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Deposit market concentration and monetary transmission: evidence from the euro area

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Abstract

I study the transmission of monetary policy to deposit rates in the euro area with a focus on asymmetries and the role of banking sector concentration. Using a local projections framework with 2003-2023 country-level and bank-level data for thirteen euro area member states, I find that deposit rates respond symmetrically to an unexpected tightening or easing of monetary policy. However, more concentrated domestic banking sectors do pass-on unexpected monetary tightening (easing) more slowly (quickly) than less concentrated banking sectors, which contributes to a temporary divergence of deposit rates across the euro area. These results suggest that heterogeneity in the degree of banking sector concentration matters for the transmission of monetary policy to deposit rates, which in turn may affect banking sector profitability.

Non-technical summary

While central banks recently increased their policy rates swiftly in response to above-target inflation, commercial bank overnight deposit rates increased much more slowly. Moreover, the gap between deposit rates across euro area member states - despite being exposed to the same key ECB interest rates - has widened. This begs the question whether deposit rates are more sluggish in response to both policy rate increases and cuts, and what factors might influence the transmission of monetary policy to deposit rates. In this paper, I explore these issues further, with a focus on the role of banking sector concentration.

Banks are likely to wish to pass-on policy rate hikes to deposit rates slowly, and cuts quickly. Given that banks tend to hold assets that have longer fixed-rate periods than their liabilities, passing-on higher policy rates quickly to deposit rates would be costly, potentially undermining their profitability and by extension affecting their ability to fulfill their intermediation tasks. At the same time, depositors may balk at swift decreases in deposit rates and withdraw their deposits. Whether banks are indeed able to adjust deposit rates asymmetrically to positive and negative changes in policy rates could thus well depend on how much market power they hold in the deposit market.

I use euro area country-level and bank-level data from January 2003-October 2023 to assess whether the transmission of unexpected positive and negative changes in monetary policy rates is indeed asymmetric. Arguing that market power increases in the degree of market concentration, I further consider whether more concentrated banking sectors set rates (more) asymmetrically.

I find that deposit rates indeed appear more rigid to upward changes in policy rates and more flexible to downward adjustments in policy, but only so in more concentrated banking sectors. The response of deposit rates in banking sectors with an average degree of concentration does not appear asymmetric. The results in the paper imply that the degree of concentration could explain faster and slower transmission of monetary policy to deposit rates across the cross-section of banking sectors by a few months up to about half a year.

This paper is intended to contribute to the recent literature on the role of deposit market power, which has largely focused on the US banking sector (which in some ways has evolved differently than the euro area banking sector) and which has explored the longer-term pass-through of policy rates, in so doing largely abstracting from potential short to medium-term asymmetries that are, however, the focus of this paper.

1 Introduction

Central banks rely on commercial banks to transmit monetary policy. The banking sector links policy to households and firms: in the euro area, it is the only sector with direct access to central bank facilities and interest rates and it remains the predominant provider of external finance to households and firms. At the same time, banks rely heavily on deposits as a source of comparatively cheap and stable funding for their lending activities, and banking sectors tend to be relatively concentrated.

Amidst the recent historically rapid increase in European Central Bank (ECB) policy rates, lending rates as charged by banks across the euro area have shot up. In stark contrast, deposit rates have remained quite sticky, also displaying an increasingly large dispersion across countries. The transmission of ECB monetary policy to bank lending rates has been much studied in recent years (see e.g. Altavilla, Canova, and Ciccarelli (2020), Boeckx, Perea, and Peersman (2020) and Hristov, Hülsewig, and Wollmershäuser (2014)), but the behaviour of bank deposit rates remains less well understood. In particular, it is not entirely clear to what extent deposit rates are upward and downward sticky in response to monetary policy, and what the drivers may be of such stickiness. The degree of market concentration is often pointed at, but recent evidence for the euro area is scarce.

In this paper, I provide empirical evidence on the asymmetric response of deposit rates to monetary policy, and relate this to the degree of concentration within a country's banking sector. I estimate the impact of unexpected positive and negative changes in monetary policy rates on deposit rates. I do so in a panel local projections setting, with country-level data for thirteen euro area member states in the 2003-2023 period and using high-frequency identification for the monetary policy shocks (Altavilla, Brugnolini, et al. (2019)). To assess whether the deposit rate response is (even more) asymmetric in countries with more concentrated banking sectors, in a second step, I also interact the monetary policy shocks with a measure of concentration.

Analogous to prices being downward rigid, deposit rates have been thought to be sticky when pushed up, see e.g. Hannan and Berger (1991) and Neumark and Sharpe (1992). Both papers provide empirical evidence based on US deposit markets showing that deposit rates respond more rigidly to upward changes in market rates than downward changes, especially so in more concentrated markets. A more recent literature has put forward different theories to explain how deposit rates are adjusted in the wake of monetary policy changes, with roles for market

power or market concentration: as nominal rates increase, bank deposits which unlike cash can yield positive interest rates become more attractive than cash thus providing banks more market power. This enables banks in more concentrated markets to pass-on policy rate changes in a more limited fashion (Drechsler, Savov, and Schnabl (2017)). Alternatively, profit-maximising banks may wish to smooth dividends. Given that loans tend to have much longer maturities or fixed-rate periods than deposits, this implies that banks have a strong motive to delay the pass-through of policy rates to deposit rates (Polo (2021), Drechsler, Savov, and Schnabl (2021)). These papers provide empirical evidence for their mechanisms, however, based on US data.

Recent evidence for euro area deposit markets is more scarce. Exploiting error correction models, papers such as Bondt, Mojon, and Valla (2005) analysed the issue of pass-through to deposit and lending rates for the euro area around the introduction of the euro. Moreover, Gambacorta and Iannotti (2007) have looked into whether the response to monetary policy had been asymmetric in Italy between 1985 and 2002. The issue of market structure has, however, been less explored since the early years of the euro. Leuvensteijn et al. (2013) and Holton and Rodriguez D'Acri (2018) do consider the role of competition or concentration, but largely focus on lending rates. Relying on supervisory projections by German banks, Heckmann-Draisbach and Moertel (2020) find that banks in more concentrated areas project raising deposit rates less forcefully than those in less concentrated areas. Recent research on euro area deposit markets, instead, has focused more on the transmission of negative policy rates (see e.g. Altavilla, Burlon, et al. (2022), Heider, Saidi, and Schepens (2019) or Ulate (2021)).

My contribution, providing evidence for deposit rate rigidity in the euro area, could be of particular interest as in Europe banks are even more important for external finance than banks in the US. Moreover, the European banking landscape has evolved differently in recent decades than the US banking sector, generally seeing much less consolidation across state lines (Corbae and D'Erasmo (2020)). The mechanism I have in mind is similar to the one in Polo (2021): profit-maximising and dividend-smoothing banks that face an asset side with a longer maturity than their liability side wish to delay passing on increases in the policy rate to the deposit rate. This motive is absent in the case of decreases in the policy rate, speeding up the transmission in that direction. The transmission of negative monetary policy shocks, however, is to some extent constrained by customer aversion to large nominal changes (Rotemberg (1982)). Whether banks are able to set deposit rates that materially differ from policy rates is affected

by market concentration: market power is assumed to increase in the degree of concentration in the banking sector.

I also contribute to the earlier (European) empirical evidence by using local projections, which allows for rich non-linear dynamics in the wake of a monetary policy shock (useful given the potential positive/negative asymmetry and the non-linearity in concentration), and by using high-frequency surprises as shocks, which allow for a cleaner identification of euro area monetary policy (Jordà (2005), Bagliano and Favero (1999) and Kuttner (2001)). One advantage of taking such shocks is that it isolates the source of common monetary policy, excluding the possibility that an external factor that is possibly tied to the banking sector, and market concentration in particular, is driving changes in the short-term rate. Taking unexpected changes in monetary policy also ensures that the estimates are not contaminated by anticipation effects (such as the ex-ante repricing of loans, deposits and other bank balance sheet items), making statements about causality potentially more credible than when taking also anticipated changes in policy.

The results in this paper imply that, on average, positive and negative shocks do not feed through to deposit rates asymmetrically in the months after a surprise change in monetary policy. However, there is an economically meaningful and statistically significant asymmetry across the degree of concentration. In more concentrated banking sectors, hikes are passed-through slower and cuts are passed-through faster within the year after a policy surprise. While the effects are somewhat short-lived, the magnitude of the temporary divergence is economically significant. Concentration thus appears to matter for how quickly ECB monetary policy has been transmitted to deposit rates across the euro area.

The remainder of the paper is organised as follows. In section 2, I discuss how concentration might matter for the transmission and discuss the predictions that I test. Section 3 is on methods and data. Subsequently, in section 4, I discuss the specification and results for the first question (whether deposit rates respond asymmetrically to positive and negative shocks, in general) as well as for the second question (whether deposit rates respond asymmetrically in more concentrated sectors). The final section concludes.

2 Theory and predictions

2.1 Asymmetry

Banks earn a wedge between loan rates and the short-term rate, and the short-term rate and deposit rates. Whereas the vast amount of deposits have a very short maturity or fixed interest rate period, loans tend to have a long(er) maturity or fixed interest rate period. This is true for fixed-rate loans, but also for variable-rate loans on which rates may be reset but only at a pre-determined (for example annual) frequency.

An unexpected increase in the short-term rate thus squeezes the wedge between the loan and short-term rate (from here on: 'loan wedge'). Profit-maximising and dividend-smoothing banks will not want to adjust deposit rates instantaneously: for a given level of profits, this bank needs to widen the wedge between the short-term and deposit rates (from here on: 'deposit wedge') to make up for the squeezed loan wedge (see e.g. Polo (2021)). Banks thus have a motive to be rigid in adjusting deposit rates to a 'positive' monetary policy shock.

An unexpected decrease in the short-term rate, however, does not squeeze the loan wedge. It remains profitable for banks to swiftly decrease the deposit rate still, but banks are potentially constrained by depositors disliking large nominal price changes (see e.g. Rotemberg (1982)). While customers are generally (and potentially rationally) inattentive, swift and substantial nominal deposit rate declines may trigger deposit outflows. Unlike in the positive shock case, in the negative shock case banks thus are incentivised to adjust the deposit rate as much as they can as fast as they can.

Whether banks can temporarily adjust rates more or less to their preference, in the wake of an unanticipated change in policy, is likely to depend on how much market power they hold (see e.g. Wang et al. (2021)). There often are relatively few banks in a given sector, not least due to high entry cost. With little competition, the upside to switching could well be more limited rendering switching costs relatively high. It then is plausible for depositors to have habits or are otherwise inattentive (see e.g. Klemperer (1995) and Reis (2006)). This yields market power to banks, which enables them to translate these motives to some price setting power at least in the short run. Large and persistent deviations in pricing, vis-à-vis outside options such as cash and bonds, could well lead to deposit outflows, but this is outside of the scope of this paper.

The idea thus is for an asymmetry to appear in the deposit wedge response to unexpected positive and negative changes in the policy rate. I first test whether this is the case, i.e. whether

the deposit rate is indeed be 'upward rigid' and 'downward more flexible' in response to surprises, which implies a widening of the deposit wedge on the way up and a stable or narrower deposit wedge on the way down. Note that to more clearly trace out the evolution of the wedge, I will consider the deposit rate relative to (or adjusted for) the short-term rate, defining the 'relative deposit rate' as follows.

$$relative\ deposit\ rate\ =\ deposit\ rate\ -\ short\ term\ rate$$

The inverse of the wedge, the relative deposit rate will allow us to see more clearly how the deposit rate evolves in comparison to the short-term rate. Moreover, table 1 reflects the expected impulse response function (IRF) signs in the first months after an unexpected change in the ECB policy rate, for both the deposit rate and the relative deposit rate.

Table 1: Expected IRF signs after policy shock (first prediction)

	Positive shock	Negative shock
ECB policy rate	++	−−
Deposit rate	0	−
Relative deposit rate (Deposit rate - ECB rate)	−−	+

2.2 Role for concentration

All else equal, market power on the part of banks ought to increase in the degree of concentration in the banking sector. After all, more concentration implies fewer alternative deposit-taking banks that compete for deposits that depositors could turn to. This then translates to (more pronounced) effects on the transmission of policy to the deposit wedge, reinforcing the asymmetry discussed before. More concentration would mean more rigid deposit rates (and thus an increase in the deposit wedge) in case of positive surprises, and more flexible deposit rates (and thus a decrease in the deposit wedge) in case of negative surprises (see also e.g. Hannan and Berger (1991)).

As recent papers that consider the role of concentration as well have done, I take the Herfindahl-Hirschman Index (HHI) as measure of concentration in the remainder of this paper (see e.g. Drechsler, Savov, and Schnabl (2017), Gödl-Hanisch (2021) and Segev et al. (2022)). Besides being commonly used, I opt for this measure as it is transparent in its calculation - it is

defined as the sum of the squared market shares in a given banking sector - and as it is readily available.[1]

I thus test whether the deposit wedge should be asymmetric for more concentrated banking sectors, even if the average sector might respond symmetrically. Table 2 shows the expected signs, taking here as given that the average sector responds symmetrically to positive and negative shocks (unlike the prediction before).

Table 2: Expected IRF signs after policy shock (second prediction)

	Positive shock		Negative shock	
	Average	**Concentrated**	Average	**Concentrated**
ECB policy rate	++	++	−−	−−
Deposit rate	+	0	−	−−
Relative deposit rate	−	−−	+	0

To illustrate these predictions, I adapt the Gerali et al. (2010)'s DSGE model with financial frictions and a banking sector, estimated for the euro area. In this model, banks maximise expected discounted profits of offering loans and deposits subject to quadratic rate adjustment costs, to reflect some rigidity in bank loan and deposit rates. In Gerali et al. (2010), these costs are symmetric. Levieuge and Sahuc (2021) introduce an altered-linex adjustment cost for loan rates, capturing that loan rates are downward rigid and upward flexible. I add an identical altered-linex adjustment cost for deposit rates, to capture the upward rigidity and downward flexibility of deposit rates as well.

The response to 100bps positive and negative policy rate shocks, with the asymmetric adjustment cost for deposit rates in line with my predictions, are plotted in figure 1. As discussed previously, the deposit rate is particularly rigid in case of a positive shock, illustrating the dividend smoothing motive and bank market power. The deposit rate is more flexible in case of a negative shock, reflecting the same factors, but not fully flexible, as banks may be constrained by the customer's aversion to large nominal changes. Without the asymmetric adjustment cost, the response of the deposit rates to positive and negative changes in policy would have been symmetric.

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[1]The HHI is taken from the ECB's SSI data bases, with market share calculated based on total bank assets. For the HHI, the definition of the market matters. The implicit assumption here is for the country to be the relevant market, which may be a strong assumption for the four large countries in particular. I discuss this issue later on, and conduct robustness checks using different country samples.

Figure 1: Model-based dynamic response to monetary policy shocks
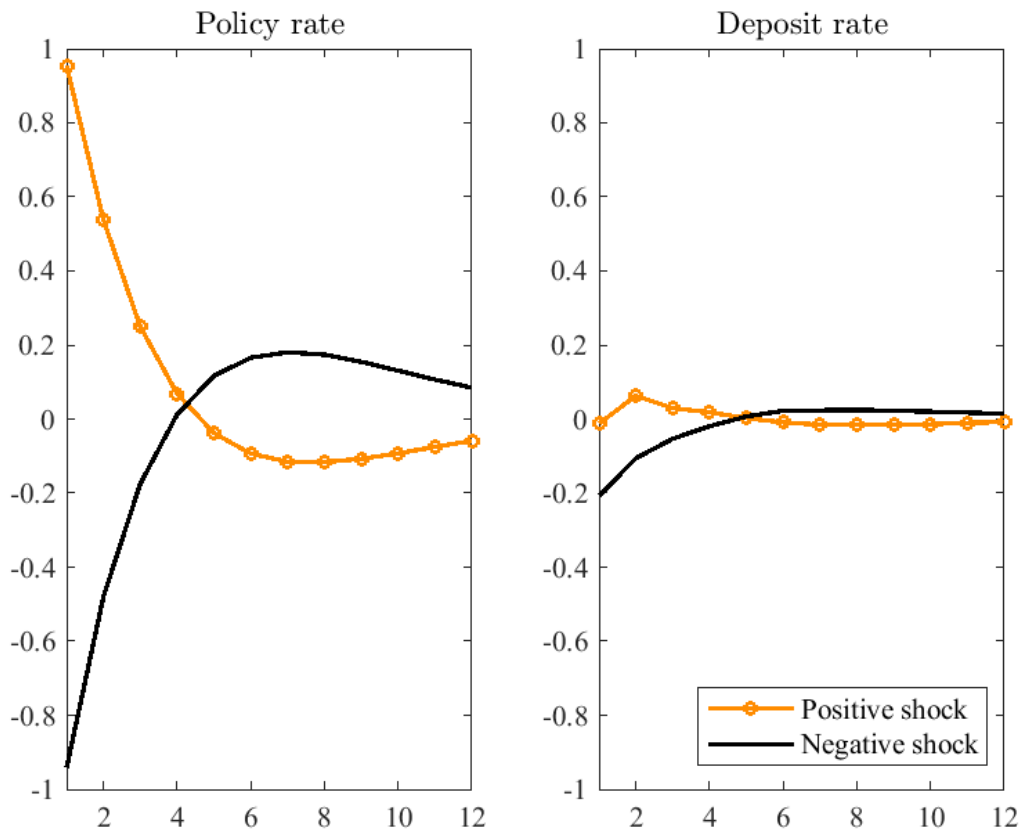
Note: plotted are the responses of the policy rate and the deposit rate (in percentage points) to positive and negative 100bps monetary policy shocks in the adaptation of Gerali et al. (2010)'s DSGE model, over a horizon of 12 months.

The assumption underpinning the empirical analyses in this paper is that monetary policy does not affect concentration (at least in the short run). This appears a reasonable assumption in general, as market concentration or market shares are slow-moving concepts. In the euro area, notably, concentration as measured by the HHI has been remarkably stable over the past two decades. The banking sector has not meaningfully consolidated across states, unlike in the much more studied US, allowing us to take the structural variation in the euro area reasonably as primarily a result of history. In any case, a robustness check is conducted taking 2003 (initial) values for the HHI, with materially similar results.

3 Methods and data

I study the dynamic response to an unexpected change in monetary policy on deposit rates in different countries in the euro area. I do so in a panel local projections framework (Jordà (2005)), which notably deals well with asymmetries and non-linearities, a central element of this paper (see e.g. Auerbach and Gorodnichenko (2012), Ramey and Zubairy (2018) and Tenreyro and Thwaites (2016)). In order to assess the potential asymmetry in the response to positive and negative monetary policy shocks, I estimate the equations separately for positive and negative shocks.

Monetary policy shocks are identified using the high-frequency approach. Following the rich literature exploiting high-frequency identification, I take the change in a risk-free short-term rate in windows of minutes before and after a policy announcement. The short window allows us to credibly interpret the change in interest rates, in the euro area most commonly derived from Overnight Index Swaps (OIS), as monetary policy 'surprise'. Specifically, I use surprises to the 1-month OIS in the baseline, seeing its close link to the policy and deposit rates. The data is taken from the Euro Area Monetary Policy Database, created by and for Altavilla, Brugnolini, et al. (2019).[2]

Monetary policy announcements can also convey central bank information on the development of the economy. This can be problematic as the macro-economic, banking and financial market response to 'pure' monetary policy shocks and so-called 'information shocks' may be different. A 'pure' shock generally is expected to imply a worse economic outlook, which can be identified by a decline in stock prices against the background of an increase in interest rates. An

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[2]I use the full monetary event window, thus taking the difference in the median quote in the 13:25-13:35 window (before the press release) and the median quote in the 15:40-15:50 window (after the press conference).

'information shock' entails a release of information on the part of the monetary policy maker to markets implying that the economy is stronger than previously expected, which would drive up stock prices in tandem with interest rates. To deal with this issue, the recent literature has separated out these shocks. I follow the now common procedure suggested by Jarociński and Karadi (2020), using the shock to the EuroStoxx 50, a European stock market index, which allows me to focus in the remainder of this paper on the 'pure' monetary policy shock.[3]

Figure 2: Monetary policy shock time series
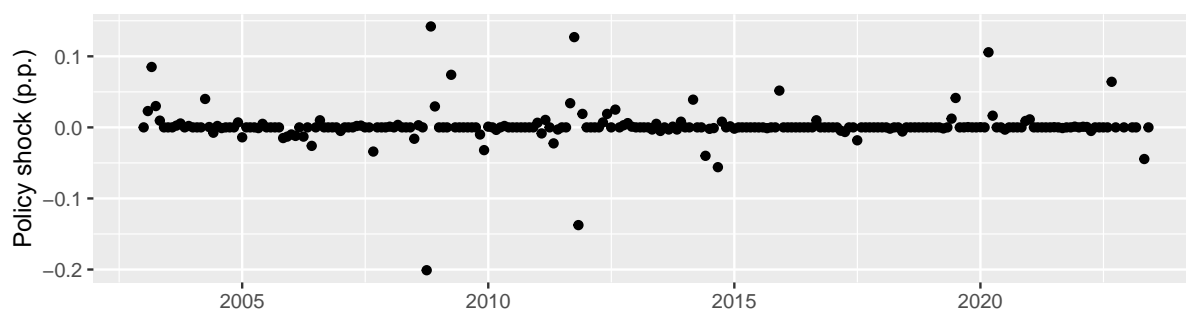
Note: the shock series reflects changes in the 1-month OIS rate (in percentage points) in a window of minutes around ECB press conferences, cleaned for information shocks and summed by month to generate a monthly series.

Using these surprises comes at the cost of the potential information value of expected changes in monetary policy - these could have different effects on relevant macro-economic, banking and financial market indicators. The differences in the effects may, however, not be too substantial, as related papers that rely on surprises only have shown macro responses that are in line with conventional wisdom. This is also reflected in figures 5, 6 and 7, with the short-term rate behaving as one might expect in response to a hike in the policy rate. Regressing deposit rates on all changes in the short-term rate, in a specification similar to the ones in Drechsler, Savov, and Schnabl (2017), also show results that are broadly consistent with the exercise I focus on in this paper. More importantly, however, I choose these surprises as my focus is showing the causal link between monetary policy and a structural factor (concentration), for which clean and credible identification is paramount. Expected changes in policy could ultimately be driven by factors that affect the banking sectors in my sample heterogeneously, and also could be associated with anticipatory behaviour by banks which would contaminate the estimates. Moreover, high-frequency surprises have the benefit of being more numerous than the number of policy rate

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[3]Results displayed in appendix charts, in any case, show that not cleaning for information shocks does not materially alter the results.

changes, also being reasonably evenly distributed over time, and are increasingly popular in the related literature. Using the same methods has as an important benefit that my results can be placed in the context of this literature, allowing for comparison.

In the baseline, I use country-level data and a weighted average of overnight and time deposits held by non-financial corporates (firms) and households. This country-level panel runs monthly from January 2003 through October 2023 (with shocks and controls running through June 2023). I include the countries that were euro area member states in 2009 (to allow for a reasonably balanced panel), excluding some particularly small member states. This leaves me with thirteen countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Slovenia and Slovakia, that in the deposit rates have displayed quite a bit of dispersion, as illustrated in figure 3. I only include countries from the moment they join the euro area, given the assumption of a common monetary policy. I conduct a range of robustness checks related to the specific sample, which suggest the key results are not driven by the choice of sample. Robustness checks, excluding data from the time when nominal rates were close to the 'effective lower bound' on nominal rates and focusing on time deposits rather than overnight deposits are also done.

Figure 3: Deposit rates across the euro area and the risk-free rate
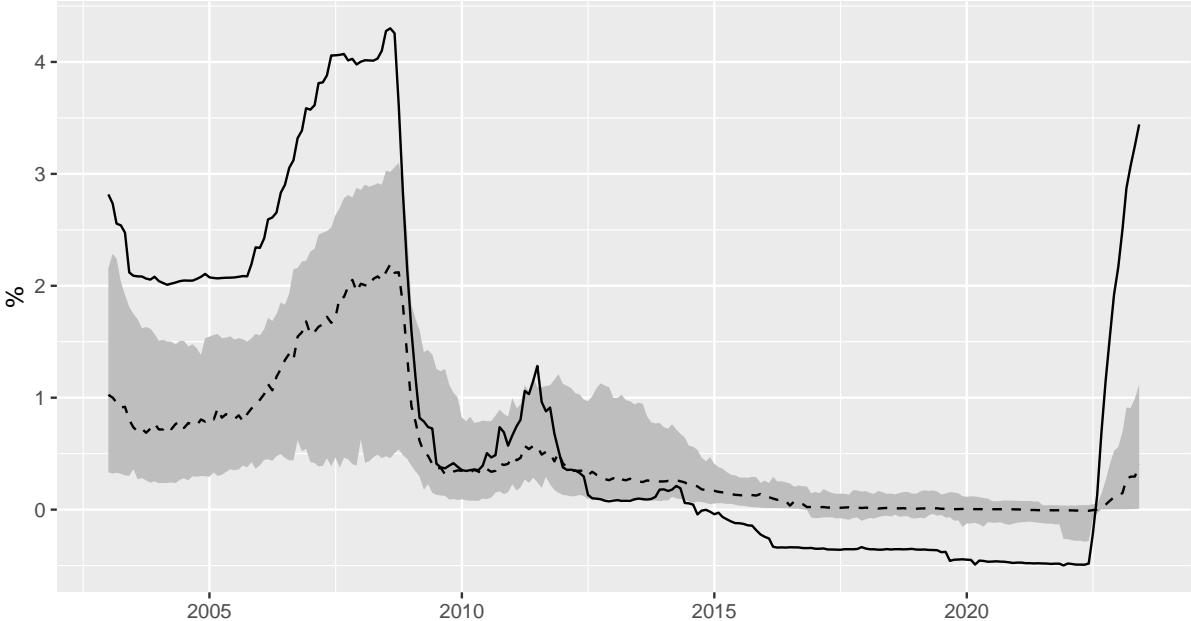
Note: the shaded area in this graph covers the range between the highest and lowest domestic (weighted) average bank non-financial corporate overnight deposit rates. The dashed lines reflect the bank interest rates of the median sector. The black line shows the 3-month OIS.

Aggregate banking data includes all banking activities conducted within country borders, including those by branches and subsidiaries of banks abroad. Banking data (incl. bank interest rates and the HHI) and most of the macro-economic is sourced from the ECB (BSI, MIR and SSI data bases) and financial market interest rate data comes from Refinitiv. The commodities price index is sourced from the IMF, industrial production data from Eurostat. Summary statistics can be found in table 3.

In an extension, I redo the analysis with individual bank-level data, taken from the ECB's IBSI and IMIR data bases. Country-level data has as a benefit that within the country it weights deposit rates of different banks by volume, whereas one benefit of individual bank data is that it gives more weight to larger countries, as they have more banks included. The results are qualitatively similar, suggesting that the unit of measure is not materially affecting key results.

Table 3: Summary statistics

Statistic	N	Mean	St. Dev.	Min	Max
mp shock	3,078	0.002	0.02	−0.14	0.14
hhi	3,130	0.12	0.08	0.02	0.39
short rate	3,130	0.91	1.50	−0.52	4.33
deposit rate	3,130	0.47	0.62	−0.29	3.10
gdp (ea)	3,078	867.96	56.71	750.76	982.99
inflation (ea)	3,091	97.87	9.68	80.30	123.47
commodities index	3,130	134.65	38.06	61.89	241.92
fx rate	3,091	1.24	0.13	0.97	1.58
gdp	3,078	68.41	74.46	2.95	274.75
inflation	3,091	97.96	9.99	76.94	139.39
loan rate	3,130	3.06	1.46	0.37	7.12
deposit volume	3,130	109.94	137.80	1.19	710.13
loan volume	3,130	375.83	382.09	13.18	1,612.98
deposit share	3,130	56.67	23.03	4.58	96.29
loan share	3,130	83.10	10.37	59.13	99.96
capital	3,130	161.89	179.14	2.91	764.34

Note that the shock is expressed in basis points, the short rate and loan share in percentages, interest rates in percentage points and exchange rate in EUR. Volumes are expressed in billion euros. Commodities, inflation and GDP are indexed to 2015.

As discussed before, I use the Herfindahl-Hirschman Index (HHI), to indicate concentration in a given domestic banking sector. The HHI is obtained by summing the squares of each bank's market share (based on total assets), yielding values between 0 (little concentration or perfect

competition) to 1 (high concentration or monopoly). For euro area countries, the average HHI for the banking sector across countries over the sampled time frame is 0.12 with the lowest and highest values being 0.02 and 0.39. Figure 4 shows the evolution of the HHI since the early years of the euro: key to the analysis considering the role of concentration is that this measure of market concentration has remained quite stable over these two decades, despite some major events in the macro economy and financial markets. This stability makes (more) credible that monetary policy does not contemporaneously affect concentration, but also that we can take the dispersion of concentration largely as a result of pre-euro events. The stability in euro area banking sector concentration is also notably different to the US banking sector, which has been studied more in the related literature and which has much consolidated over the past four decades.

When measuring concentration, an important consideration is the relevant market. Constrained by the available data that is organised by country, I assume that the relevant market is the domestic market. This appears to be a reasonable assumption for most euro area countries. Most countries are sufficiently small that it is feasible for banks to operate throughout the country. This may, however, not be the case for the four large countries in the euro area (France, Germany, Italy and Spain). For the larger countries, as in the US, regional markets exist. Unfortunately, the data is not so granular that this issue can be addressed directly for these four large member states. I keep the four member states in the baseline, but conduct a robustness check excluding them (with results materially the same).

4 Specification and results

4.1 Do deposit rates respond asymmetrically?

First, I consider whether an average banking sector passes-through a positive monetary policy shock (a surprise increase in the short-term rate) slowly and a negative shock (a surprise decrease in the short-term rate) more quickly. To test this, I have the following empirical specification, where i reflects the country, t the month and h the horizon ahead.

$$Y_{i,t+h} = \sum_{s \in \{p,n\}} \mathbb{1}(s_t = s)[\alpha_{i,h}^s + \beta_{0,h}^s mps_t + \gamma_h^s \sum_{l=1}^{L} X_{t-l}' + \theta_h^s \sum_{l=1}^{L} X_{i,t-l}' + \epsilon_{i,t+h}^s] \qquad (1)$$

Figure 4: Herfindahl-Hirschman Index (HHI) by market
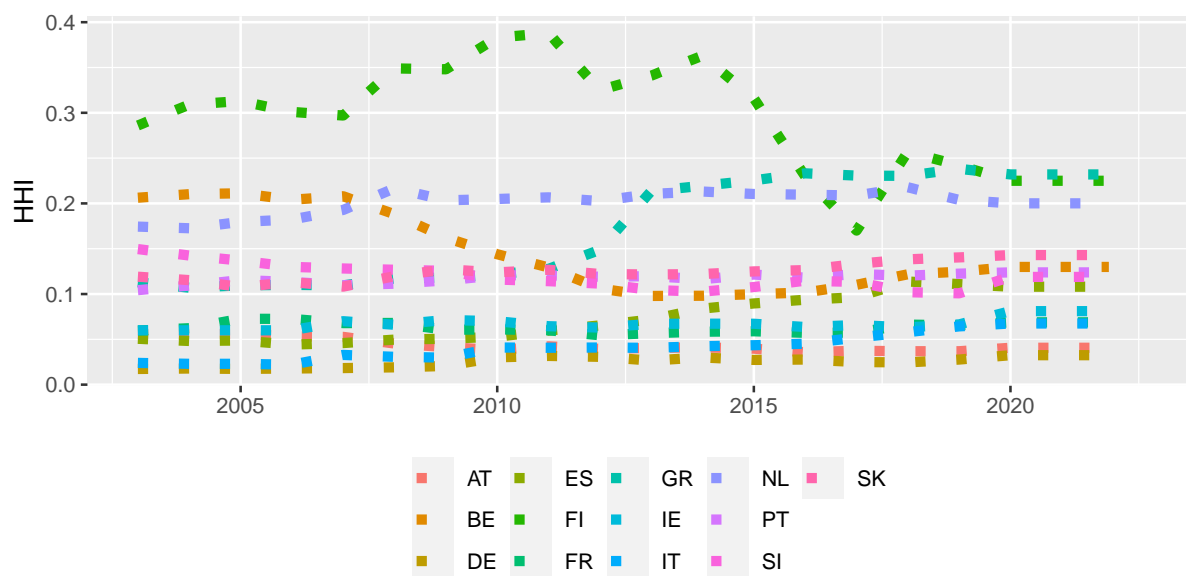
Note: the HHI is calculated for each country by summing the square of each bank's market share, based on total assets.

Dependent variables $y_{i,t}$ are the short-term interest rate (3-month OIS rate) and the deposit rate relative to the short term rate (i.e. deposit rate - short-term rate), which for the sake of brevity I will refer to as the 'relative deposit rate'. This is the inverse of the deposit wedge, which will allow us to see directly if the deposit rate is higher or lower relative to the short-term rate after a surprise change in policy. In the baseline, I consider the weighted average rate on overnight and time deposits held by non-financial corporates (NFCs) and households separately.[4]

Explanatory variable of interest is the monetary policy shock mps_t, which reflects the response of the 1-month OIS in a narrow window around the ECB press conference (as discussed before). Euro area control variables X_t are real GDP (interpolated using industrial production, following Chow and Lin (1971)), HICP inflation, a commodities price index, the USD-EUR exchange rate and a month dummy. These controls recognise that the monetary policy transmission is likely to be affected by the state of the macro economy and the financial sector, as well as potential seasonal effects. I also include lags of the shock variables, in order to deal with

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[4]The weighted average rate is constructed taking the rates on overnight (immediately withdrawable) deposits and deposits with an agreed maturity (new business), weighted by the volumes on outstanding amounts. In the appendix, I also include results for overnight and time deposits separately.

potential serial correlation due to announcement day observations being converted into monthly series (Ramey (2016)).[5]

Domestic control variables $X_{i,t}$ are real GDP, HICP inflation, loan rates, overnight deposit and loan volumes, bank capital, loan volumes as share of both loan and bond volumes ('loan share'), overnight deposit volumes as share of deposit and money market fund (MMF) volumes ('deposit share'), the HHI as well as a dummy for countries with a large proportion of adjustable-rate mortgages (following Albertazzi, Fringuellotti, and Ongena (2024)). The other rates and volumes are meant to capture the interplay between bank assets and other liabilities, as well as the interactions between quantities and prices. The loan and deposit share capture role of non-banks in providing intermediary services to firms and households as alternative to banks. The specification also includes country-horizon fixed effects, meant to soak up time-invariant country-specific factors.

The baseline specification includes six lags for dependent and control variables, a 12 month horizon (h) and Driscoll and Kraay (1998) standard errors, which are robust to general forms of spatial and temporal dependence. All volume variables enter in logs, all rates in percentages. To test whether deposit rates respond asymmetrically to positive and negative monetary policy shocks, I estimate the response of the deposit rate to these positive and negative shocks separately, depending on the sign of the shock. I introduce the switching variable s_t, where mps_t stands for the policy shock in month t.

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s_t = \begin{cases} n & \text{for} \quad mps_t < 0 \\ p & \text{for} \quad mps_t > 0 \end{cases}
$$

4.1.1 Results

The cumulative impulse responses (both for positive and negative shocks) in the figures referenced below are scaled to a <u>positive</u> 100 basis points change in the short-term rate, with the black lines reflecting the response to positive shocks and the red/dotted lines reflecting the response to negative shocks. 68% and 90% confidence intervals have been plotted. The left-hand

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[5]Until 2015, the ECB Governing Council met twelve times a year rather than the eight times a year since, as a result of which on occasion two meetings could occur within the same calendar month. Surprises from this period are summed in the process of creating a monthly series.

graph show the response of the short-term rate, the right-hand graph the relative deposit rate (i.e. the deposit rate minus the short-term rate).

For β_0 in the right-hand side figures to be zero implies that the nominal deposit rate changes one-for-one with the short-term rate. Positive IRFs for the relative deposit rate imply that the deposit rate has increased by more than the short-term rate, narrowing the wedge between the short-term rate and the deposit rate. A negative IRF, conversely, implies that the short-term rate has increased more than the deposit rate; the deposit rate has become relatively low compared to the prevailing short-term rate.

Figure 5 plots the IRFs for the baseline case: the weighted average rate on overnight and time deposits held by non-financial corporates. It shows that there's no statistically significant difference between positive and negative shocks, for both the short-term rate and the relative deposit rate. The estimates for the relative deposit rate are negative at least for the first few months, implying for the positive shock case that the deposit rate is lagging the short-term rate, whereas for the negative shock case it implies that that the short-term rate would be moving down to the broadly stable deposit rate. In both cases, however, the deposit rate is relatively rigid, and considering the clearly overlapping confidence intervals symmetrically so.

The response of an average banking sector to positive and negative monetary policy shocks can thus not be said to be asymmetric. Figure 6 plots the IRFs for deposits held by households. They are identical to those in the baseline with NFCs, which may be somewhat surprising as household and NFC depositor behaviour may be thought of as different, potentially with NFCs more attentive to policy. However it is consistent with the aggregate time-series for deposits held by households and NFCs generally co-moving. In any case, the prediction that deposit rates are upward rigid and downward flexible in response to monetary policy shocks does not seem to hold for the average euro area banking sector.

4.1.2 Robustness

To consider the robustness of the aforementioned results, I conduct a number of tests taking different samples and also using the surprise change in policy as an instrument for the short-term rate rather than as shock directly. Unless indicated differently, I take the baseline specification and alter one element at time only. Overall, the results do not materially change.

In the baseline, I use the surprises identified by the high-frequency approach 'directly' as monetary policy shock (with the results scaled to a 100 bps increase of the short-term rate).

Dynamic response to positive (black) and negative (red) monetary policy shocks
(β_0)

Figure 5: NFC

Short–term rate

Relative deposit rate

Figure 6: Households

Short–term rate

Relative deposit rate
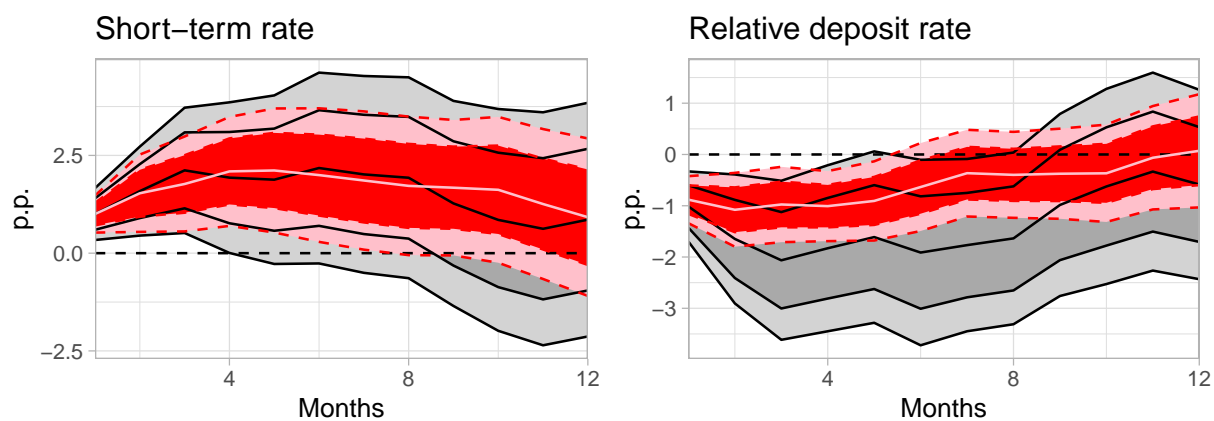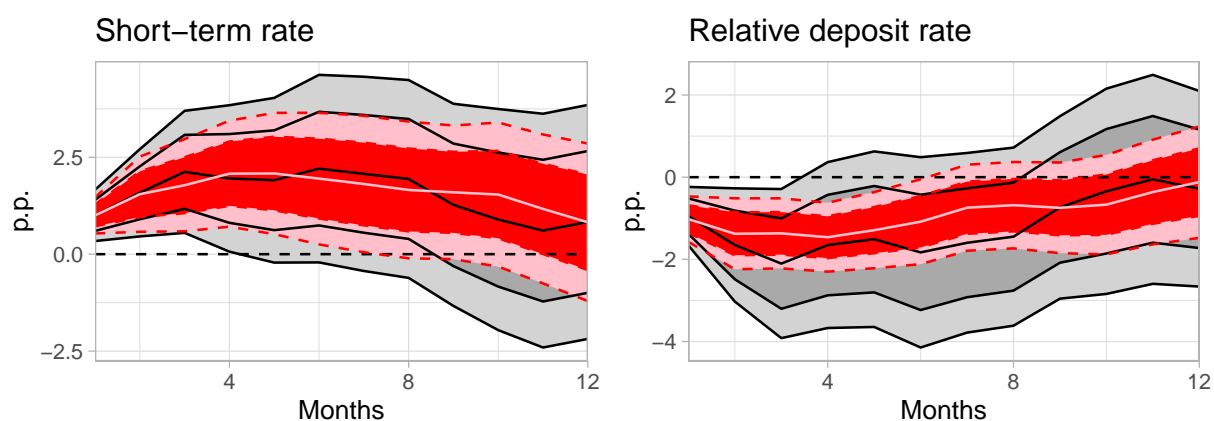
Figure 7: NFC, shocks as instrument

Short–term rate

Relative deposit rate
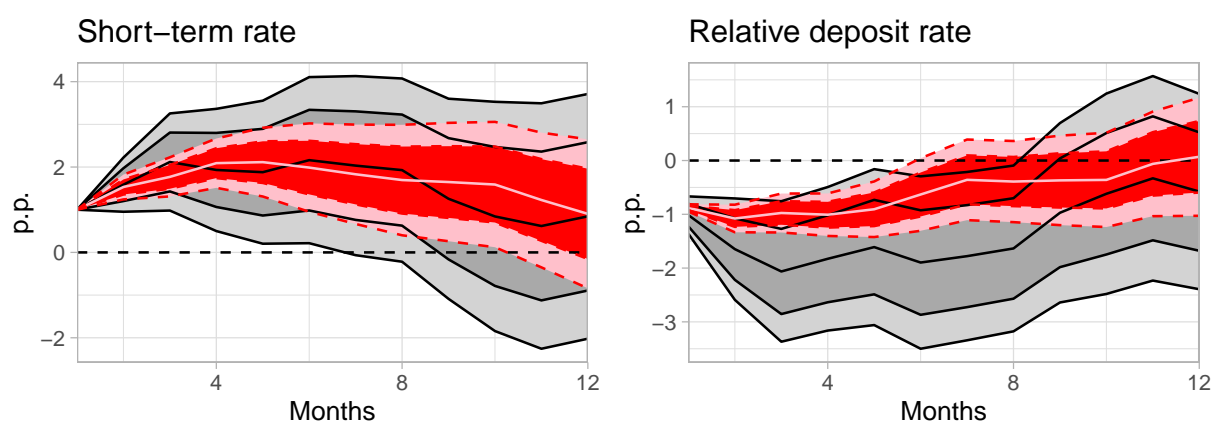
Note that the cumulative impulse responses are scaled to a 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted. The negative rate case (in red) has been normalised to 100 basis point positive response, to allow for direct comparison of the positive and negative rate case.

Alternatively, one could use these surprises to instrument for the short-term rate, as it ultimately is surprises in the short-term rate that we're interested in. The dynamics, plotted in figure 7, are however very similar to those in the baseline, with mostly narrower confidence bands.

Appendix figures A1 and A2 show the results for non-financial corporate overnight deposits and time deposits separately, and figures A4 and A5 for household overnight deposits and time deposits separately, to address potential concerns about the weighted average rate results being driven by one type of deposits. All display qualitatively very similar dynamics, with overlapping confidence intervals, reflecting slowly adjusting deposit rates in both the overnight and time deposit categories, across sectors, in both positive and negative shock cases.

One could be concerned that the results are affected by the lower bound of nominal interest rates binding in the later years of the 2010s. To address this, I shorten the sample until mid-2014. The impulse responses of the short-term rate, plotted on the left-hand side of figure A7, are qualitatively similar to the dynamics seen in the baseline, though the response to the positive shock does appear to be weaker in the sense that it is shorter lived. This also feeds through to the relative deposit rate, plotted on the right-hand side. These results are still not in line with the prediction. Due to the lack of persistence in the positive shock case, the impulse responses for the positive and negative shock case do not overlap anymore.

As discussed in the section on identification, the definition of the market matters for the measure of concentration. Specifically, it may be more appropriate to restrict attention to only those small member states that can be quite confidently said to have one integrated domestic banking sector rather than a number of regional ones, perhaps alongside a domestic market. The results when excluding the large four economies in the euro area are plotted in figure A8; they are similar to the baseline results which use the full sample. Relatedly, it may not be appropriate to omit the very small member states from the sample. Including them, as done in figure A9, also yields identical results.

4.2 Do deposit rates in concentrated sectors respond asymmetrically?

Even if the European banking sector has not shown asymmetric responses in their deposit rates on average, it could well be that concentration explains some of the divergence in deposit rates across sectors after a change in policy. If the response of deposit rates is indeed asymmetric in more concentrated banking sectors, deposit rates increase slowly in response to a positive shock, but decrease quickly in response to a negative shock in a banking sector that sees more

than average concentration. Market power may then explain some of the dispersion seen after (unexpected) changes in policy. To test whether this is the case, I alter the specification from the previous section slightly.

Inspired by Holm-Hadulla and Thürwächter (2021) who consider the impact of non-bank lending on the monetary policy transmission, I interact the measure of concentration with the monetary policy shock. Specifically, I interact the demeaned value of a country's HHI value. Demeaning facilitates the interpretation of β_0 as the coefficient for the 'average' sector (as in the previous section) and β_1 for the additional effect on sectors with above-average concentration. The rest stays as before. Note that the HHI level had been and continues to be included amongst the control variables.

$$
\begin{aligned}
Y_{i,t+h} = \sum_{s \in \{p,n\}} \mathbb{1}(s_t = s)[\alpha_{i,h}^s + (\beta_{0,h}^s + \beta_{1,h}^s(hhi_{i,t} - \overline{hhi}))mps_t \\
+ \gamma_h^s \sum_{l=1}^{L} X_{t-l}' + \theta_h^s \sum_{l=1}^{L} X_{i,t-l}' + \epsilon_{i,t+h}^s]
\end{aligned}
\tag{2}
$$

4.2.1 Results

The graphs containing results are divided in a left-hand and right-hand side, showing respectively β_0, the coefficient on a monetary policy shock for a sector with an average degree of market concentration, and β_1, the additional impact of a monetary policy shock for a market with above-average market concentration (expressed in percentage point deviation from the average). I discuss the positive and negative shock cases in turn.

Positive shocks   In graph 8, the IRFs for (weighted average) deposits held by non-financial corporates are plotted. We see on the left-hand side that, in response to a positive shock, β_0's point estimate (capturing the average sector's deposit rate relative to the short-term rate) turns negative for the eight months after a surprise change in policy. This reflects that the nominal deposit rate is sticky and an increase in the short-term rate takes a few months to substantially increase the deposit rate for the average banking sector. A negative IRF here implies that the short-term rate increases by more than the deposit rate, and the deposit rates thus declines relative to the short-term rate.

The graph on the right-hand side shows that the deposit rate takes even longer to increase upward in more concentrated sectors, in response to a positive shock: the deposit rate is more

Dynamic response to positive monetary policy shocks

Figure 8: NFC deposit rate response (resp. β_0, β_1)
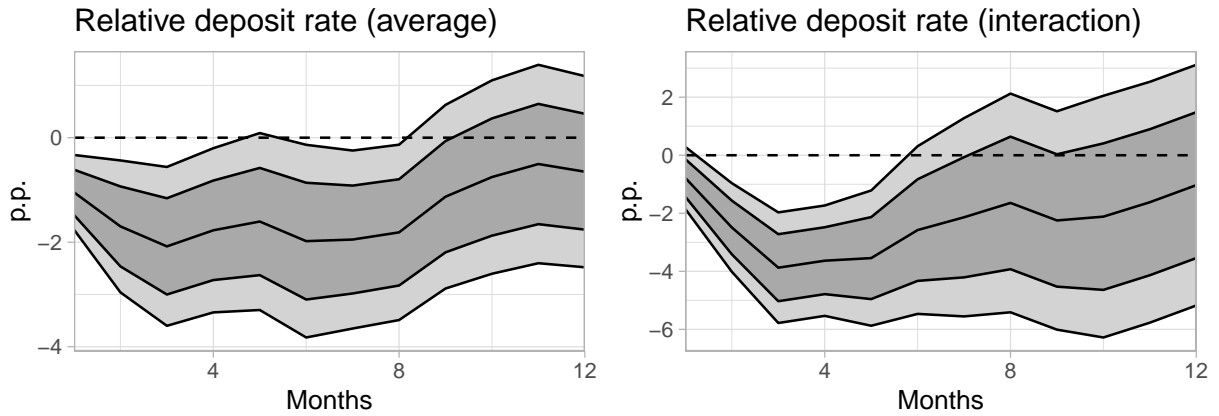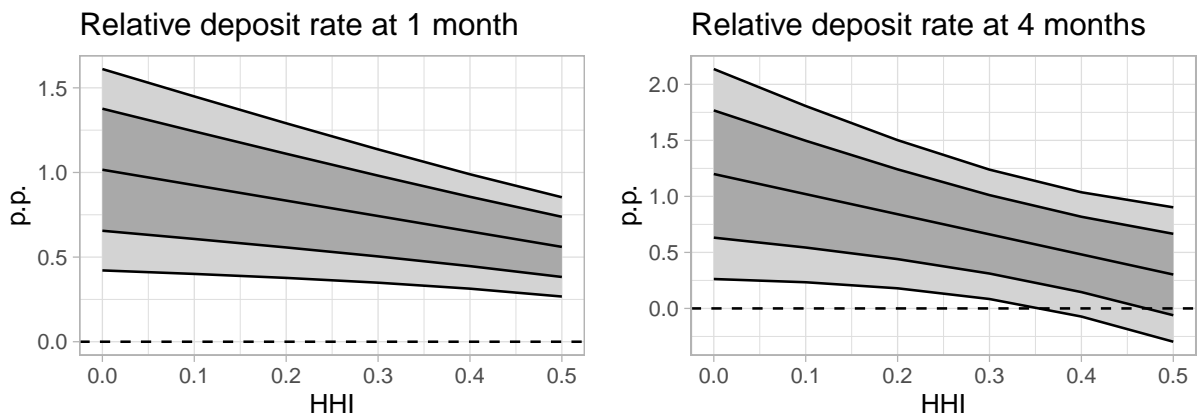

Figure 9: NFC rate response - linear combination of β_0 and β_1
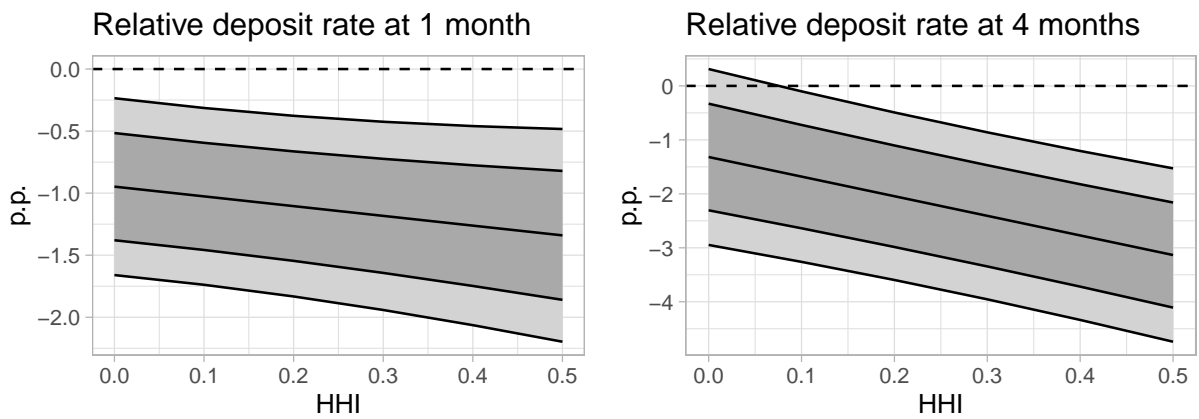
Figure 10: Household deposit rate response (resp. β_0, β_1)
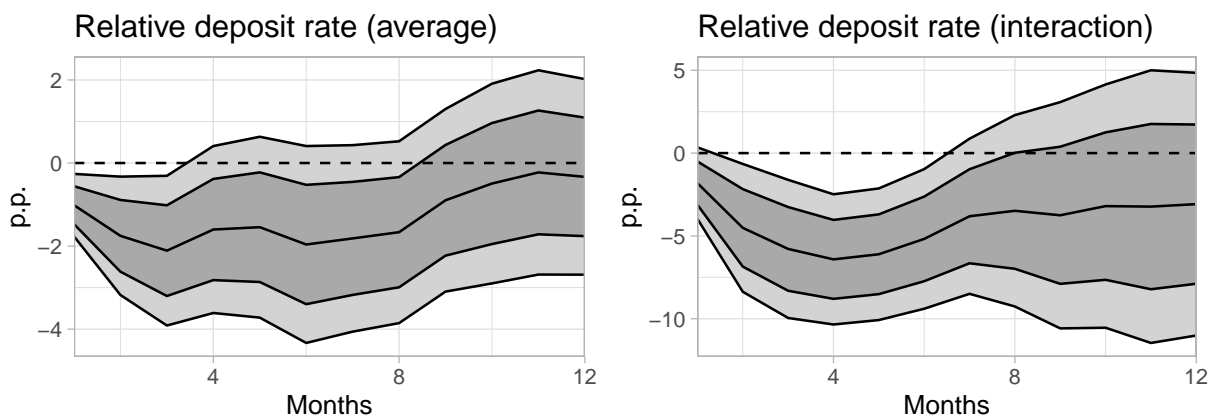
Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

sticky in more concentrated sectors. The wedge between the short-term rate and the deposit rate widens substantially. β_1 is statistically significant for about six months after the shock, and the estimates also suggest that this difference is economically meaningful. β_1 should be interpreted as the change in the deposit rate for a 100bps shock if the HHI value were to be one point higher than the average. As the HHI values range from 0 to 1, a meaningful interpretation can be obtained by dividing the printed estimates by for example ten: in month four, a 0.1p above-average HHI value would imply a wider wedge by about 40bps. Given that the HHI in the euro area has recently seen a dispersion of about 0.3p, this would imply a temporary gap between deposit rates in the least and most concentrated banking sectors of about 120bps. Appendix graphs A10 and A11 for overnight deposits and time deposits, held by NFCs, separately show that the dynamics are similar across both deposit types, with similar magnitudes. The time deposit rate response is more erratic, which may be explained by the smaller volumes of NFC time deposits.

Another way to represent these results is by adding these coefficients (β_0 and β_1) up, to consider how a 100bps monetary policy shock affects the relative deposit rate across a range of HHI values. The prediction was for a higher HHI to imply a lower (relative) deposit rate, reflecting that higher-HHI banking sectors would keep nominal deposit rates low relative to the short-term rate. The more concentrated the banking sector, the lower the deposit rate in the wake of an unexpected change in policy: this implies a downward slope across the HHIs, which is indeed what we see for month one and four in figure 9 (shown for the NFC case, with the HHI ranging between 0 and 0.5 to reflect a range of plausible values in the euro area). Note that month four is the trough, and that the effect gradually fades afterwards as seen in the figure before.

Figure 10 shows the IRFs for the weighted averge deposits held by households. The left-hand graphs (β_0) display a very similar dynamic to the graph for non-financial corporates, implying that the average banking sector's deposit rates also is sticky for households. However, the response of the household weighted average deposit rate in the more concentrated banking sector (β_1) is even stronger than in the non-financial corporate case: household deposit rates in more concentrated banking sectors appear even stickier than NFC deposit rates. Graphs A13 and A14 for overnight deposits and time deposits, held by households, separately show that while both deposit types feature the downward trough in the months after a change in policy, the magnitude is much larger for household time deposits than household overnight deposits.

Dynamic response to negative monetary policy shocks

Figure 11: NFC deposit rate response (resp. β_0, β_1)

Relative deposit rate (average)

Relative deposit rate (interaction)
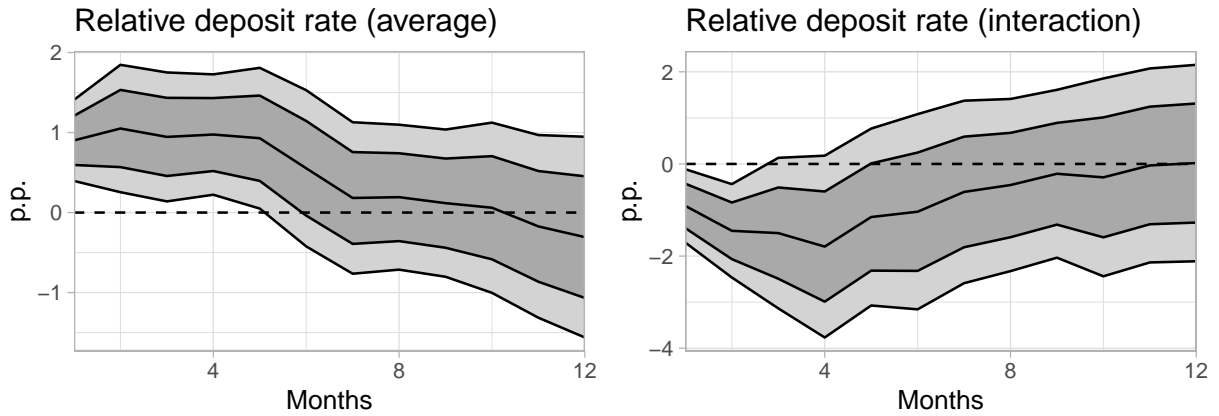
Figure 12: NFC rate response - linear combination of β_0 and β_1

Relative deposit rate at 1 month

Relative deposit rate at 4 months

Figure 13: Household rate response (resp. β_0, β_1)
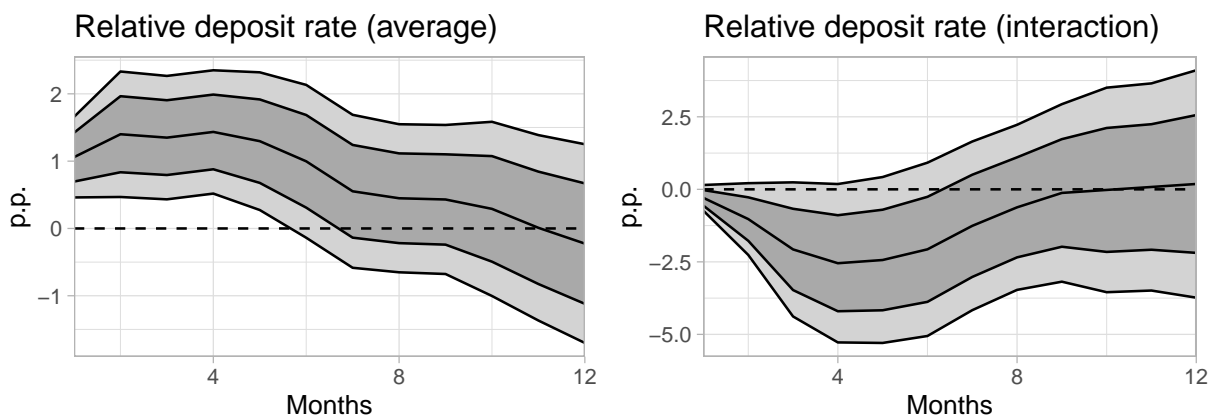
Relative deposit rate (average)

Relative deposit rate (interaction)

Note that the cumulative impulse responses are scaled to a negative 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Negative shocks The following graphs are scaled to a <u>negative</u> 100bps shock. As in the case of positive shocks, the prediction was for more concentration to lead to lower (relative) deposit rates in the short term. This is reflected on the right-hand side of figure 11 for NFCs. The clear downward hump in the early months means that while the average sector (left-hand side graph) sees the deposit rate stay rigid for about half a year, and thus move close to the declining short-term rate (see before), the relative deposit rate in more concentrated markets does decline. The right-hand side graph, thus tells us that sectors with more market concentration have been able to pass-through rate cuts more quickly than less concentrated banking sectors, keeping their deposit rates moving more in tandem with the declining short-term rate.

This can also be seen in the figure 12, which shows again the cross section of HHIs on impact and in month four. The downward slope in these graphs means that for lower HHIs the (relative) deposit rate decreases relatively little, unlike for higher-HHI sectors. Whereas, in month four, the most concentrated banking sectors appear to have fully passed-through the rate cut (as reflected by the statistically insignificant estimates around the 0.5 HHI value), the less concentrated banking sectors have not.

Figure 13 shows the IRFs for deposits held by households, which is quite similar to figure 11 for NFCs. The downward hump in β_1 (on the right-hand side) is statistically significant and economically meaningful. As in the NFC case, a 0.1pp higher HHI is associated with deposit rates that are about 25bps lower in month four than in the average sector.

On the whole, the results appear to hold when considering overnight and time deposits separately (see graphs A22 and A23 for NFC and graphs A25 and A26 for households), with downward trough clearly present for overnight deposit results. The time deposit results are more erratic, which may be explained by this deposit category having been smaller in volume.

4.2.2 Robustness

As before, I consider whether the sample of member states materially affects the results. Figures A16 and A28 show the results for overnight deposits when only small member states are included, and figures A17 and A29 show the results when all 2009 member states are included. β_1 is statistically significant for about the same number of horizons as in the baseline case, both in the positive and negative shock case. The point to stress here is that the downward hump in the right-hand side graphs (that reflects that there is a role for concentration in explaining the dispersion in deposit rates after a policy surprise) is universally present.

Another latent concern, of monetary policy affecting concentration, is addressed by taking initial (2003) values of the measure of concentration that had not been affected by future unexpected changes to monetary policy. Taking these values rather than current values of HHI yield similar results, notably with the hump for β_1 present, as can be seen in figures A15 and A27. However, the effects in the positive case are more short-lived.

4.3 Individual bank data

Country-level data has the benefit of country-level observations being correctly weighted for the size of individual banks. A downside is that then all countries in turn are weighted similarly. To consider whether this matters, I redo the empirical exercise with individual bank data collected by the Eurosystem in the IBSI/IMIR databases. Larger countries tend to have more banks in the sample, which should somewhat correct for this issue.

The baseline specification is as before, amended with some bank-level controls and bank-horizon fixed effects. Subscript b denotes a bank-level observation. X_b include a leverage ratio, sovereign debt ratio, assets, deposit volumes, and loan volumes. The panel runs from 2008 until October 2023, and covers between about 60-90% of a given sector.

$$
\begin{aligned}
Y_{b,i,t+h} = \sum_{s \in \{p,n\}} &\mathbb{1}(s_t = s)[\alpha_{b,h}^s + (\beta_{0,h}^s + \beta_{1,h}^s(hhi_{i,t} - \overline{hhi}))mps_t \\
&+ \gamma_h^s \sum_{l=1}^{L} X_{t-l}' + \theta_h^s \sum_{l=1}^{L} X_{i,t-l}' + \iota_h^s \sum_{l=1}^{L} X_{b,t-l}' + \epsilon_{i,t+h}^s]
\end{aligned}
\tag{3}
$$

The results as plotted in figures A18 and A30 are broadly in line with the baseline country-level results. β_1 displays a downward hump (around the fourth month), which is statistically significant for the positive shock case. This suggests that the weighting issues presented by the way the data is aggregated are not of a major concern.

5 Conclusion

In this paper, I consider whether the response of deposit rates in the euro area to positive and negative monetary policy shocks is asymmetric, and whether this may be due to the degree of banking sector concentration. More specifically, I empirically assess - using euro area country-level and bank-level data - whether a surprise increase or decrease in interest rates trigger different responses by deposit-taking banks.

The results show that deposit rates in the euro area are indeed sticky upwards and more flexible downwards for banking sectors that are more concentrated than the average banking sector. The difference is statistically significant and economically meaningful, with deposit rates a few months after a surprise 100 basis point change in monetary policy temporarily diverging by tens of basis points between more and less concentrated banking sectors in the euro area. Equivalently, these results imply that the transmission to deposit rates in more concentrated banking sectors is slower when rates rise and faster when rates decline, with differences in the euro area context translating to delays of a few months up to about half a year. These results are broadly robust for a range of specifications, and hold across sectors (households and NFCs) and deposit types (overnight and time deposits.

This asymmetry in the monetary transmission could matter for the real economy in (at least) two ways: (1) bank profitability may be affected differently depending on the concentration of their local market (as also suggested by the cross-sectional response of net interest income, displayed in appendix figures A21 and A33), which could in turn lead to (undesirably) different effects on bank lending in response to monetary policy surprises. And, (2) how quickly households and NFCs learn about changes in monetary policy, via the deposit rate, may vary across the monetary union. This may potentially affect how quickly they adjust their economic behaviour, and in so doing would contribute to heterogeneity in the transmission of monetary policy to the real economy.

These results also potentially carry implications for the debate about the future evolution of the economic and monetary union: further progress towards completing the banking union, and by extension a greater integration of the euro area banking sector, could help to reduce heterogeneity in concentration across banking sectors. This then may reduce the dispersion seen in deposit rates across member states and further enhance homogeneity in the transmission of monetary policy.

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Altavilla, Carlo, Lorenzo Burlon, Mariassunta Giannetti, and Sarah Holton (2022). "Is there a zero lower bound? the effects of negative policy rates on banks and firms". In: *Journal of Financial Economics* 144.3, pp. 885–907. DOI: 10.1016/j.jfineco.2021.06.032.

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A   Appendix

Dynamic response to positive (black) and negative (red) monetary policy shocks

(β_0)

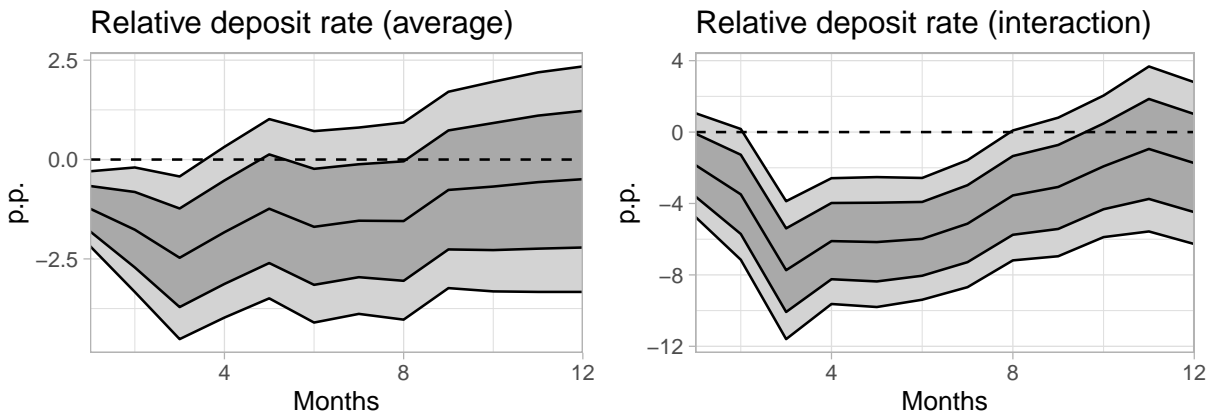Figure A1: NFC overnight deposits
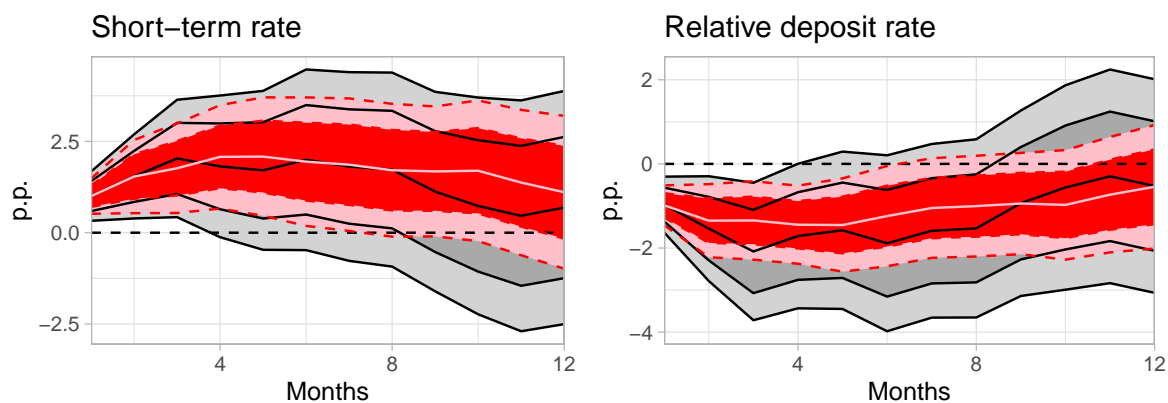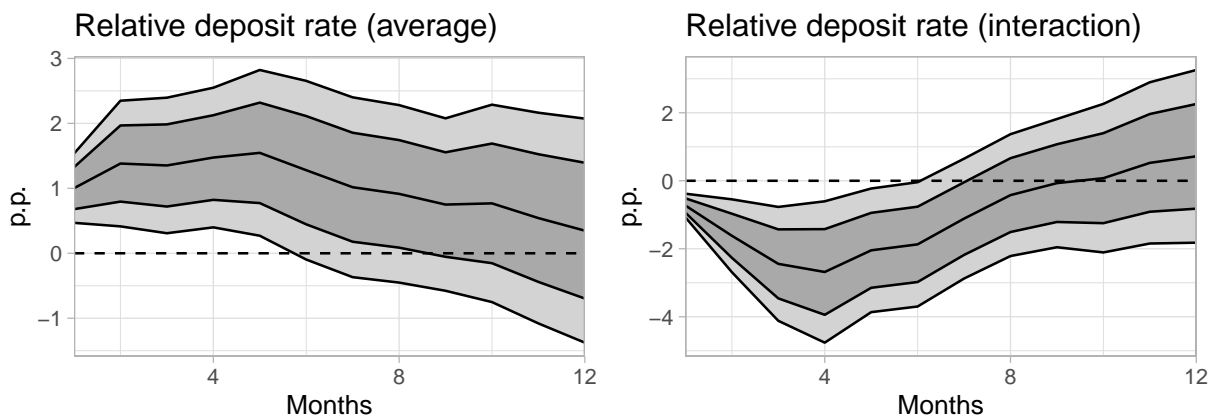

Figure A2: NFC time deposits
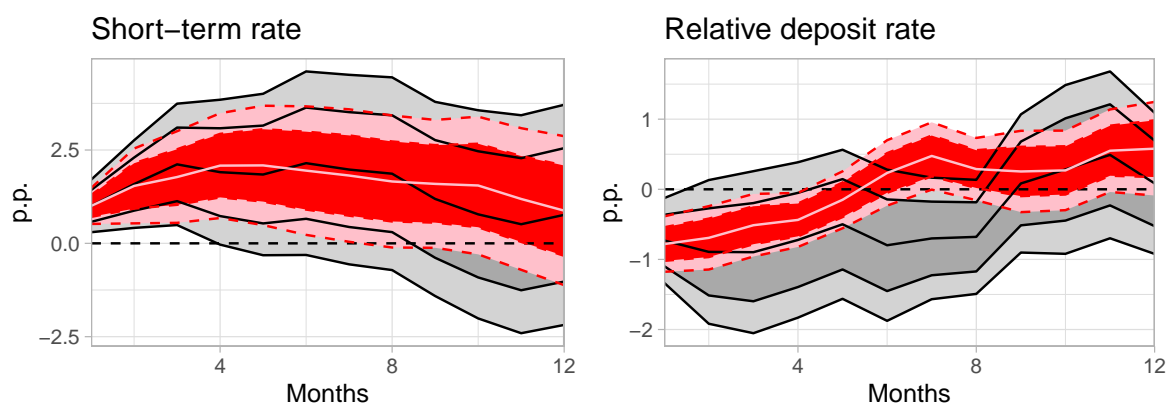
Figure A3: NFC overnight deposits, shocks as instrument
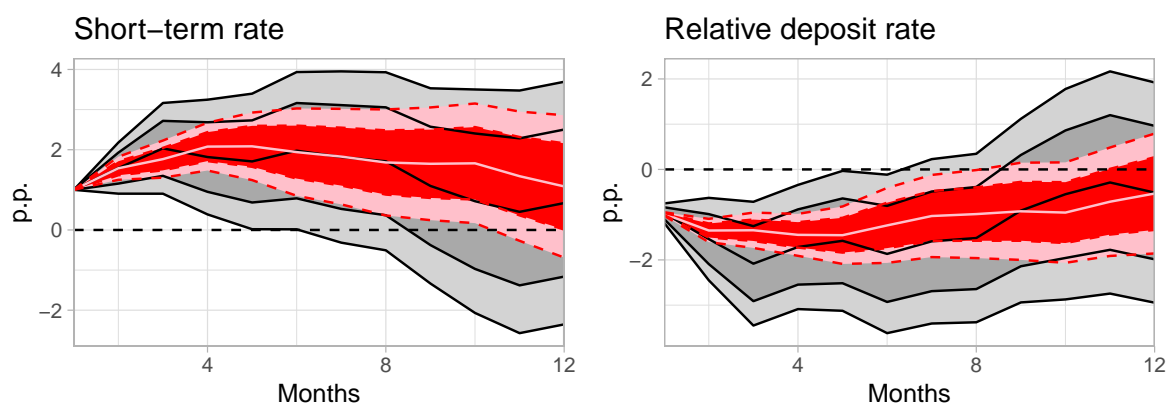
Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic response to positive (black) and negative (red) monetary policy shocks

(β_0)

Figure A4: Household overnight deposits
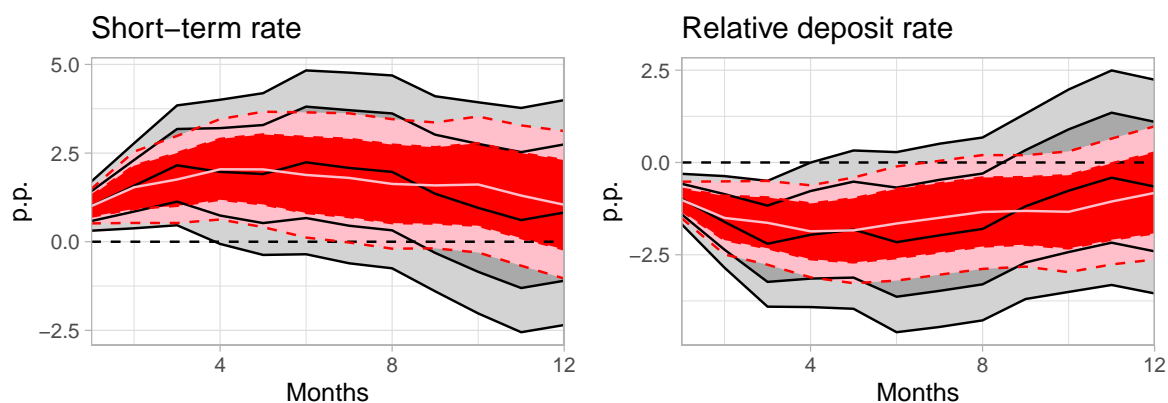
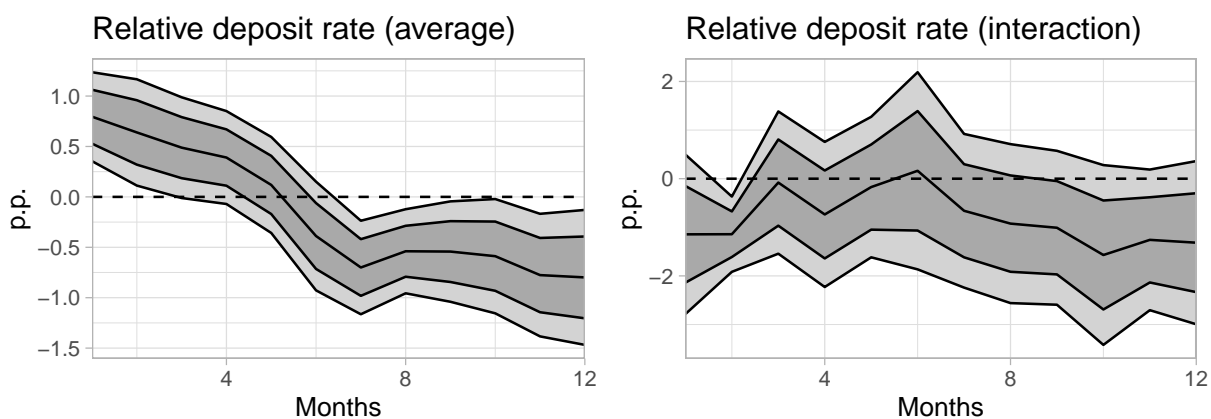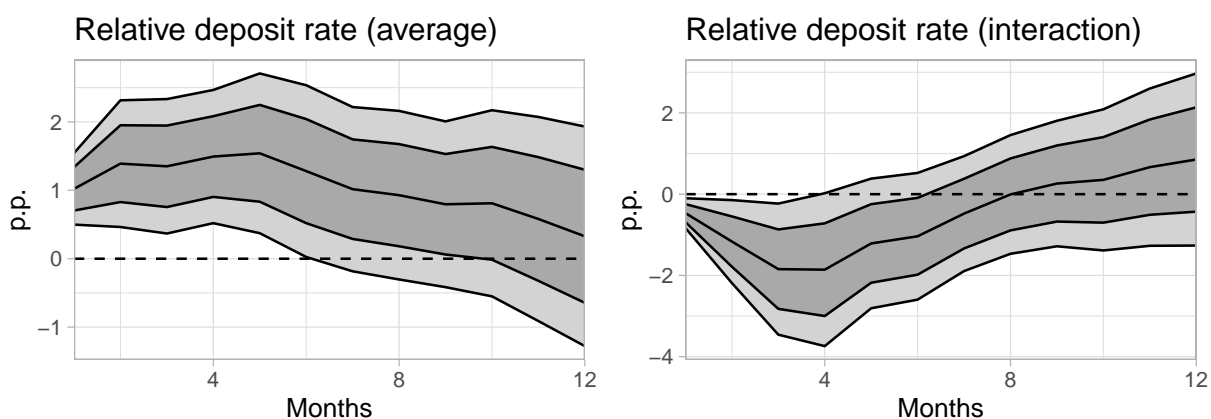Figure A5: Household time deposits
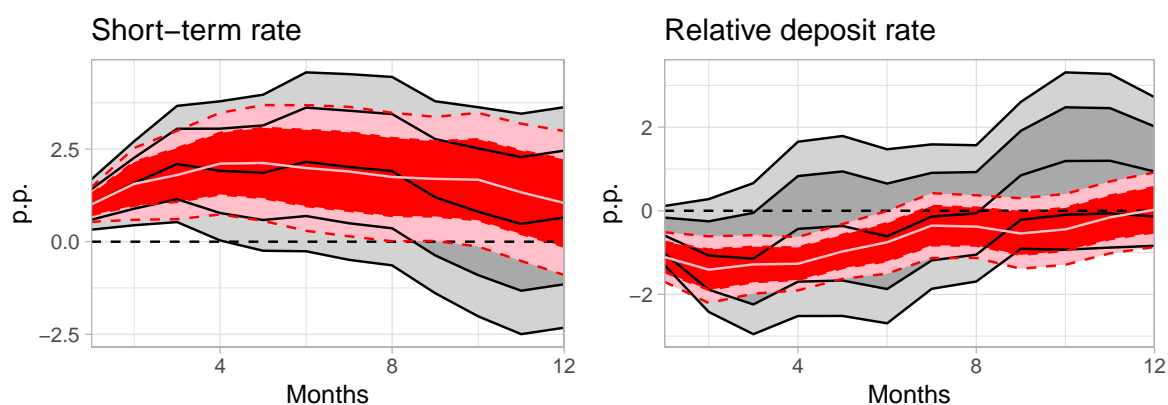
Figure A6: NFC time deposits, shocks as instrument
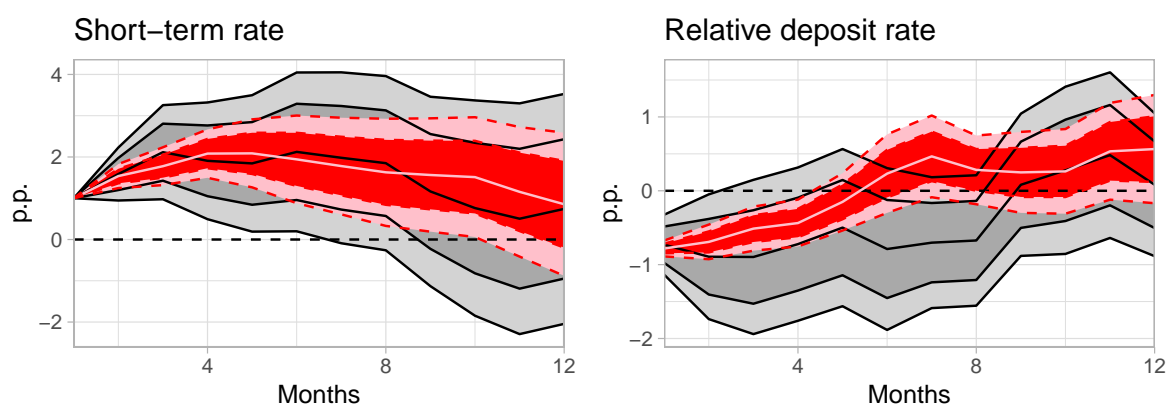
Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic response to positive (black) and negative (red) monetary policy shocks

(β_0)

Figure A7: NFC overnight deposits, pre-ELB sample

Short−term rate

Relative deposit rate
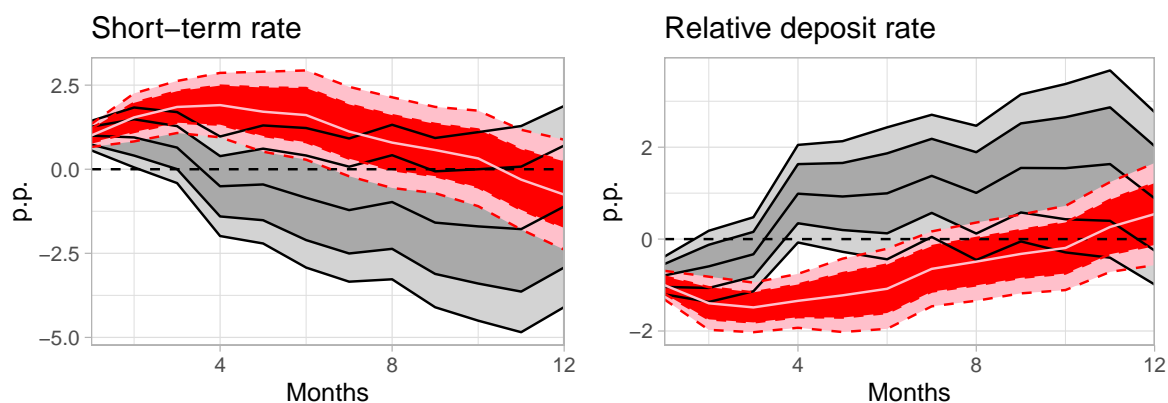
Figure A8: NFC overnight deposits, small member states

Short−term rate

Relative deposit rate
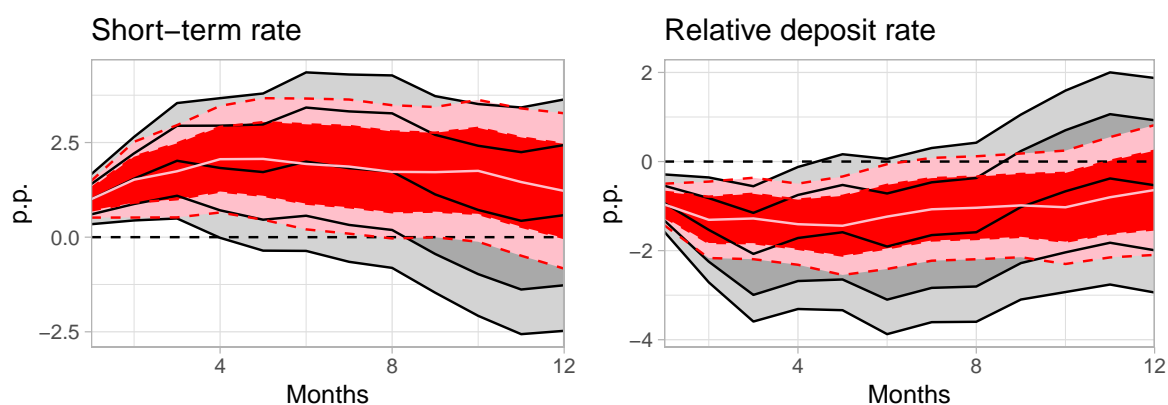
Figure A9: NFC overnight deposits, all member states
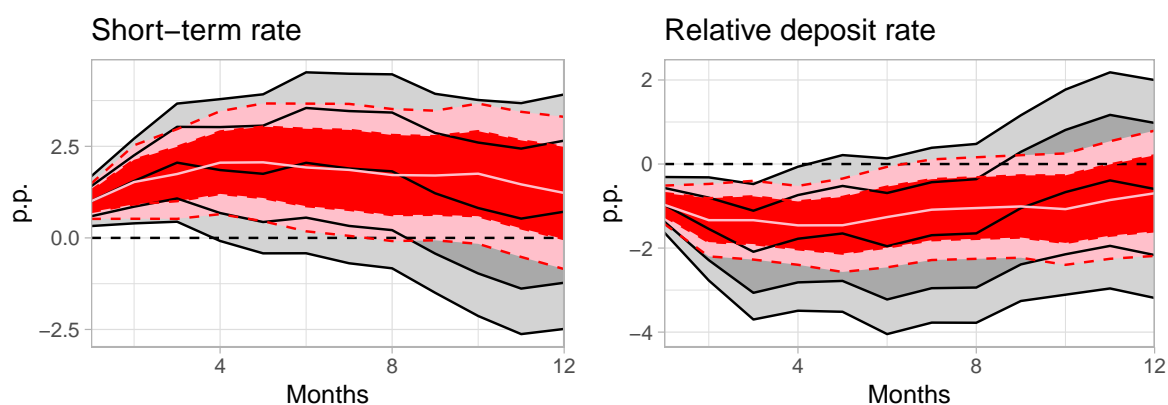
Short−term rate

Relative deposit rate

Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic responses to positive monetary policy shocks (resp. β_0, β_1)

Figure A10: NFC overnight deposits
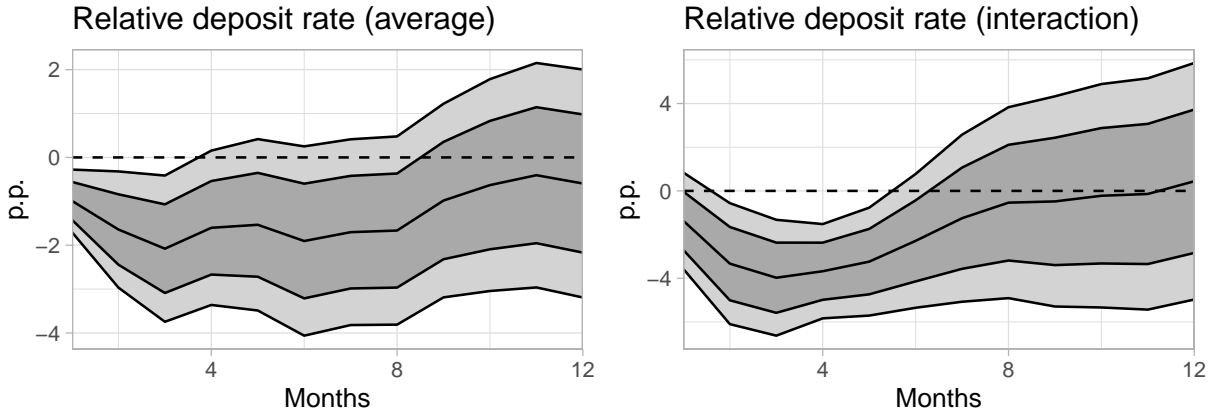
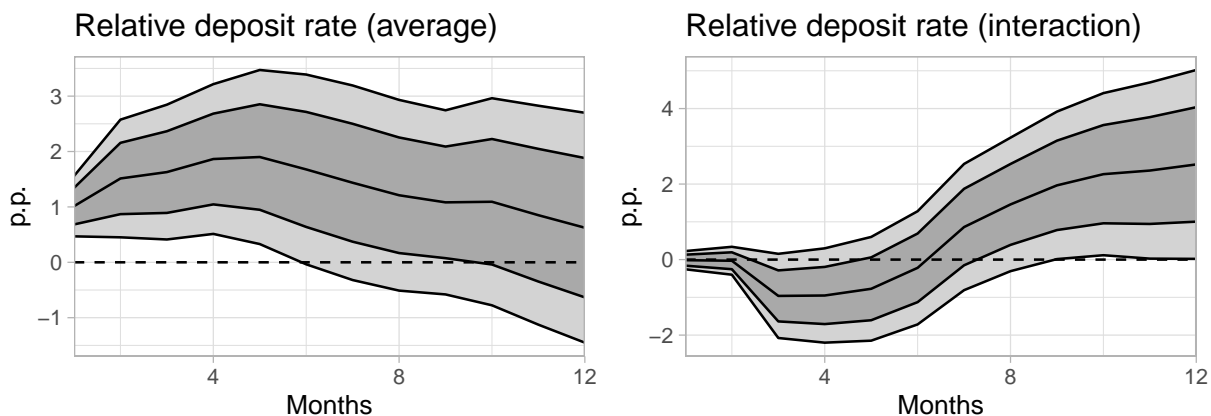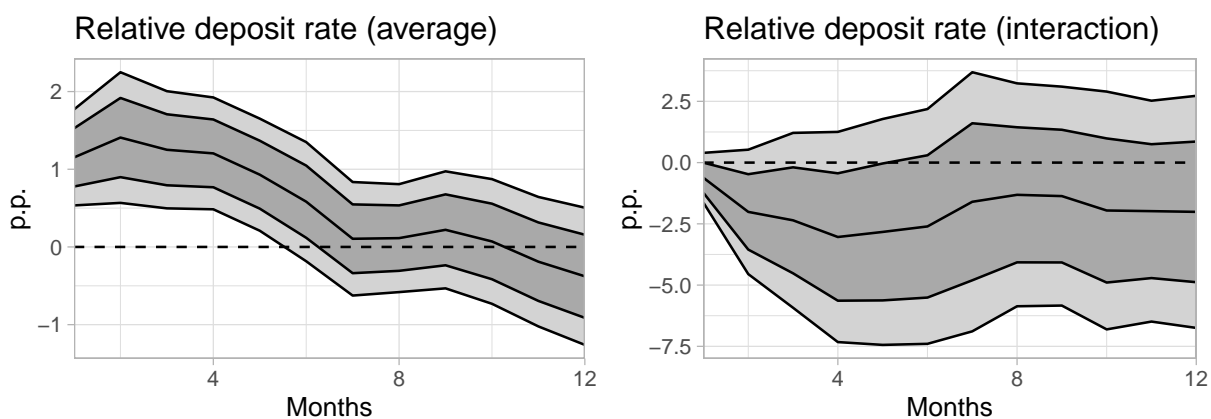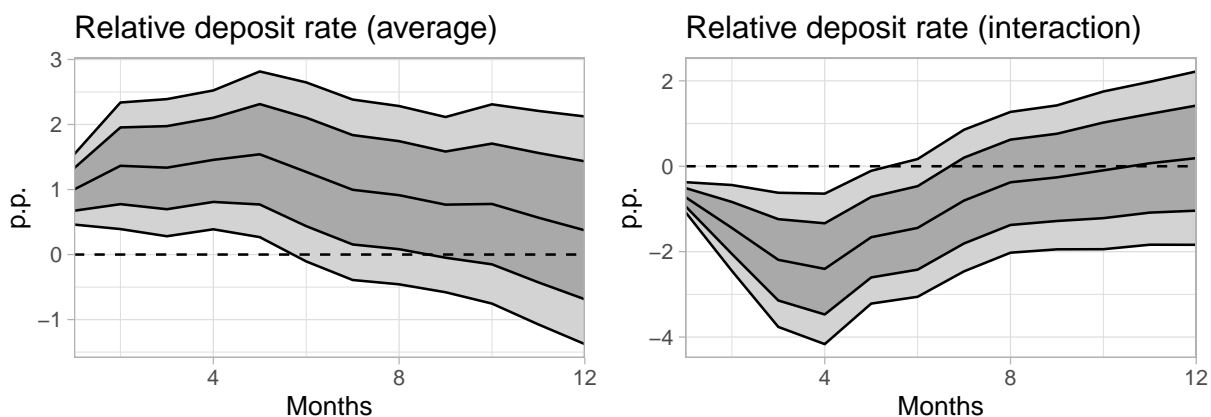Figure A11: NFC time deposits
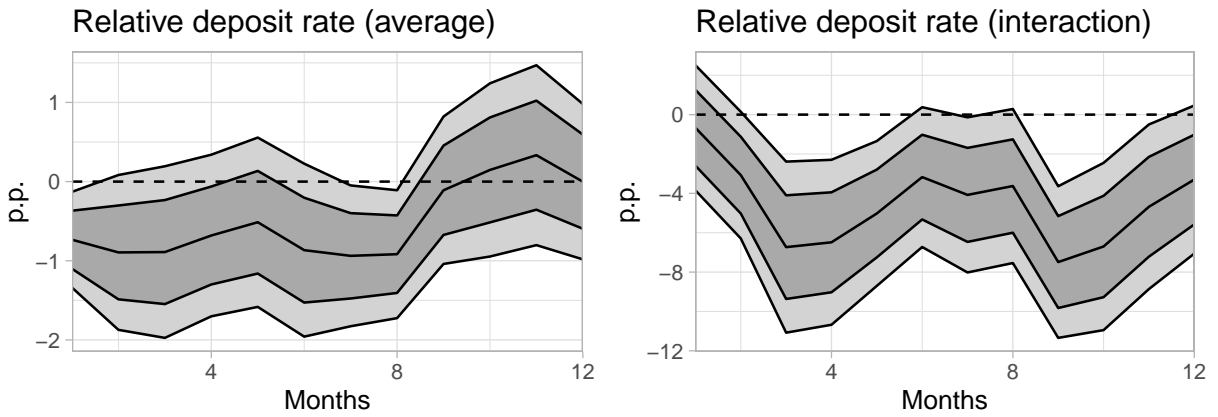
Figure A12: NFC overnight deposits, all shocks

Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic responses to positive monetary policy shocks (resp. β_0, β_1)

Figure A13: Household overnight deposits

Relative deposit rate (average)

Relative deposit rate (interaction)

Figure A14: Household time deposits

Relative deposit rate (average)

Relative deposit rate (interaction)

Figure A15: NFC overnight deposits, HHI initial values
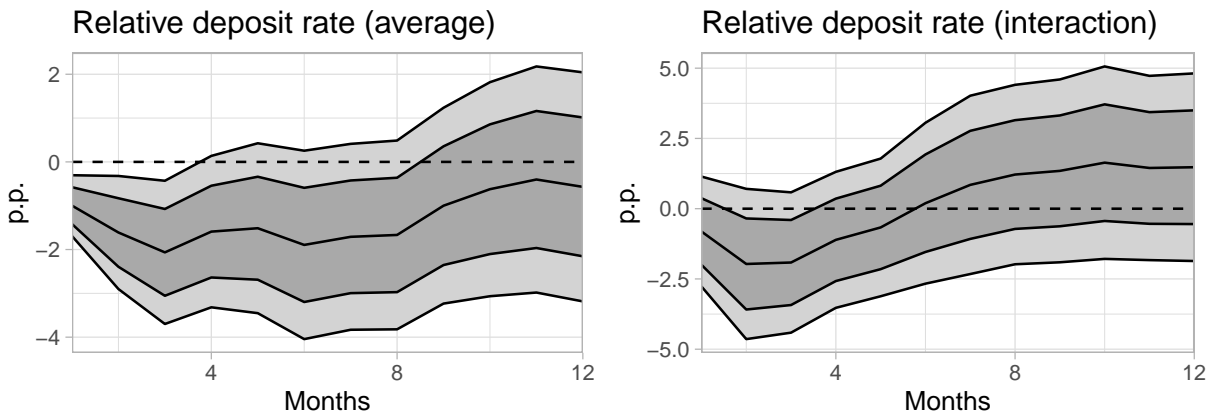
Relative deposit rate (average)

Relative deposit rate (interaction)

Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic responses to positive monetary policy shocks (resp. β_0, β_1)

Figure A16: NFC overnight deposits, small member states

Relative deposit rate (average)

Relative deposit rate (interaction)

Figure A17: NFC overnight deposits, all member states

Relative deposit rate (average)

Relative deposit rate (interaction)

Figure A18: NFC overnight deposits, individual bank-level data

Relative deposit rate (average)

Relative deposit rate (interaction)

Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic responses to positive monetary policy shocks (resp. β_0, β_1)

Figure A19: NFC overnight deposits, four lags

Relative deposit rate (average)

Relative deposit rate (interaction)
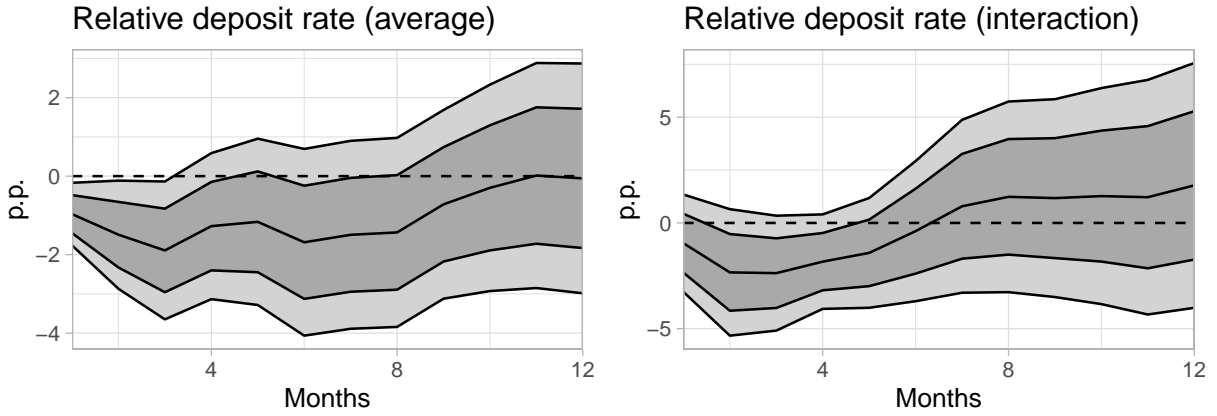
Figure A20: NFC overnight deposits, eight lags

Relative deposit rate (average)

Relative deposit rate (interaction)
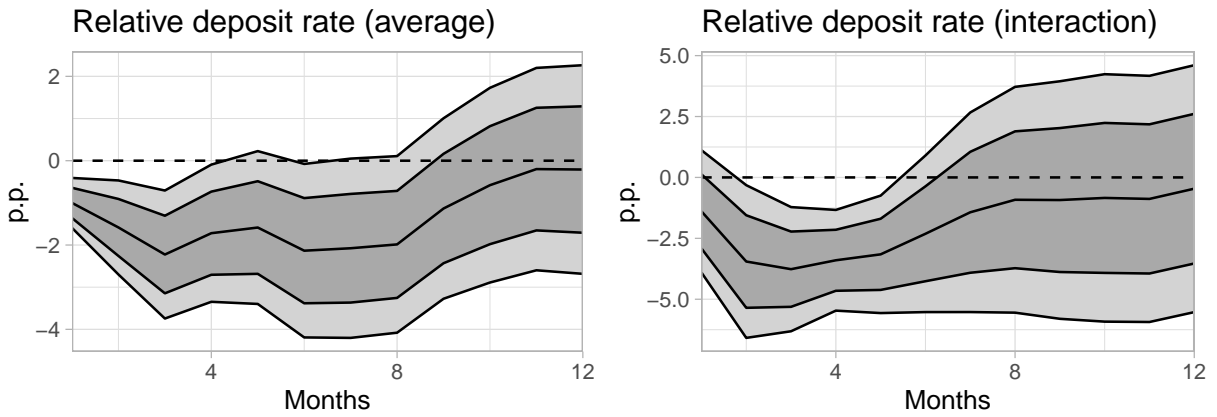
Figure A21: Net interest income (as share of total income)
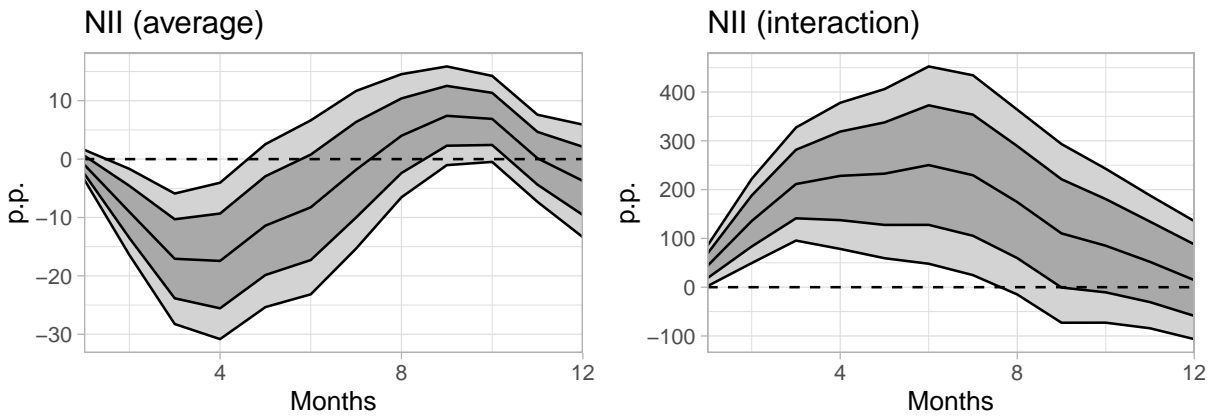
NII (average)

NII (interaction)

Note that the cumulative impulse responses are scaled to a <u>positive</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic responses to negative monetary policy shocks (resp. β_0, β_1)

Figure A22: NFC overnight deposits

Figure A23: NFC time deposits

Figure A24: NFC overnight deposits, all shocks

Note that the cumulative impulse responses are scaled to a <u>negative</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic responses to negative monetary policy shocks (resp. β_0, β_1)

Figure A25: Household overnight deposits

Figure A26: Household time deposits

Figure A27: NFC overnight deposits, HHI initial values

Note that the cumulative impulse responses are scaled to a negative 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic response to negative monetary policy shocks (resp. β_0, β_1)

Figure A28: NFC overnight deposits, small member states
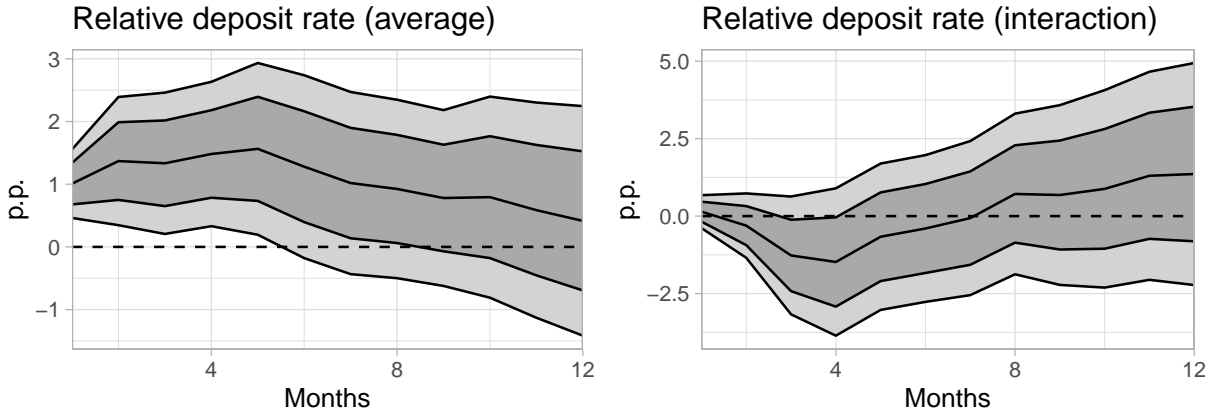
Figure A29: NFC overnight deposits, all member states
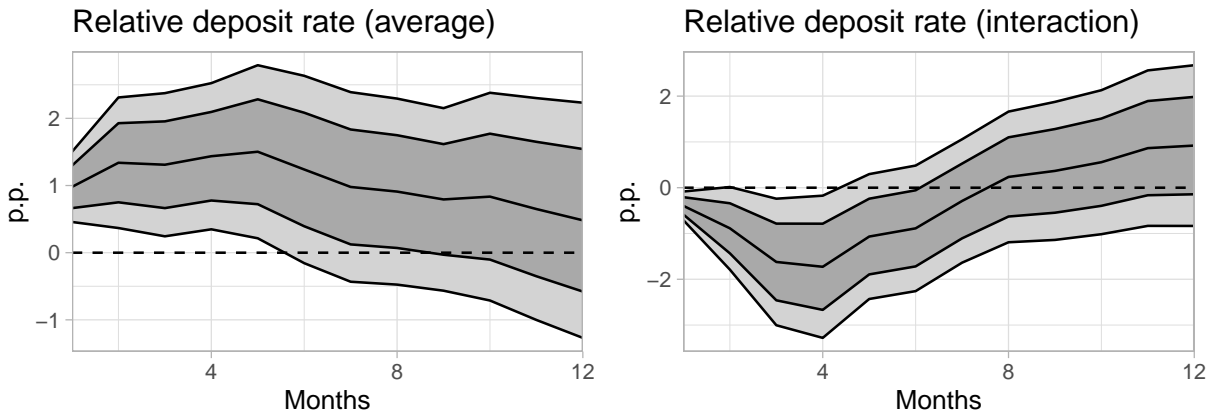
Figure A30: NFC overnight deposits, individual bank data
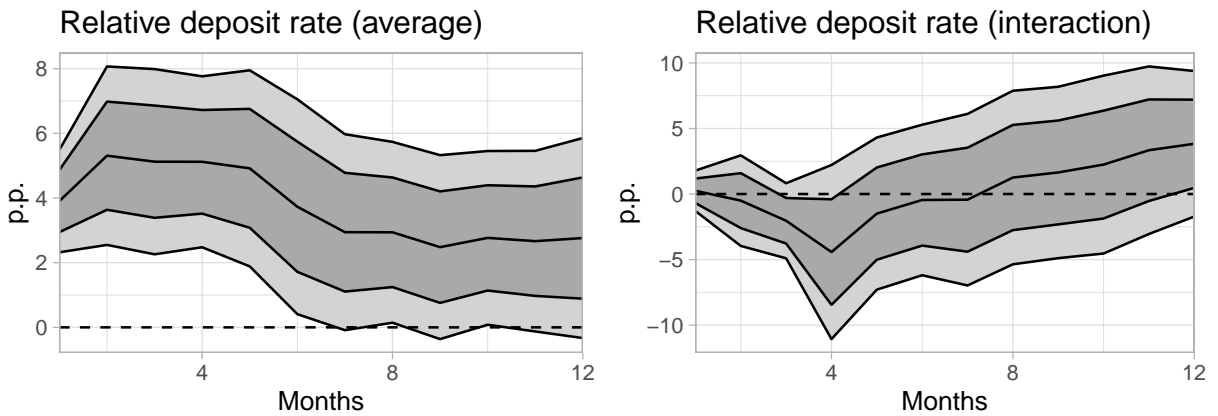
Note that the cumulative impulse responses are scaled to a negative 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

Dynamic responses to negative monetary policy shocks (resp. β_0, β_1)

Figure A31: NFC overnight deposits, four lags
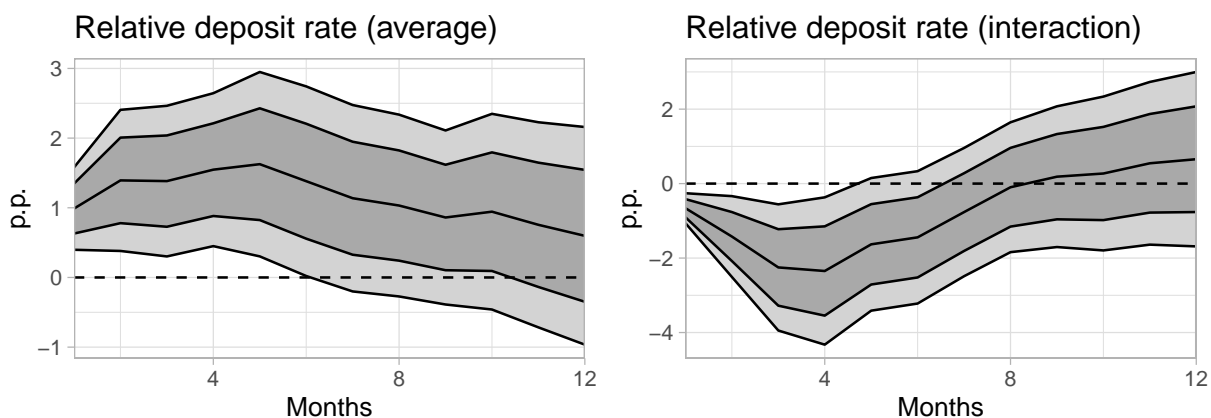
Figure A32: NFC overnight deposits, eight lags
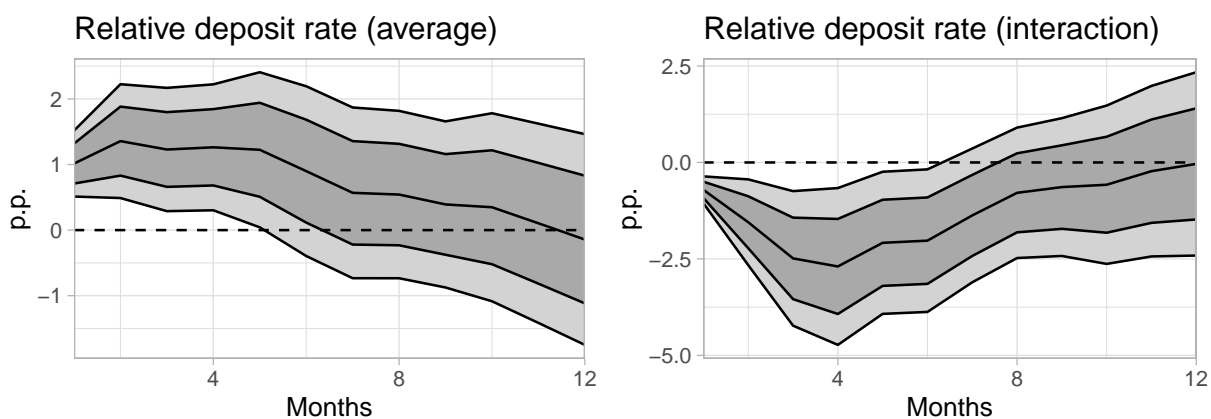
Figure A33: Net interest income (as share of total income)

Note that the cumulative impulse responses are scaled to a <u>negative</u> 100 basis point response of the short-term rate on impact, with 68% and 90% confidence intervals plotted.

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