed effects.

Another approach would be to estimate the relationship in differences. However, due to the delay between a change in monetary policy rates and market rates as well as the difference between changes in market rates and changes in bank rates, this is non-trivial.

We also (plan to) include measures for competition and/or market concentration.

Structural indicators seek to derive the degree of competition from market characteristics, the underlying idea being that in highly concentrated markets, firms can exert some market power. As a result, under the structure-conduct-performance paradigm, margins such as loan spreads should be positively related to concentration. However, it is also plausible that few firms in a market operate in strong competition to each other. Hence, the relationship between individual competition (or pricing power) and concentration is not trivial. We (plan to) include into our analysis a Herfindahl-Hirschmann index to infer the effect that a bank's market environment has on price setting.

We calculate a bank i's local market share, LMS, i.e. the share of a specific portfolio p in the aggregate per county c (of which Germany has 294) in the following way:

$$LMS^p_{ci} = \frac{X^p_{ci}}{\sum_j X^p_{cj}} \ in \ c = 1, ..., 294 \ , \tag{2}$$

where the sum goes over all banks j with head quarter in county (i.e. administrative district) c. For X^p_{ci} we alternatively use total assets, deposits, loans to non-financial private customers and interbank loans. If the market is concentrated, for example, strongly at one single bank, then the local market share of this bank is close to 1.

From there, the Herfindhal-Hirschman Index which assigns a single value of concentration to a market is calculated as

$$HHI^p_c = \sum_i (LMS^p_{ci})^2 \ , \tag{3}$$

where the sum goes over all banks i with head quarter in county c. Again, in a highly concentrated market, the HHI^p_c approaches a value of 1.

3 Data

3.1 Data sources

We use the interest rate statistics as well as the LSI stress tests waves.

3.1.1 German LSI stress tests

We use information from four waves of the LSI stress test and survey conducted jointly by the Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) and the Deutsche Bundesbank among all German small and medium-sized banks. This survey, for which participation is compulsory for banks, was conducted in 2015, 2017, 2019 and 2022 and contains various information on banks' risk exposure in the low-interest rate environment and afterwards. In our study, we use in particular the following information:

- 2015 wave: hypothetical pass-through of banks over 1 year under a +200bp shock for saving deposits (with notice period of 3 months), term deposits (notice period larger than 1 year), loans, loans for residential real estate

- 2017 wave: hypothetical pass-through of banks over 1 year under a +200bp shock for loans to central banks, interbank loans, loans to non-banks, deposits from banks and central banks, sight deposits from non-banks, other deposits from non-banks

3.1.2 Interest rate statistics

The MFI interest rate statistics is collected in Europe in a harmonized way since 2003 on a monthly basis[1]. In Germany, the data is collected from a representative sample which is composed of around 230 banks. Sample banks report interest rates agreed between bank and customer for several loan portfolios and various types of deposits, as well as corresponding volumes. The aggregate information is publicly available. We use this information as well as the (non-public) bank-individual information on interest rates for various portfolios.

3.2 Descriptive statistics

We apply a mild outlier correction by winsorizing the 1st and 99th percentile of all variables.

In Table 1, we show summary statistics of all relevant variables across the complete sample period from 2003 to 2023.

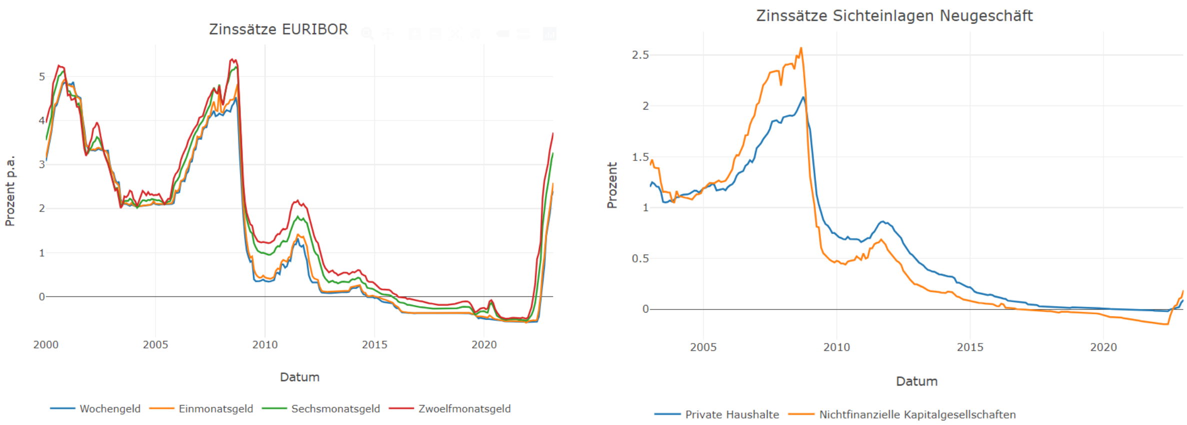
Figure 1 shows the development of the reference rate illustrating the dramatic change of the Euro short-term rate (ESTR) as well as EURIBOR rates since 2022. Interest rates for sight deposits increased slightly but have not experienced a similar increase in the last two years.

[1]The basis for the MFI interest rate statistics is Regulation ECB/2001/18, later amended by ECB/2013/34 and then ECB/2014/30.

Table 1: Descriptive statistics

Variable	N	Mean	St. Dev.	Pctl(25)	Median	Pctl(75)
EIR_{HH}	44,875	0.471	0.689	0.003	0.138	0.737
EIR_{NFC}	44,861	0.526	0.802	0.000	0.121	0.881
RR	48,337	0.728	1.393	−0.360	0.090	2.020
$DeltaVol_{HH}$	46,346	0.206	10.817	−0.008	0.005	0.018
$DeltaVol_{NFC}$	45,774	0.561	49.677	−0.036	0.005	0.050
$log(TA)$	40,646	22.874	1.303	22.019	22.528	23.346
credit relationship	40,533	0.773	0.232	0.778	0.851	0.896
deposit strength	40,640	0.704	0.251	0.610	0.795	0.881
liquidity	28,762	0.045	0.044	0.014	0.032	0.061
BIP	48,337	735.605	124.311	630.693	721.167	839.581
ALQ	48,337	7.170	1.908	5.700	6.800	8.000

Figure 1: Development of interest rates: EURIBOR and sight deposits.



4 Results

In this section, we show the results of our analysis.

4.1 Hypothetical pass-through in the low-interest rate environment

When banks were asked about their potential pass-through following a shock, their answers show a certain heterogeneity. Figures 2 and 3 illustrate the pass-through for assets and liabilities according to the 2015 and 2017 LSI stress test wave, respectively.

Figure 2 shows results from the LSI stress test 2015. While the distribution of the pass-though for loans and loans for residential real estate (RRE) are similar, the pass-thorough of saving deposits (with notice period of 3 months) is much lower and the differences across individual banks are larger.

The LSI stress test 2017 contains granular information on the pass-though of the following portfolios: loans to central banks (FO ZB), interbank loans (FO B), loans to non-banks (FO NB), deposits from banks and central banks (VB BZB), sight deposits from non-banks (VB Nb Tf), other deposits from non-banks. As shown in Figure 3, there is a substantial heterogeneity in the distribution across portfolios.

Figure 2: Pass-through for assets and liabilities according to the LSI stress test 2015. The pass-through is shown for loans and loans for residential real estate (left hand side), and saving deposits (with notice period of 3 months) and term deposits (notice period larger than 1 year) (right hand side).

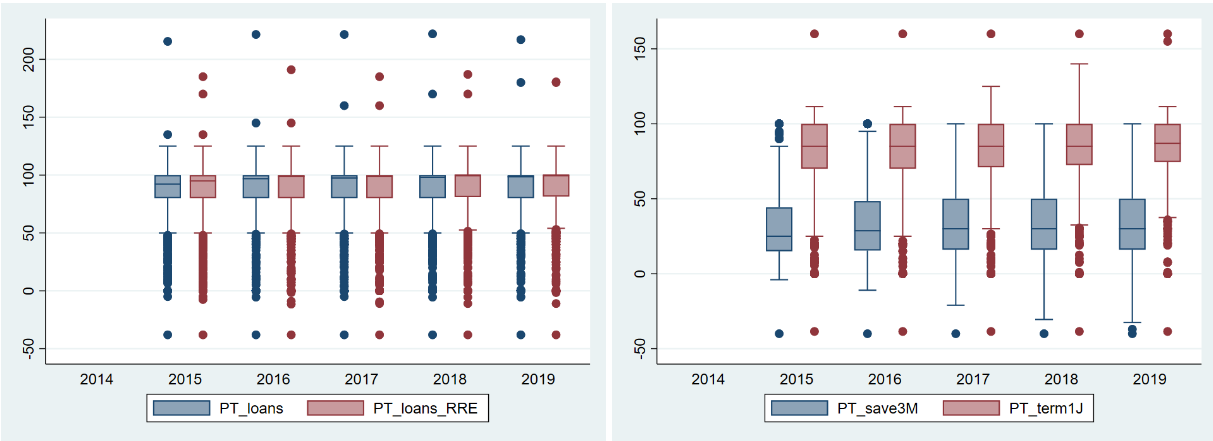
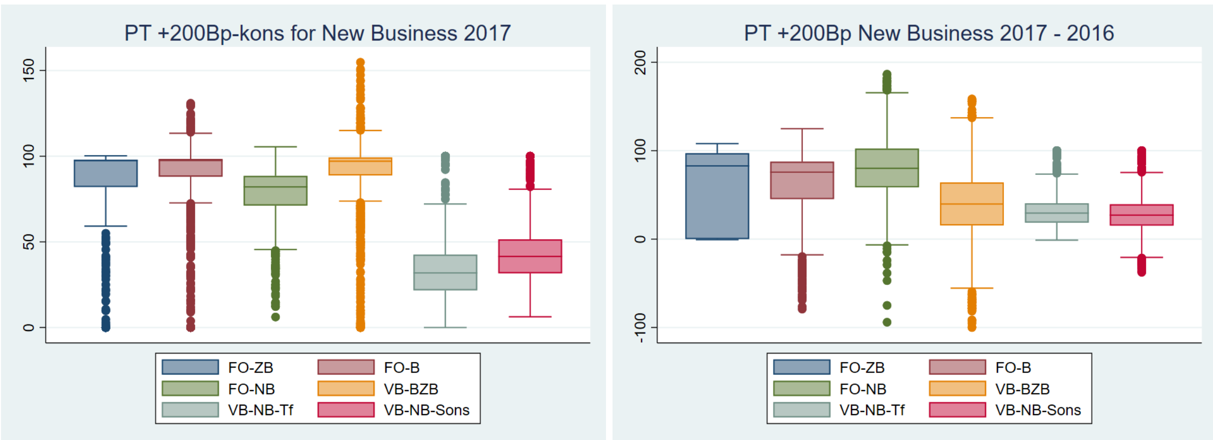


Figure 3: Pass-through for assets and liabilities according to the LSI stress test 2017. The portfolios are: loans to central banks (FO ZB), interbank loans (FO B), loans to non-banks (FO NB), deposits from banks and central banks (VB BZB), sight deposits from non-banks (VB Nb Tf), other deposits from non-banks (VB NB sons).



4.2 Dynamics of interest rate changes - part 1

We analyse the dynamics of the term structure[2] 2022-2023 and focus on points in time when substantial changes occured. As a first input, we take note of the days when ECB

[2]EURIBOR for maturities 1 week until 12 months.

rate shocks became effective. Table 2 provides the dates and the corresponding interest rate steps representing the ECB monetary policy decisions affecting the key rate.

Table 2: ECB interest rate changes during 2022 and 2023.

Date (press release)	**Date (with effect from)**	**Shift**
21/07/2022	27/07/2022	+ 50 bp
08/09/2022	14/09/2022	+ 75 bp
27/10/2022	02/11/2022	+ 75 bp
15/12/2023	21/12/2022	+ 50 bp
02/02/2023	08/02/2023	+ 50 bp
16/03/2023	22/03/2023	+ 50 bp
04/05/2023	10/05/2023	+ 25 bp
15/06/2023	21/06/2023	+ 25 bp
27/07/2023	02/08/2023	+ 25 bp
14/09/2023	20/09/2023	+ 25 bp

We observe the following qualitative facts:

- 26th of June 2022 is the first day when the term structure is no longer monotonously increasing
- 24th of November 2022 is the first day when we observe an inverted term structure

To further pin this down analytically, we fit splines to the time series of daily interest rates for different maturities and calculate the first derivative. The maxima in this function then should indicate points in time which correspond to steep changes in the respective rates.

For the one-day yields of the ESTR, the shift in ECB rates are translated nearly one-to-one into changes in the yields. However, for longer maturities, we see a less clear relationship which we analyse in the following.

4.3 Dynamics of interest rate changes - part 2

Here, we analyse the time delay from a monetary policy announcement until when the resulting shift has been transmitted to market rates for different maturities (if at all). The delay is different for different maturities, but also for different points in times. As an example, we show the delays for the 3M-EURIBOR in Figure 4 and the distribution for different points in time and different maturities in Figure 5.

Figure 4 illustrates that the delay varies roughly between 25 and 60 days, with the longest delay after the interest rate change on 02/11/2022 which is the first day with an inverted term structure, and a similar delay for 21/06/2023. It is notable that after 27/07/2022 when the term structure is no longer monotonously increasing, delays seem to increase in line with the findings by Kho (2023).

Moreover, we observe differences across the different maturities between 1 week and 12 months for each point in time. As shown in Figure 5, the distribution is especially large for 22/03/2023 and for 21/06/2023. Regarding the interest rate responses on 02/11/2022, the delay is apparently longer across all maturities.

Figure 4: Time span between effective change in monetary policy rates and the point in time when the 3M EURIBOR changed by the same amount. The last monetary policy rate change in September 2023 was not transmitted in full until 09/03/2024 (cut-off for data in this version).

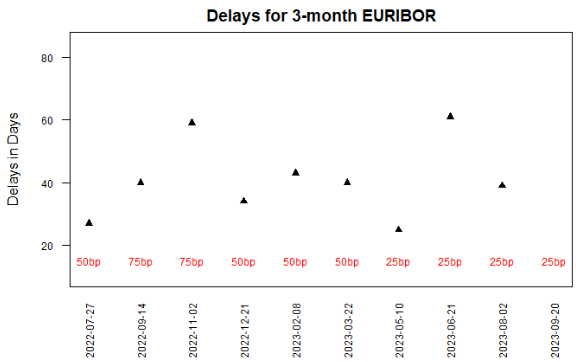
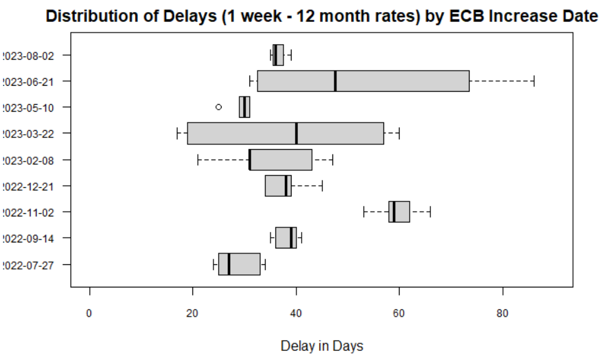


Figure 5: Distributions of the time span between effective change in monetary policy rates and the point in time when the market rate changed by the same amount for different points in time. Distribution shown for maturities between 1 week and 12 months. The last monetary policy rate change in September 2023 was not transmitted in full for any maturity until 09/03/2024 (cut-off for data in this version) and is thus omitted in the figure.



4.4 Heterogeneity across banks

To investigate differences across individual banks in a cross-sectional analysis, we first focus on the representative sample of German banks as provided by the interest rate statistic.

In Table 3 we show the results of regression 1 for sight deposits. For both NFC and households, we observe that the reference rate is highly significant and the estimated beta is 0.44 (NFC) and 0.34 (households), respectively.

Moreover, we estimate interaction models for HH deposits and NFC deposits and show the results on Tables 4 and 5.[3] We observe that for households, credit relationship and

[3] As a robustness test, we have also included year as well as month fixed-effects to account for yearly time variation and potential seasonal effects. The results remain qualitatively unaltered for both the baseline estimations as well as the interaction models and are available upon request.

deposit strength have a highly significant negative interaction coefficient meaning that a higher degree of credit relationship or deposit strength decreases the impact of the reference rate. For NFC deposits, the same effect is observed for the credit relationship. Figures 6 and 7 illustrate the marginal effects of a reference rate increase on the respective deposit rates conditional on the degree of relationship lending.

For NFC deposits, we find that deposit strength itself and size (log TA) both have a negative impact on the interest rates, which we attribute to market power. Furthermore, we observe a positive interaction between the size (log TA) and the reference rate for households, but the reference rate itself then turns insignificant. Concerning volumes, we find that a positive trend in volume (NFC deposits) is associated with a higher interest rate - a possible mechanism is that decisions to increase rates might attract more deposits.

Finally, Table 6 shows the horse race between non-linear effects. From this analysis we can infer that the negative interaction term between the reference rate and credit relationship stays significant.

Figure 6: Marginal effect of an increase of the reference rate on private house holds' deposit rates conditional to the degree of relationship lending.

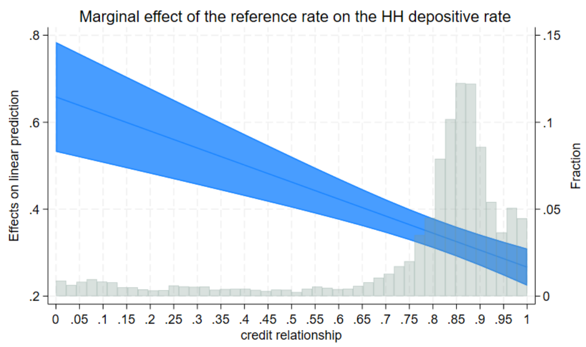
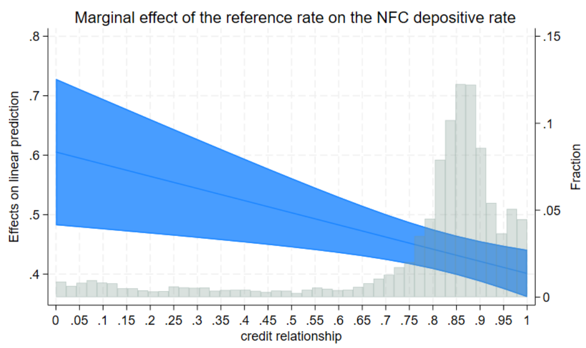


Figure 7: Marginal effect of an increase of the reference rate on non-financial corporations' deposit rates conditional to the degree of relationship lending.



5 Discussion

We have put together different views on the transmission of monetary policy to customers and the economy:

Table 3: Regression results.

	(1) EIR_{SD}^{HH}	(2) EIR_{SD}^{NFC}
RR	0.338***	0.438***
	(0.0184)	(0.0176)
ΔVOL_{SD}^{HH}_w	0.0103	
	(0.0320)	
ΔVOL_{SD}^{NFC}_w		0.0327**
		(0.0128)
LOG_TA	-0.103	-0.130*
	(0.0720)	(0.0731)
CR_REL1	-0.538	-0.560
	(0.386)	(0.347)
DEP_STR	-0.274	-0.779***
	(0.243)	(0.283)
LIQ	-0.524	-0.651
	(0.669)	(0.508)
idp_g_yoy	-0.924***	-0.898***
	(0.0827)	(0.0831)
alq_d_yoy	-0.0299***	-0.0578***
	(0.0115)	(0.00964)
_cons	3.228**	4.229***
	(1.568)	(1.604)
N	27,819	28,195
R^2	0.685	0.806
$r2\_a$	0.685	0.806

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The transmission of increasing monetary policy rates to interbank rates shows a time lag that depends non-trivially on the maturity. We also see a difference between banks' planning how they would adjust interest rates in case of a shock and their actual behaviour when rates were increased.

One doubt could be raised whether it may be more useful to consider volumes instead of interest rates. In general, it can be questioned whether banks treat interest rates as a target variable or whether they focus on volumes or interest earnings/payments. Focusing on volumes as dependent variables may be useful to consider effects of strategic decisions: A bank might attempt to increase their loan portfolio (by setting attractive conditions) and thus an increase of their loan volume might be related to a certain market behaviour.

On the other hand, the most important variable from an economic perspective might be the net interest income which can be seen as a product of volumes and interest rates, and thus related to both quantities.

In our study, we cannot disentangle whether interest rates emerge from strategic decisions on other quantities or whether interest rates themselves are the banks' target variables. Nevertheless, we think that the volume effects may have very different backgrounds (demand changes over the business cycle, changes in the level of competition etc.) and it is not clear that they relate to strategic effects influenced by the banks.

6 Conclusion

We have shed light onto the mechanisms underlying monetary policy transmission in terms of interest rate pass-trough.

A Definition and estimation of pass-through

The interest rate pass-though describes the transmission of monetary policy through banks with important implications for the real economy, especially with rapidly increasing interest rates in 2022 and 2023.

Despite this importance, we observe that in the literature summarized in section 1, there is not a single definition of the pass-through, but rather different approaches. Therefore, we briefly summarize the different concepts and approaches.

First, from a conceptual point of view, let us assume a term structure at day 0. We then assume a parallel shock of +100 bp to the term structure at day 1. In this scenario, the pass-through could be defined as follows:

- The interest rate applied to new business directly after the shock (i.e. on day 1 ff.) minus the interest rate that was applied to new business at day 0
- The interest rate applied to new business directly after the shock (i.e. on day 1 ff.) minus the average portfolio interest rate at day 0
- The percentage of the shock that is transmitted to the overall portfolio (existing and new) after a certain time (e.g. one year), i.e. the average interest rate at day 365 minus the average interest rate at day 0
- ...

We observe that in different articles, the exact definition depends on the concept different authors have in mind as well as on the available data.

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Table 4: Interaction model results for HH deposits.

	(1)	(2)	(3)	(4)	(5)
	EIR_{SD}^{HH}	EIR_{SD}^{HH}	EIR_{SD}^{HH}	EIR_{SD}^{HH}	EIR_{SD}^{HH}
RR	0.658***	0.459***	0.354***	0.338***	-0.261
	(0.0644)	(0.0655)	(0.0203)	(0.0184)	(0.291)
c.RR#c.CR_REL1	-0.391***				
	(0.0753)				
c.RR#c.DEP_STR		-0.174**			
		(0.0840)			
c.RR#c.LIQ			-0.386		
			(0.387)		
c.RR#c.ΔVOL_{SD}^{HH}_w				-0.00816	
				(0.0243)	
c.RR#c.LOG_TA					0.0260**
					(0.0129)
ΔVOL_{SD}^{HH}_w	0.00855	0.0104	0.0104	0.0166	0.0112
	(0.0320)	(0.0327)	(0.0322)	(0.0311)	(0.0323)
LOG_TA	-0.114*	-0.141*	-0.0967	-0.103	-0.140*
	(0.0642)	(0.0746)	(0.0720)	(0.0719)	(0.0763)
CR_REL1	-0.300	-0.722*	-0.505	-0.538	-0.654*
	(0.328)	(0.382)	(0.388)	(0.386)	(0.384)
DEP_STR	-0.279	-0.0640	-0.272	-0.274	-0.249
	(0.231)	(0.255)	(0.243)	(0.243)	(0.235)
LIQ	-0.476	-0.543	-0.217	-0.524	-0.622
	(0.644)	(0.712)	(0.646)	(0.670)	(0.660)
idp_g_yoy	-0.950***	-0.945***	-0.923***	-0.924***	-0.912***
	(0.0827)	(0.0848)	(0.0831)	(0.0827)	(0.0830)
alq_d_yoy	-0.0337***	-0.0294**	-0.0271**	-0.0299***	-0.0314***
	(0.0112)	(0.0114)	(0.0113)	(0.0115)	(0.0114)
_cons	3.272**	4.064**	3.026*	3.225**	4.152**
	(1.412)	(1.625)	(1.560)	(1.565)	(1.687)
N	27,819	27,819	27,819	27,819	27,819
r2	0.703	0.691	0.686	0.685	0.691
r2_a	0.703	0.690	0.686	0.685	0.691

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Interaction model results for NFC deposits.

	(1) EIR_{SD}^{NFC}	(2) EIR_{SD}^{NFC}	(3) EIR_{SD}^{NFC}	(4) EIR_{SD}^{NFC}	(5) EIR_{SD}^{NFC}
RR	0.605***	0.491***	0.436***	0.438***	0.125
	(0.0628)	(0.0608)	(0.0196)	(0.0176)	(0.239)
c.RR#c.CR_REL1	-0.204***				
	(0.0720)				
c.RR#c.DEP_STR		-0.0757			
		(0.0793)			
c.RR#c.LIQ			0.0388		
			(0.331)		
c.RR#c.ΔVOL_{SD}^{NFC}_w				0.00272	
				(0.0119)	
c.RR#c.LOG_TA					0.0136
					(0.0105)
ΔVOL_{SD}^{NFC}_w	0.0329***	0.0328**	0.0327**	0.0309***	0.0318**
	(0.0124)	(0.0127)	(0.0127)	(0.0115)	(0.0126)
LOG_TA	-0.136*	-0.148**	-0.131*	-0.131*	-0.150**
	(0.0701)	(0.0719)	(0.0723)	(0.0731)	(0.0753)
CR_REL1	-0.433	-0.619*	-0.562	-0.560	-0.615*
	(0.331)	(0.346)	(0.349)	(0.347)	(0.345)
DEP_STR	-0.744***	-0.689**	-0.780***	-0.779***	-0.770***
	(0.256)	(0.276)	(0.282)	(0.283)	(0.280)
LIQ	-0.641	-0.661	-0.679	-0.653	-0.697
	(0.506)	(0.528)	(0.476)	(0.506)	(0.518)
idp_g_yoy	-0.904***	-0.906***	-0.899***	-0.898***	-0.893***
	(0.0836)	(0.0840)	(0.0833)	(0.0831)	(0.0835)
alq_d_yoy	-0.0587***	-0.0573***	-0.0580***	-0.0578***	-0.0585***
	(0.00925)	(0.00949)	(0.00957)	(0.00963)	(0.00969)
_cons	4.230***	4.600***	4.254***	4.231***	4.719***
	(1.544)	(1.582)	(1.585)	(1.605)	(1.673)
N	28195	28,195	28,195	28,195	28,195
r2	0.809	0.807	0.806	0.806	0.807
r2_a	0.809	0.806	0.806	0.806	0.807

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Horse-Race between non-linear effects

	(1) EIR_{SD}^{HH}	(2) EIR_{SD}^{NFC}
RR	0.689	0.503
	(0.472)	(0.340)
ΔVOL_{SD}^{HH}_w	0.0236	
	(0.0291)	
c.RR#c.ΔVOL_{SD}^{HH}_w	-0.0190	
	(0.0223)	
c.RR#c.CR_REL1	-0.356***	-0.188**
	(0.0719)	(0.0735)
c.RR#c.DEP_STR	-0.130	-0.0234
	(0.111)	(0.0933)
c.RR#c.LIQ	-0.441	0.0359
	(0.358)	(0.320)
c.RR#c.LOG_TA	0.00217	0.00449
	(0.0175)	(0.0126)
LOG_TA	-0.136*	-0.149**
	(0.0696)	(0.0709)
CR_REL1	-0.429	-0.484
	(0.327)	(0.335)
DEP_STR	-0.116	-0.716***
	(0.232)	(0.252)
LIQ	-0.150	-0.692
	(0.621)	(0.474)
idp_g_yoy	-0.961***	-0.907***
	(0.0835)	(0.0832)
alq_d_yoy	-0.0299***	-0.0590***
	(0.0109)	(0.00931)
ΔVOL_{SD}^{NFC}		0.0000450***
		(0.00000587)
c.RR#c.ΔVOL_{SD}^{NFC}_w		0.00844
		(0.0109)
_cons	3.735**	4.540***
	(1.558)	(1.596)
N	27,819	28,195
r2	0.707	0.810
r2_a	0.707	0.809

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$