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**Regional loan market structure,
bank lending rates and monetary transmission**

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Regional loan market structure, bank lending rates and monetary transmission¹

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Abstract

The present paper utilizes AnaCredit loan-level data to examine the impact of regional loan market structure on lending rates. The analysis focuses on newly issued loans to small non-financial corporations in the euro area during the monetary policy tightening phase of 2022 and 2023. The findings suggest that banks tend to charge higher lending rates when they possess larger regional market shares. This outcome is driven by differences between banks rather than by individual banks adjusting their lending rates to regional market conditions. Overall, there is no strong evidence that market power conveyed by higher regional market concentration impeded the transmission of the monetary policy tightening to lending rates. If anything, there are indications that this type of market power may hinder the short-term pass-through of the unexpected component of monetary policy.

Keywords: Lending rates, pass-through, loan market concentration

JEL-Classification: D40; E43; G21

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1 Introduction

The structure of the banking market is potentially a crucial determinant for loan pricing and the transmission of monetary policy. This is primarily because the degree of concentration may be linked to the level of competition or market power. However, market structure measures often prove to be poor proxies for bank competition in cross-country studies when other factors, such as legal restrictions on competition or foreign bank entry, are considered (Berger, Demirgüç-Kunt, Levine and Haubrich, 2004; Claessens and Laeven, 2004; Beck, Demirgüç-Kunt and Levine, 2006). Conversely, low concentration in the banking market is frequently associated with intense competition and low margins in the banking sector (this argument is particularly prominent in the German context; see, for example Dombret 2016 for a discussion). Part of the explanation for this contradiction could be that, in cross-country studies, measures of market structure are calculated at the national level. Regional-level measures are more appropriate for capturing the competitive environment when competition predominantly takes place at the regional level. This is especially pertinent in countries like Germany, where banks with geographically restricted business scopes play a significant role.

Against this background, the aim of the present paper is to empirically investigate whether regional concentration of the banking market significantly influences lending rates on loans to non-financial corporations (NFCs) within euro area countries. The study focuses on the period of monetary policy tightening in 2022 and 2023. Two measures of regional market concentration and their interplay are considered: overall market concentration, as captured by the Herfindahl-Hirschman Index (HHI), and bank-specific regional market shares.

This paper addresses two key questions: 1) Does regional market concentration influence banks' market power? This is evaluated by examining whether market concentration impacts the level of bank lending rates. 2) Does market concentration – through its effect on market power – affect the pass-through of monetary policy and market rates to bank lending rates? This issue is highly relevant from a monetary policy perspective. Understanding the potential relationship between regional market concentration and the pass-through of interest rates enables central banks to better comprehend potential heterogeneities in the transmission of monetary policy. Additionally, it aids in understanding the potential consequences of changes in the banking market structure for monetary policy transmission.

If regional market structure is relevant for market power, this should primarily be evident in business with small NFCs. These borrowers generally have fewer outside options in the form of banks in other regions or alternative funding sources beyond bank loans. Therefore, the paper focuses on loans to small or micro NFCs as defined by the European Commission. According to the Commission's definition, an NFC is considered small if it has fewer than 50 employees and either a turnover or a balance sheet total of less than 10 million euros. Additionally, the paper only considers loans to NFCs that are not part of a group, as NFCs belonging to a group might naturally have better outside options, such as internal capital markets.

For the investigation, the comprehensive AnaCredit dataset is leveraged in two ways. First, AnaCredit encompasses nearly the entire market for loans to NFCs in the euro area, enabling the calculation of regional market concentration measures and bank-specific regional market shares for loans to small NFCs. Second, regressions can be conducted at the single loan level, with the lending rate serving as the dependent variable and measures of regional market concentration as explanatory variables. This approach allows for the assessment of whether a bank charges higher rates on loans to small NFCs in regions where overall concentration and/or its own market shares are higher. It also allows for the assessment of whether such an adjustment to regional market conditions occurs within a bank. This can be achieved by focusing on variations in banks' lending rates for banks that issue loans in different regions via the inclusion of bank fixed effects. To the best of my knowledge, this paper is the first to utilize such a comprehensive loan-level dataset to both determine regional market structure and evaluate its impact on lending rates and monetary transmission.

This paper relates to several papers that have investigated the relationship between lending rates and measures of competition or market structure. Some of these papers examine the influence of market structure or market power on lending rates at the national level (e.g. Corvoisier and Gropp, 2002; van Leuvensteijn, Kok Sørensen, Bikker and van Rixtel 2013; Leroy and Lucotte, 2015). Other studies have used data from a single country to analyse the impact of market structure or market power on lending rates, often relying on bank-specific measures. A notable contribution in this context is by Heckmann-Draisbach and Hardt (2024), whose research questions, based on German data, closely align with those of this paper. However, their empirical approach differs. Heckmann-Draisbach and Hardt employ bank-level data on anticipated changes in lending rates under various hypothetical interest rate scenarios, and then regress both lending rates and the differences between scenarios on bank-specific measures of market structure or market power. Cañón, Cortés and Guerrero (2022) use Mexican loan-level data to investigate the impact of market power on lending rates. They employ the Lerner index,

which is bank-time specific, thereby excluding the possibility of incorporating bank fixed effects in their econometric model. In line with the methodology of this paper, Gödl-Hanisch (2022) examines the effect of regional market structure on lending rates in the US. Using US bank-branch level data, the author calculates market structure measures at the regional (county) level and subsequently employs this branch-level data to assess the impact of market structure on both lending and deposit rates.²

Leveraging the comprehensiveness of the AnaCredit dataset, this paper, to the best of my knowledge, is the first to make the following contributions to this literature:

- It examines the role of the banking market structure on the regional level for rates on NFC loans in the entire euro area, within countries and in some specifications also within banks. A wide range of other variables that might potentially influence lending rates are therefore controlled for.
- It thus focuses on the segment of NFC loans where regional market structure is expected to matter most: lending to small, independent NFCs.
- It disentangles the effects of overall market concentration and bank-specific market shares on lending rates, offering a more nuanced understanding of how market concentration impacts lending rates.

The findings indicate that larger bank-specific regional market shares are associated with higher lending rates, while overall market concentration appears to play a less important role. However, the relationship between regional market shares and lending rates vanishes when bank fixed effects are included in the estimations. Furthermore, there is no strong evidence to suggest that regional market shares or overall market concentration significantly affected the pass-through of monetary policy measures or market rates to lending rates during the monetary policy tightening episode of 2022 and 2023.

2 Formulation of hypotheses

Considering market concentration as an indicator of competition or market power involves several assumptions. First, it is assumed that lower concentration leads to increased competition. This may be true, as a less concentrated market with a higher number of banks provides more options for potential borrowers, thereby enhancing their bargaining power with respect to a particular bank. Second, there must be barriers to market entry of some kind. Otherwise, even if the actual concentration in a banking system is high, the threat of new competitors entering the market might limit actual

² This approach is based on the seminal work of Drechsler, Savov and Schnabl (2017), which examines the deposit market in the US.

market power. This point is particularly relevant for regional markets within a country: entering a new regional market is likely to be less costly for a bank than entering a new country. However, there may still be barriers to entry. Customers might value the physical presence of a bank they do business with, necessitating the establishment of local branches. Evidence from the US indicates that this is indeed the case, although the importance of local branches appears to be declining (Anenberg, Chang, Grundl, Moore and Windle, 2018). Furthermore, lending to a region that is farther away from a branch may make the gathering of relevant information by the bank more difficult or expensive (Agarwal and Hauwald, 2010; Heitz, Martin and Ufier, 2023).

Even if both assumptions outlined above may seem strong, they can be empirically tested when assessing the role of regional market concentration on lending rates. If higher regional market concentration is an indicator of a less competitive banking market, one would also expect higher concentration to entail higher lending rates. This is because both theoretical and empirical findings strongly suggest that competition is negatively related to lending rates. A simple model supporting this view is outlined in Annex Ia. The hypothesis is also consistent with settings assumed in the DSGE-literature, where the elasticity of loan demand is constant (see Gerali, Neri, Sessa and Signoretti, 2010 or Gödl-Hanisch, 2022). Empirical studies exploiting variation between euro area countries confirm that the level of lending rates tends to decrease when competition measures indicate a more competitive banking market (e.g. van Leuvensteijn et al., 2013; Leroy and Lucotte, 2015). Within Germany, Heckmann-Draisbach and Hardt (2024) find a positive association between regional market concentration and lending rates, supporting the idea that market concentration is a suitable indicator for competition.

The third assumption appears more problematic, as it pertains to the classic "confounding problem." One has to assume that regional market concentration arises exogenously with respect to lending rates. However, regional market structure may be endogenously influenced by factors that also affect bank lending rates. Ideally, one would seek some form of "exogenous market structure shock." However, finding such a shock for the entire euro area is exceedingly difficult. Therefore, it is crucial to control for potential confounders in the empirical investigations as thoroughly as possible. This leads to the first hypothesis to be tested:

H1: A positive link between regional market concentration and lending rates can be established in regressions that account for a wide range of other factors potentially impacting lending rates.

Loan level data from the AnaCredit dataset, containing a wide array of variables concerning the characteristics of the borrower and the loan, are well suited in this context.

They allow for controlling for borrower-related factors as well as for numerous loan characteristics. Additionally, they enable the inclusion of fixed effects at the country level to capture country-specific forces that might influence banks' market power, such as legal restrictions on competition or foreign bank entry mentioned earlier in the paper. Furthermore, they allow for assessing whether there is an adjustment of loan pricing to regional market structure taking place within banks. Technically, this can be implemented by including fixed effects at the bank level. These fixed effects capture bank-specific factors such as cost efficiency and indicators of market power at the bank level, often measured by the Lerner index.³ Importantly, they also absorb the effects of bank-specific funding costs on lending rates. As such, estimations with bank fixed effects focus on the effects of loan market structure and loan market power, as opposed to market power in funding markets (see for example Wang, Whited, Wu and Xiao, 2022 for a comparison of these types of market power and Carletti, Leonello and Marquez, 2024 for the relevance of interactions between both types of market power). The loan level data also allow for including fixed effects on the bank-sector level that absorb a potential specialization of banks in lending to certain sectors (see e.g. Jahn, Memmel and Pfingsten, 2013 and Blickle, Parlato and Saunders, 2023 for evidence of such a specialization).

If the empirical results support H1, the next step is to examine how market power stemming from a more concentrated banking market influences the pass-through of monetary policy measures and market rates to lending rates. This leads to the second hypothesis:

H2: A higher concentration in the regional loan market leads to a weaker transmission of policy and market rates to lending rates.

The theoretical basis for H2 is less robust compared to H1. Models with constant demand elasticities, such as those by Gerali et al. (2010) or Gödl-Hanisch (2022), suggest that the mark-up on lending rates is a constant multiple of the market or policy rate. As market power increases, this constant multiple rises, resulting in a higher mark-up (consistent with H1) but also a stronger pass-through, which contradicts H2. Conversely, assuming a linear loan demand function in lending rates may produce the opposite effect: increased market power leads to a diminished pass-through. This outcome is demonstrated in the simple model presented in Annex Ia (also see Corvoisier and Gropp, 2002 for a slightly different model). Empirical studies for Europe and Germany indicate that greater market power among banks results in a muted pass-through (see again van Leuvensteijn et al., 2013 and Leroy and Lucotte, 2015 for cross-country studies for euro area countries and

³ See Silva, Stancato de Souza and Guerra (2022) for a nice approach to calculate the Lerner index not only at the bank level but also at the local level.

Heckmann-Draisbach, 2022 for Germany). Ultimately, H2 is supported by this empirical evidence. However, it is important to acknowledge that the theoretical foundation for H2 is less solid than that for H1.

So far, there has been no discussion on whether overall market concentration or bank-specific market shares are more relevant in the context of H1 and H2. The model outlined in Annex Ib suggests that higher bank-specific market shares lead to higher lending rates, particularly when bank funding costs are low. Additionally, higher bank-specific market shares result in a muted pass-through. The extent to which overall market concentration affects lending rates and the pass-through depends on the values of the model parameters.

For instance, if market concentration increases due to the merger of two banks operating within the same market, it is possible that the higher concentration enables all banks in the market to charge higher lending rates. However, it might also be the case that only the merging banks can increase their lending rates, while other banks may reduce theirs in response to the increased market power of the new, larger competitor. Consequently, the effect of the merger on average regional lending rates would be ambiguous, depending on the extent to which the merging banks raise their rates relative to the extent to which other banks lower theirs, as well as the significance of the merging banks within the market. This example suggests that disentangling the effects of overall market concentration and bank-specific market shares is a worthwhile endeavour.

3 Data sources and description

The primary data source for this paper is the AnaCredit dataset, which is collected across all euro area countries. This dataset provides comprehensive information on all loans granted to NFCs by euro area banks, provided the total loan volume at the bank-borrower level exceeds 25,000 euros. This dataset is well-suited for calculating market concentration measures on the regional level and at the same time for examining the determinants of lending rates. A detailed description of the dataset can be found in ECB, 2019.

The calculation of regional market concentration measures is based on loans to NFCs that are classified as small or micro according to the European Commission's definition: having no more than 49 employees and either a balance sheet total or turnover not exceeding 10 million euros. Additionally, only loans to NFCs that are not part of a corporate group are considered. Loans with financial guarantees are excluded from the sample if the protection provider or its parent entity belongs to the public sector, as such guarantees often indicate promotional loans. For the purposes of this paper, it is preferable

to exclude these loans, as a high market share achieved by directing through a lot of promotional loans is probably not a good indicator of market power. Regional market shares are calculated based on outstanding loan volumes plus credit lines recorded as off-balance sheet amounts as of December 2021.

The analysis of the potential impact of market concentration on lending rates is based on newly granted loans to NFCs from January 2022 until December 2023. Several restrictions are applied to the sample to ensure greater homogeneity. Only loans that meet the following criteria are considered: they must be granted to small or micro NFCs that are not part of a corporate group, be denominated in euros, have an initial interest rate fixation period of no more than three years, have a volume between 25,000 euros and 10 million euros, and the borrower must not have a probability of default (PD) exceeding 10% (if the PD is available). The homogeneity of initial interest rate fixation facilitates the analysis of monetary policy pass-through, as it is expected to imply a corresponding homogeneity in market reference rates. Furthermore, loans to highly risky borrowers or those already in default are excluded from the sample due to the upper bound on the probability of default (PD). This exclusion is intended to reduce the prevalence of “evergreening” loans within the dataset (see Peek and Rosengren, 2005 for evergreening loans). Such loans are often granted under very specific circumstances, which may result in distorted relationships between lending rates and other loan characteristics. The sample is further restricted to loans for which the reporting bank is the sole creditor. Additionally, loans with financial guarantees are excluded if the protection provider or its parent entity belongs to the public sector, as such guarantees – as outlined above – often indicate promotional loans. The pricing of these loans is typically strongly influenced by the design of public support programmes.

Another step in creating the sample involves excluding banks that grant a high proportion of loans with zero or below zero interest rates. These banks are defined as those for which the share of newly granted loans with zero or below zero interest rates in 2023 – when market rates had already risen significantly due to monetary policy tightening – exceeded 25%. This criterion affects less than 5% of banks. However, it turns out that including these banks in the sample can significantly affect the overall results. The results are more robust, particularly concerning the exclusion of individual countries, when these banks are removed from the sample. The business models of the excluded banks and their ownership structures suggest that zero or below zero interest loans are often used by borrowers to purchase products offered by entities within the corporate group to which the lending bank belongs. Consequently, the zero or below zero interest rate could be interpreted as an incentive for borrowers to buy these products, leading to distorted relationships between lending rates and other loan characteristics. Overall, the share of

zero or below zero interest rate loans – including those granted by banks with a high proportion of these loans that were finally excluded from the sample – accounts for approximately 12% of all loans granted in 2023. This is only slightly higher than the corresponding share for loans to large NFCs, which stands at around 10%. Therefore, zero or negative interest rate loans are not a phenomenon exclusive to business with small NFCs. As a result, excluding banks with a high proportion of these loans from the sample does not systematically reduce the sample weight of a specific type of business activity uniquely tied to small NFCs.

The AnaCredit dataset includes information on bank ownership relations. This information is utilized to consolidate market shares of banks that belong to the same banking group and to create bank fixed effects at the banking group level.

Finally, complementary regional data on population densities and regional GDP (both absolute and per capita) are sourced from Eurostat. Information on monetary policy surprises is obtained from the euro area monetary policy event study database, provided by and described in Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019). Bank level variables used in certain estimations are sourced from the individual balance sheet items (iBSI) dataset. Data on bank deposit rates, utilized in the robustness section, are drawn from the individual MFI interest rate (iMIR) dataset. The iBSI and iMIR datasets provide information on balance sheet items and lending or deposit rates at the individual bank level for euro area banks (for further details on these datasets see Morandi and Bojaruniec, 2016).

4 Measures of regional market concentration

The calculation of regional market concentration measures relies on data on outstanding loans to NFCs from the AnaCredit dataset. These measures are calculated at both the NUTS-3 and NUTS-2 levels.⁴ The primary focus will be on the NUTS-3 level data, while results pertaining to the NUTS-2 level can be found in Annex II.

To calculate the measures of regional market concentration, each outstanding loan (including off-balance sheet amounts) is assigned to a bank-region cluster based on the NUTS-3 or NUTS-2 region where the borrower is located and the creditor banking

⁴ NUTS stands for “Nomenclature des Unités territoriales statistiques”. In Germany, for instance, there are 401 NUTS-3 regions. A NUTS-3 region corresponds to a “Landkreis” or a “kreisfreie Stadt”. NUTS-2 regions are larger geographical units that encompass several NUTS-3 regions. In Germany, there are 38 NUTS-2 regions, which correspond to “Regierungsbezirke”.

group.⁵ Using these assignments, bank-specific market shares and measures of overall market concentration, which aggregate information on banks' market shares in each region, can be calculated. The benchmark measure for overall market concentration in this paper is the HHI.

The HHI and bank-specific regional market shares both pertain to December 2021. The HHI is calculated as the sum of the squares of the regional market shares of all banks active in the respective region. The HHI ranges from zero, in the hypothetical scenario of an infinite number of infinitesimally small banks, to one, in the case of a single bank covering the entire regional market. The bank-specific regional market share represents the proportion of the outstanding loan amount in a region for the respective bank relative to the total outstanding loan amount in that region.

Table 1 presents descriptive statistics for the HHI across all euro area NUTS-3 and NUTS-2 regions for which the measure can be calculated, as of December 2021. Additionally, the table includes similar statistics for the concentration ratio (CR3), which is the sum of the market shares of the three largest banks in each region. The mean, standard deviation, and percentiles of these measures are relatively similar for both NUTS-3 and NUTS-2 regions. Moreover, the share of the sum of squares within countries indicates that a significant portion of the variation in regional market concentration measures occurs within countries for NUTS-3 regions. In contrast, this within-country share is considerably smaller for NUTS-2 regions. The table also reveals a high correlation between HHI and CR3, suggesting that a high market share of the largest banks coincides with a high overall market concentration.

⁵ A group is defined based on group identifiers available in the euro area-wide AnaCredit dataset. For single banks that are not part of a group, the loan is assigned to the respective single bank. In the subsequent text, "banking group" will be referred to simply as "bank".

Table 1: Descriptive statistics for regional HHI and CR3

	NUTS-3		NUTS-2	
	HHI	CR3	HHI	CR3
Mean	0.169	0.581	0.142	0.526
Standard deviation	0.098	0.175	0.090	0.202
25th percentile	0.106	0.468	0.077	0.365
50th percentile (median)	0.142	0.565	0.124	0.517
75th percentile	0.214	0.685	0.185	0.669
75th - 25th percentile	0.109	0.217	0.108	0.304
Share sum of squares within countries	0.632	0.628	0.218	0.203
Correlation	0.89		0.95	
Number of observations	939		178	

Note: Values for the HHI and CR3 pertain to December 2021. Including off-balance-sheet-amounts; loans to small- and micro-sized companies only; on banking group level; no loans with financial guarantees from public sector institutions. “75th - 25th percentile” denotes the difference between the 75th and the 25th percentile of the distribution. “Share sum of squares within” denotes the proportion of the sum of squares within countries (with one minus this share being the share of sum of squares between countries).

5 Empirical setup

Loan-level regressions are employed to evaluate the impact of regional market concentration on lending rates. These regressions include loans that were newly granted between January 2022 and December 2023 to small and micro NFCs that are not part of a corporate group (for additional sample restrictions, see Section 3). The regressions are conducted in Stata using the "reghdfe" command, as described by Correia (2017).

The regressions include:⁶

- Measures of market concentration: These include the regional HHI and the bank-specific regional market share. Furthermore, they also include the interaction between both variables. The interaction term allows the effect of one measure to depend on the level of the other. For instance, a high bank-specific market share might affect lending rates differently in a regional market with high overall concentration compared to a market with lower overall concentration.
- Bank level variables or fixed effects on varying levels to capture bank-related factors: Bank-level variables include the size of the bank, measured by the logarithm of total assets, and two business model variables: the share of deposits from private households and NFCs over total assets and the share of loans to private households and NFCs over total assets. In tighter settings, bank level

⁶ The selection of variables is similar to that in Deutsche Bundesbank, 2023, p.53.

variables are replaced by fixed effects on the bank-country level⁷ or even on the bank-country-borrower sector level. The borrower sector variable can take six values based on the NACE-1 code of the borrower.⁸ These fixed effects aim to capture bank characteristics and bank-sector specialization. In some settings, bank fixed effects are expanded by the time dimension to the bank-country-time level to capture time variant bank characteristics as well.

- Fixed effects on the country-sector-size-time level. This approach aligns with the suggestion of Degryse, De Jonghe, Jakovljevic, Mulier and Schepens (2019) to capture borrower-related effects. Note, however, that contrary to their approach, fixed effects are applied at the country level rather than the regional level. This is because fixed effects at the regional level would eliminate the variation necessary to identify the effect of the HHI variable. The size classes used to construct the fixed effects are based on the number of employees: up to 4 employees, 4-14 employees, 15-29 employees and 30-49 employees.
- Control variables describing loan characteristics: The log loan amount (including off-balance sheet amounts), the value of protections for the loan relative to the loan amount, indicators for whether the initial interest rate fixation is above 3 or above 12 months plus interactions of these indicators with the difference between the 12-month Euribor and the 3-month Euribor in the respective month, the original maturity, whether the loan is a working capital loan, the loan type (credit line, leasing, factoring or other loan), the amortisation type and whether the creditor can seize assets other than the protection (recourse). Additionally, a variable is included that flags relationship lending loans. A newly granted loan is flagged as a relationship lending loan if any loan relations between the lender and the borrower are recorded in AnaCredit in the 24 months prior to the loan's origination. This variable is included to avoid confounding, as regional market structure might be related to the prevalence of relationship lending (Petersen and Rajan, 1995), and relationship lending itself might be a determinant of lending rates (Bolton, Freixas, Gambacorta and Mistrulli, 2016). Another variable captures the share of loans in a respective region of a bank over all loans of a bank (pertaining to outstanding loans volumes at the end of 2021). This variable aims to control for potential bank specialization in certain regions (see Casado and

⁷ Bank level variables and fixed effects are applied at the banking group level, rather than at the level of single banks (although for banks that are not part of a group both levels coincide). In case of bank level variables, all values from iBSI single banks that belong to the same banking group are aggregated. As indicated above, for the purpose of simplicity “banking group” will be referred to simply as “bank”.

⁸ The six values are: construction (NACE-1 code F), manufacturing (NACE-1 codes A, B and C), real estate (NACE-1 code L), trade (NACE-1 code G), utilities (NACE-1 codes D and E) and services (all remaining NACE-1 codes),

Martínez-Miera, 2024 for this type of specialization).⁹ Finally, borrower risk is captured via the volume-weighted average PD over all newly granted loans for which a PD is observed. This average PD is calculated for every region-sector-time bucket and subsequently assigned to all newly granted loans in this bucket.

- Regional variables: These pertain to the same level as the measure of market structure and include regional GDP, regional GDP per capita and population density. All regional variables are expressed in logs. Population density pertains to 2021, while the GDP-variables pertain to 2019 in order to prevent temporary effects of the Covid-19 pandemic from affecting these variables.

6 Relevance of regional market concentration for the level of lending rates

This section investigates the relevance of regional market concentration for the level of lending rates. The baseline model can be written as follows:

$$lr_{i,b,j,t} = \beta' \mathbf{MC}_{b,r(j)} + \gamma_1' \mathbf{B}_b + \mathbf{fe} + \gamma_2' \mathbf{X}_i + \gamma_3' \mathbf{R}_{r(j)} + \varepsilon_{i,b,j,t} \quad (1)$$

Here, $lr_{i,b,j,t}$ refers to the lending rate for loan i granted by bank b in month t to an NFC j from sector $s(j)$ in region $r(j)$ in country $c(j)$. The vector $\mathbf{MC}_{b,r(j)}$ includes the measures of market concentration encompassing the regional HHI, the bank-specific regional market share and the interaction of both variables. It can also be written as: $\beta_{HHI} * HHI_{r(j)} + \beta_{MS} * MS_{b,r(j)} + \beta_{INT} * HHI_{r(j)} * MS_{b,r(j)}$ where $MS_{b,r(j)}$ is the market share of bank b in region $r(j)$. $\mathbf{B}_b$ denotes bank-related controls. These are either the variables on the bank level mentioned in the previous section (bank size, share of deposits from private households and NFCs over total assets and share of loans to private households and NFCs over total assets) or fixed effects on the bank-country level, the bank-sector-country level or the bank-year/month level. $\mathbf{fe}$ contains the fixed effects capturing borrower-related effects which are on the country-sector-size-time level. The vector $\mathbf{X}_i$ includes the loan characteristics described in the previous section¹⁰ and $\mathbf{R}_{r(j)}$ is a vector with the regional variables other than the measure of overall market concentration.

⁹ Note that while this variable is measured at the banking group level, the relationship lending variable is defined at the single bank level. This implies that a loan is not flagged as a relationship lending loan if a single bank grants a new loan to a borrower with whom another bank belonging to the same banking group had a loan relationship in the previous 24 months but not the single bank itself. The reason for this somewhat “tighter” definition is that the share of loans flagged as relationship lending loans is very high (around 90%) even when this tighter condition is applied.

¹⁰ Note that the index “ i ” is strictly speaking not appropriate for all the variables in $\mathbf{X}$, since relationship lending, the share of loans of a bank in the respective region over all loans of that bank and the PD vary at levels other than the single loan level. However, to keep the notation simple I include these variables in $\mathbf{X}_i$.

Finally, $\varepsilon_{i,b,j,t}$ is an error term. Error terms are clustered at the regional level and the bank level for the calculation of standard errors of the coefficients.

In this context, specifications with bank fixed effects evaluate whether a specific bank in a specific country systematically varies its lending rates in response to regional market concentration measures. This analysis is extended to settings where variations in lending rates are examined for loans from a specific bank in a specific country to a specific sector, or from a specific bank in a specific country during a specific month. Observing an effect of regional market concentration measures in “within bank settings” would strongly suggest a relationship between regional market concentration, market power and lending rates as time-invariant factors at the bank level, or even at the bank-sector-level or time invariant and time variant factors at the bank level are implicitly controlled for.

To facilitate the interpretation of the results, the coefficients in β' are used to calculate mark-ups in four different settings: a bank with a high market share in a highly concentrated market, a bank with a low market share in a highly concentrated market, a bank with a high market share in a market with low concentration, and a bank with a low market share in a market with low concentration. The latter setting serves as the benchmark. A highly concentrated market is defined as one with an HHI value at the 75th percentile of the distribution across all regions, while a market with low concentration is defined as one with an HHI value at the 25th percentile. Additionally, a high market share is defined as the average of the market shares of the top three regional lenders (the lenders whose market shares contribute to CR3) across all regions, whereas a low market share is set to zero for convenience. This zero market share can be interpreted as a loan granted by a bank that was not active in the market at the end of 2021.¹¹

The results in column (1) of Table 2 suggest that banks with high regional market shares charge higher lending rates, which aligns with the model outlined in Annex Ib. A high regional market share is associated with an increase in lending rates of 52 bps or 65 bps compared to the case of a low (zero) regional market share combined with a low HHI. These figures are substantial and economically relevant, given that the average lending rate in the sample is approximately 4%. In contrast, the effect of a high HHI combined with a low market share – compared to a low HHI and a low regional market share – is

¹¹ The mark-ups are calculated from the coefficients in β' as follows: Let $p75_{HHI}$, $p25_{HHI}$ and $CR3_{MS}$ represent the 75th and 25th percentile of the HHI-distribution, respectively, and let $CR3_{MS}$ denote the average market share of CR3 banks. The mark-ups relative to the reference category are then calculated as follows:

- 1) HHI high, market share high: $\beta_{INT} * p75_{HHI} * CR3_{MS} + \beta_{HHI} * p75_{HHI} + \beta_{MS} * CR3_{MS} - \beta_{HHI} * p25_{HHI}$
- 2) HHI high, market share low: $\beta_{HHI} * p75_{HHI} - \beta_{HHI} * p25_{HHI}$
- 3) HHI low, market share high: $\beta_{INT} * p25_{HHI} * CR3_{MS} + \beta_{MS} * CR3_{MS}$

much smaller, amounting to roughly 12 bps. This suggests that overall market concentration, as measured by the regional HHI, is less relevant. When bank fixed effects are included, the positive relationship between regional market share and lending rates disappears entirely. The results lose both statistical and economic significance, with absolute effects not exceeding 2 bps. Thus, the results in column (1) seem to be driven by variation between banks – absorbed by bank fixed effects in columns (2) to (4) – rather than by variation within banks. The fact that the results in columns (2) to (4) become not significant does not necessarily contradict the idea that higher market concentration is associated with increased market power, manifesting as higher lending rates. However, it indicates that, at the level of an individual bank, there is no adjustment of lending rates in response to higher concentration. Such "within-bank adjustment" would provide more convincing evidence in support of H1 than "between-bank adjustment," which might be influenced by other bank-level factors.

When the analysis is conducted at the NUTS-2 regional level, the point estimates remain quite similar, but the standard errors are significantly higher (see Table 6 in Annex II). This is likely due to clustering occurring at the NUTS-2 level instead of the NUTS-3 level, resulting in a considerably lower number of clusters (see Table 1 for the number of NUTS-2 and NUTS-3 regions).

The results in column (1) are primarily driven by non-regional banks (see Table 9 in Appendix IV, comparing column 1 with column 3), whereby a regional bank is defined as one where the loan volume in the most important region constitutes a significant portion of its total loans.¹² However, the effect of the regional market share is significantly diminished for non-regional banks when bank-country averages for measures of regional market concentration are included in the estimations (see Table 9, column 3 versus column 4). This suggests that regional market shares affect lending rates of non-regional banks, but that these banks adjust lending rates to the average regional market share they hold in a country, rather than to the share in each individual regional market. On the other hand, the effect of the HHI remains rather constant. If Equation (1) (specification in column 1) is re-estimated for non-regional banks using bank-country average values for the regional market share, the effects become more pronounced (see Table 9, column (5)). Although the main part of the paper will continue to use regional variables for estimations, the robustness section will consider bank-country average values of the regional market share.

¹²A bank is defined as regional if the proportion of its loan volume in the most important region exceeds the 10th percentile of the distribution of this proportion across all banks.

The results in column (1) are consistent with H1. Although overall concentration, as measured by the HHI, appears to be less relevant, an increase in market concentration still implies an increase in the bank-specific market share of the bank serving the average client.¹³ In other words, if the HHI increases – which, according to the results, does not by itself affect lending rates – the bank-specific market share for the average client also increases, which, according to the results, leads to higher lending rates. A more formal way of deriving the relationship between the regional HHI and the average mark-up charged by banks in a region is as follows: the average mark-up in a market stemming from $\beta' \mathbf{MC}_{b,r(j)}$ in Equation (1) can be calculated by averaging $\beta' \mathbf{MC}_{b,r(j)}$ over all banks in the market and weighting this average by the banks' market shares. It turns out that the average mark-up depends on the three estimated parameters β_{HHI} , β_{MS} and β_{INT} as well as on the HHI in the market in the form: $(\beta_{HHI} + \beta_{MS}) * HHI + \beta_{INT} * HHI^2$. Bank-specific market shares are aggregated in such a way that they can be expressed as the HHI.¹⁴ This means that the average mark-up can be depicted as a function of the HHI alone. The same applies to the marginal effect of the HHI on the average mark-up. This is simply the derivative of the average mark-up with respect to the HHI which is $(\beta_{HHI} + \beta_{MS}) + 2 * \beta_{INT} * HHI$. As shown in Figure 2 in Annex III, this marginal effect decreases with the level of the HHI in the specification without bank fixed effects. It ceases to be positive at rather high levels of regional market concentration. This implies that an increase in concentration leads to higher average lending rates in a market, except when concentration is already high. Thus, at high levels of concentration, further concentration does not seem to be associated with additional market power for banks.

To sum up, the relationship between lending rates and market concentration that emerges from specification (1) indicates the following connection between market concentration and market power: First, at the bank-region level, higher regional market shares are associated with greater market power. Second, at the regional level, an increase in the HHI is associated with an increase in the average market power of a bank, provided the HHI level in the region is not too high. Therefore, if an increase in market power is

¹³ To understand this, it is helpful to interpret the HHI as follows: the HHI is the average market share of all banks in the market, whereby this average is weighted by market shares. For example, if there are two banks in a market, one with a 90% share of the loan market and the other with a 10% share, 90% of the loan volume is held by the bank with a 90% market share, and 10% of the loan volume is held by the bank with a 10% market share. The “market share weighted” average market is then calculated as: $0.9*0.9+0.1*0.1=0.82$ which is exactly the HHI.

¹⁴ With B being the number of banks in a region, the HHI as $\sum_{b=1}^B MS_b^2$ and omitting the subscript $r(j)$ for convenience, the market share weighted average mark-up in a region is:

$$\begin{aligned} & \sum_{b=1}^B MS_b (\beta_{HHI} * HHI + \beta_{MS} * MS_b + \beta_{INT} * HHI * MS_b) = \\ & \sum_{b=1}^B MS_b (\beta_{HHI} * \sum_{b=1}^B MS_b^2 + \beta_{MS} * MS_b + \beta_{INT} * \sum_{b=1}^B MS_b^2 * MS_b) = \\ & \sum_{b=1}^B (\beta_{HHI} * MS_b * \sum_{b=1}^B MS_b^2 + \beta_{MS} * MS_b^2 + \beta_{INT} * MS_b^2 * \sum_{b=1}^B MS_b^2) = \\ & \beta_{HHI} * \sum_{b=1}^B MS_b^2 + \beta_{MS} * \sum_{b=1}^B MS_b^2 + \beta_{INT} * \sum_{b=1}^B MS_b^2 * \sum_{b=1}^B MS_b^2. \end{aligned}$$

associated with a muted pass-through of monetary policy measures to lending rates, as suggested by H2, we would expect the following picture: First, at the bank-region level, higher regional markets shares should be associated with a lower pass-through. Second, on the regional level, an increase in the HHI should be associated with a lower average pass-through, provided the HHI level is not too high.

Table 2: Effect of regional HHI and bank-specific market shares on the level of lending rates

	(1)	(2)	(3)	(4)
HHI high; MS high	0.524*** (0.121)	0.0025 (0.0463)	-0.0046 (0.0451)	-0.0003 (0.0478)
HHI high; MS low	0.121*** (0.0371)	0.0031 (0.02)	0.0083 (0.0192)	-0.0003 (0.0187)
HHI low; MS high	0.654*** (0.1475)	-0.0036 (0.0469)	-0.015 (0.0451)	-0.0025 (0.0475)
Number of observations	1,011,316	1,011,111	1,009,943	1,005,219
Loan level controls	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes
Bank variables	Yes	No	No	No
FE: size x sec x coun x y/m	Yes	Yes	Yes	Yes
FE: bank x coun	No	Yes	No	No
FE: bank x sec x coun	No	No	Yes	No
FE: bank x coun x y/m	No	No	No	Yes

Note: MS stands for market share, av. for average, FE for fixed effect, sec for sector, reg for region, y/m for year/month, coun for country. Standard errors based on residuals clustered at the regional level and at the bank level in parentheses. Effects relative to setting “HHI low, MS low”.

7 Regional market concentration and monetary policy pass-through

To evaluate the impact of regional market concentration on the pass-through from market and policy rates to lending rates, two approaches are utilized. The first approach assesses the strength of the pass-through by interacting the variables of interest with a market rate. In this context, the 3-month Euribor is selected, as it has been identified as a suitable reference rate for loans to NFCs in the euro area (Deutsche Bundesbank, 2023). The estimation equation is essentially the same as Equation (1), with the key difference being that $MC_{b,r(j)}$, X_i , and $R_{r(j)}$ now also include interactions of all variables with the 3-month

Euribor.^{15 16} The results in Table 3 show the effect of a change in the 3-month Euribor across the four different settings described above. The effect of the change is again presented for three settings relative to the "HHI low, market share low" setting.¹⁷

The results from specifications without bank fixed effects suggest that the pass-through from the 3-month Euribor to lending rates is stronger when bank-specific market shares are higher (see Table 3, column 1). Specifically, a 100-bps increase in the Euribor leads to a rise in lending rates that is 7 to 9 bps higher in cases of a high regional market share compared to cases with low market share and low overall market concentration. While these effects are moderate, their direction contradicts hypothesis H2. In contrast, when bank fixed effects are included in the estimations (columns 2 to 4), there is no evidence of a statistically significant or economically meaningful impact of market concentration measures on the pass-through. The analysis conducted on the NUTS-2 level yields largely similar results (see Table 7 in Annex II). It is important to note that the effects of market concentration measures on the pass-through in columns (2) and (3) might still emerge even if the pass-through was not adjusted to market concentration measures within a bank but only between banks. This is because the effects on the pass-through are reflected in changes in lending rates rather than their levels. The bank fixed effects control for changes in the composition of loans across banks and bank-sector clusters over time, which might induce changes in lending rates. Only the bank-time fixed effects in column (4) absorb all variation stemming from a bank-specific pass-through, so that a potential effect of measures of market concentration would have to reflect within bank adjustments to these measures. Therefore, even if the effects of market concentration measures are anticipated to manifest only between banks rather than within banks – as indicated by the results in Section 6 – the specifications with bank fixed effects or even bank-sector fixed effects are preferable. These specifications do not absorb the between-bank variation in pass-throughs, yet they do control for potential changes in the composition of loans across banks or bank-sector clusters. A potential impact of bank variables on the pass-through is captured via the interaction of these variables with the 3-month Euribor also in these specifications, while bank variables in levels drop out due to the inclusion of bank fixed effects.

Similar to the case of the level estimations, one can calculate the marginal effect of an increase of the HHI on the average pass-through in a market. Again, this average is a

¹⁵ Except for the interest rate fixation variables, which are still interacted with the difference between the 12-month and the 3-month Euribor.

¹⁶ If $\mathbf{B}_b$ contains bank variables (not bank fixed effects), variables from $\mathbf{B}_b$ are also interacted with the 3-month Euribor.

¹⁷ The calculation is analogous to the one described in Footnote 11, but now employs coefficients that pertain to the interactions of the market concentration variables with the 3-month Euribor.

market share weighted average over all banks.¹⁸ Considering specification (1), which is not the preferred specification but the only one leading to significant effects, it turns out that an increase in the HHI entails a stronger pass-through from the 3-month Euribor to lending rates, except when the level of HHI is quite high (see Figure 3 in Annex III). Results in Section 6 indicated that an increase in the HHI tends to enhance the market power of banks (in the form of higher lending rates) when the HHI is not too high. Thus, an increase in concentration is associated with a stronger pass-through when it is also associated with an increase in market power (compare Figure 2 and Figure 3 in Annex III). This contradicts H2 as well.

Table 3: Effect of regional HHI and bank-specific market shares on the pass-through of the 3-month Euribor to lending rates

	(1)	(2)	(3)	(4)
HHI high; MS high * 3M Euri	0.0684* (0.0408)	0.0197 (0.0227)	0.02 (0.0228)	-0.0192 (0.0128)
HHI high; MS low * 3M Euri	0.0329*** (0.0055)	-0.0003 (0.0087)	-0.001 (0.0091)	-0.0127 (0.0081)
HHI low; MS high * 3M Euri	0.0927* (0.0522)	0.0318 (0.0322)	0.032 (0.0321)	-0.0134 (0.0122)
Number of Observations	1,011,316	1,011,111	1,009,943	1,005,219
Loan level controls	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes
Bank variables	Yes	No	No	No
FE: size x sec x coun x y/m	Yes	Yes	Yes	Yes
Bank variables x Euribor	Yes	Yes	Yes	No
FE: bank x coun	No	Yes	No	No
FE: bank x sec x coun	No	No	Yes	No
FE: bank x coun x y/m	No	No	No	Yes

Note: MS stands for market share, Euri for the 3-month Euribor, av. for average, FE for fixed effect, sec for sector, reg for region, y/m for year/month, coun for country. Standard errors based on residuals clustered at the regional level and at the bank level in parentheses. Coefficients show magnitude of interaction with 3-month Euribor relative to setting “HHI low, MS low”.

¹⁸ The calculation is analogous to the one described in Section 6 and Footnote 14, but now employs coefficients that relate to the interactions between the market concentration variables and the 3-month Euribor.

The second approach to assess the role of market concentration for monetary policy pass-through relies on monetary policy surprises from the euro area monetary policy event study database by Altavilla et al (2019). This database captures changes in financial variables within a narrow window around the announcement of monetary policy decisions by the ECB Governing Council. In this context, these changes can be interpreted as reflecting the unexpected component of monetary policy decisions.

To utilize the monetary policy surprises, the data is rearranged so that each loan is assigned to a specific monetary policy decision by the ECB Governing Council and its corresponding monetary policy surprise. Loans are linked to a monetary policy surprise if their inception date (the date of signature of the loan contract) falls within a five-week period surrounding the corresponding monetary policy meeting.¹⁹ Such a period encompasses a pre-period of 14 days before and a post-period of 21 days after the meeting.²⁰ The length of these periods is chosen to ensure that periods do not overlap.²¹ When meetings are spaced six or more weeks apart, loans can have inception dates that fall outside the five-week periods. Those loans are excluded from the sample, which is why the sample size declines somewhat compared to the sample sizes in Table 2 and Table 3. The sample includes 15 monetary policy decisions from February 2022 until October 2023.

Using the unexpected component of monetary policy decisions might seem preferable in the context of this paper, as it allows for a cleaner identification of monetary policy effects. However, the drawback is that monetary policy surprises are not necessarily a good indicator of actual market developments in the weeks before and after the surprise occurs. It is possible that the monetary policy surprise and the change in actual market rates from the weeks before to the weeks after the surprise have opposite signs. This might be less of an issue when considering a longer time period, as one would expect surprises and actual changes to align in the same direction on average in the long run. However,

¹⁹ The sample used throughout the paper includes only loans for which the month of inception and the month when the loan was first reported coincide. This means that the inception and reporting dates can be up to nearly a month apart. For variable rate loans, this implies that the reported lending rates at the end of the month are not necessarily identical to the lending rates at inception. To address this issue, the lending rate of variable rate loans with daily rate adjustments is adjusted by the change in the reference rate reported by the bank for this loan that occurred between the inception date and the end of the month.

²⁰ Loans inceptioned on the day of the meeting are discarded, as they cannot be properly assigned to either the pre- or the post-period. Note that the post-period is longer because the lending rate of loans inceptioned in the post-period, and thus assigned to the post-period, might have been determined in the pre-period (if lender and borrower agree on the lending rate before a monetary policy decision but close the contract only after the monetary policy decision). To increase the share of loans in the post-period for which the lending rate was presumably determined after the monetary policy surprise, the post-period is extended to 21 days.

²¹ In the sample period beginning in 2022, monetary policy decisions occurred at least five weeks apart. Therefore, time windows around the decisions spanning five weeks (two weeks before and three weeks after the decision) do not overlap.

the data used here cover only fifteen monetary policy decisions. Additionally, the magnitude of the monetary policy surprises is in general quite limited. This raises the question as to whether there is a relationship between these surprises and lending rates after all.

Thus, in a first step, the general relevance of these surprises for lending rates is investigated. The following model is used in this context:

$$lr_{i,b,j,t(m)} = \beta' \mathbf{MC}_{b,r(j)} + \gamma_1' \mathbf{B}_b + \mathbf{fe} + \gamma_2' \mathbf{X}_i + \gamma_3' \mathbf{R}_{r(j)} + \delta MPS_{t(m)} + \varepsilon_{i,b,j,t(m)} \quad (2)$$

The time index $t(m)$ now refers to the five-week period around monetary policy meeting m . The monetary policy surprise MPS denotes the change of the 3-month OIS rate in the “monetary event window” (as defined in Altavilla et al., 2019) for meeting m for all observations stemming from the 21 days *after* a monetary policy decision and equals zero for all observations stemming from the 14 days *before* a monetary policy decision. The 3-month OIS rate is chosen as it is the closest substitute to the 3-month Euribor. The vector $\mathbf{X}_i$ includes the same variables as above. To allow for a more flexible setting, some of the variables are interacted with the five-week periods, so that the coefficients relating to them vary between these periods. These variables include indicators for the loan purpose and type (indicators for working capital loans, leasing loans and factoring loans), the relationship lending indicator, the log loan amount and the interest rate fixation variables.²² Furthermore, PDs are aggregated into buckets on the region-sector-period-pre/post level. This means that PDs are measured separately for each pre- and post-period (i.e. for each 14-day period before and each 21-day period after a monetary policy meeting). The time dimension of the fixed effects is no longer at the monthly level but at the level of the 15 periods. Borrower characteristics are either captured via fixed effects on the size-sector-country-period level or in a tighter setting on the size-sector-region-period level.²³ The latter approach coincides with the suggestion in Degryse et al. (2019). In estimations that include fixed effects at the regional level, the HHI in levels included in $\mathbf{MC}_{b,r(j)}$ as well as the regional variables included in $\mathbf{R}_{r(j)}$ drop out. The coefficient of interest is δ , which captures the pass-through of the monetary policy surprise to lending rates. Note that the fixed effects in all cases absorb the 15 periods and thereby the period-

²² Since the coefficient for the interest rate fixation variables varies in five-week intervals, the interactions with the difference between the 12-month and 3-month Euribor are removed from the estimation.

²³ Note that fixed effects on the region-period level can be included, as the variation of interest stemming from the monetary policy surprises occurs within these periods.

specific averages in lending rates. Error terms are clustered at the regional level and the bank-period level for the calculation of standard errors of the coefficients.²⁴

The results of estimation Equation (2) with a varying set of fixed effects in Table 4 convey an important message: a more pronounced effect of the monetary policy surprise emerges if bank fixed effects are added to the estimation (column 1 vs. column 2 of Table 4). Once they are added, further modifications of fixed effects barely change the results.

Table 4: Effect of monetary policy surprises on lending rates

	(1)	(2)	(3)	(4)
MPS	0.17 (0.3295)	0.686** (0.3208)	0.664** (0.326)	0.704** (0.3467)
Number of observations	720,594	716,770	710,553	684,552
Loan level controls	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	No
Bank variables	Yes	No	No	No
FE: size x sec x coun x per	Yes	Yes	Yes	No
FE: size x sec x reg x per	No	No	No	Yes
FE: bank x coun x per	No	Yes	No	No
FE: bank x sec x coun x per	No	No	Yes	Yes

Note: MPS stands for monetary policy surprise, FE for fixed effect, sec for sector, per for period, coun for country. Standard errors based on residuals clustered at the regional level and at the bank-period level in parentheses.

The next step is to assess whether the pass-through from monetary policy surprises to lending rates is affected by the variables of interest, namely the HHI, bank-specific market shares, and the interaction of both variables. The extension of Equation (2) implemented for this purpose is straightforward:

$$lr_{i,b,j,t(m)} = \beta' MC_{b,r(j)} + fe + \gamma_2' X_i + \gamma_3' R_{r(j)} + \delta_1' MC_{b,r(j)} MPS_{t(m)} + \delta_2' Z_i MPS_{t(m)} + \delta_3' R_{r(j)} MPS_{t(m)} + \varepsilon_{-}(i, b, j, t(m)) \quad (3)$$

The vector Z_i contains a subset of the variables in X_i namely indicators of the loan purpose and type (indicators for working capital loans, leasing loans and factoring loans), the relationship lending indicator, and the share of loans in a respective region of a bank over all loans of a bank. As can be seen from Equation (4), the three variables of interest are allowed to affect the pass-through from monetary policy surprises to lending rates through the interaction with $MPS_{t(m)}$. Furthermore, the remaining regional variables

²⁴ If error terms are clustered at the regional level and bank level as before, standard errors of the coefficients turn out to be very large. As every period can be considered to be a separate event, it is justified to cluster at the bank-period dimension.

(regional GDP, regional GDP per capita and population density) are allowed to affect the pass-through to ensure that the effect of the three variables of interest on the pass-through is not confounded with the effect of some other regional variable. Finally, the interaction with the monetary policy surprises with the variables in $\mathbf{Z}_i$ is meant to capture potential differences in the pass-through for different loan types. The interaction also ensures that the effect of the variables of interest on the pass-through is not confounded with the effect of relationship lending or with the effect of the importance of a region for a bank (for the latter see Casado and Martínez-Miera, 2024).

The consideration of bank-specific effects in the pass-through of monetary policy surprises deserves special attention. All specifications include fixed effects on the bank-sector-country-period level, causing bank variables in levels to drop out of the estimations. However, this type of fixed effect does not account for the potential impact of bank characteristics on the pass-through. The rationale is similar to the estimations where variables are interacted with the 3-month Euribor: bank fixed effects only fully absorb the variation in the pass-through between banks if they are interacted with the time dimension on which the monetary policy indicator or market rate varies. As above, the potential effect of bank characteristics on the pass-through will be captured in two ways: 1) By interacting bank variables with $MPS_{t(m)}$, allowing these variables to affect the pass-through in the same way as the variables in $\mathbf{Z}_i$. 2) By including bank fixed effects at the country-period-pre/post level. This means that bank fixed effects are not only included for every period but for every country-period-pre/post combination. These fixed effects then fully absorb heterogeneity in the pass-through on the country-bank level.

Once again, the coefficients of interest (in δ'_1) are not presented in their “raw” form, but are used to calculate the differences in the pass-through for the three settings relative to the setting “HHI low, market share low”.²⁵ The results are shown in Table 5. Columns (1) and (2) suggest that banks pass on monetary policy surprises to a lesser extent in regions where their own market shares are high. The magnitude of the effects is considerable, although they are not statistically significant due to the large standard errors. This evidence aligns with H2. In column (3), bank fixed effects are not only included at the period level but at the pre-period/post period level. This implies that the average pass-through of monetary policy surprises at the bank level is fully absorbed by the fixed effects, thereby implicitly controlling for all bank-related factors that might drive the pass-through (such as capital, liquidity, profitability, etc.). When the bank-specific pass-through is controlled for in this manner, there is no longer evidence that

²⁵ The calculation is analogous to the one described in Footnote 11, except that the coefficients used now relate to the interactions of the market concentration variables with MPS .

higher regional market shares are associated with a weaker pass-through. Instead, there is some evidence of a muted pass-through for banks with a low market share in highly concentrated markets. The results are qualitatively similar if the analysis is carried out on the NUTS-2 level (see Table 8 in Annex II).

Table 5: Effect of regional HHI and bank-specific market shares on the pass-through of monetary policy surprises to lending rates

HHI high; MS high * MPS	-0.4131 (0.3269)	-0.5204 (0.3306)	0.0525 (0.2074)
HHI high; MS low * MPS	-0.1573 (0.1147)	-0.1782 (0.1104)	-0.2587** (0.1137)
HHI low; MS High * MPS	-0.4552 (0.3865)	-0.5854 (0.3932)	0.2074 (0.1953)
Number of observations	716,045	709,798	713,720
Loan level controls	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes
FE: size x sec x coun x per x pre/post	Yes	Yes	Yes
FE: bank x coun x per	Yes	No	No
FE: bank x sec x coun x per	No	Yes	No
Bank variables x per x pre/post	Yes	Yes	No
FE: bank x coun x per x pre/post	No	No	Yes

Note: MS stands for market share, MPS stands for monetary policy surprise, av. for average, FE for fixed effect, sec for sector, reg for region, per for period, coun for country. Per x pre/post indicates variation on the level of all pre- and post-periods (i.e. all 14-day periods before and all 21-day periods after a monetary policy meeting). Standard errors based on residuals clustered at the regional level and at the bank-period level in parentheses. Coefficients show strength of pass-through of monetary policy surprises relative to the setting “HHI low, MS low”.

The analysis of the marginal effect of an increase of the HHI on the average pass-through in a market delivers a picture that aligns with H2 (see Figure 3 upper panel in Annex III). The results from specification (2) indicate that an increase of the HHI is associated with a weaker pass-through at lower levels of the HHI. Unlike the results in Table 5, this result is statistically significant, albeit marginally. This contrasts with what was found for the pass-through from the 3-month Euribor to lending rates. Given that the results in Section 6 suggest that an increase in the HHI is associated with an increase in market power when the level of the HHI is low, this result supports H2. Therefore, it can be concluded that an increase in market power, driven by higher market concentration, does indeed hamper the pass-through of the unexpected component of monetary policy. It is important to note that these results relate to the short-term (1-3 weeks) pass-through.

8 Dynamic pass-through effects

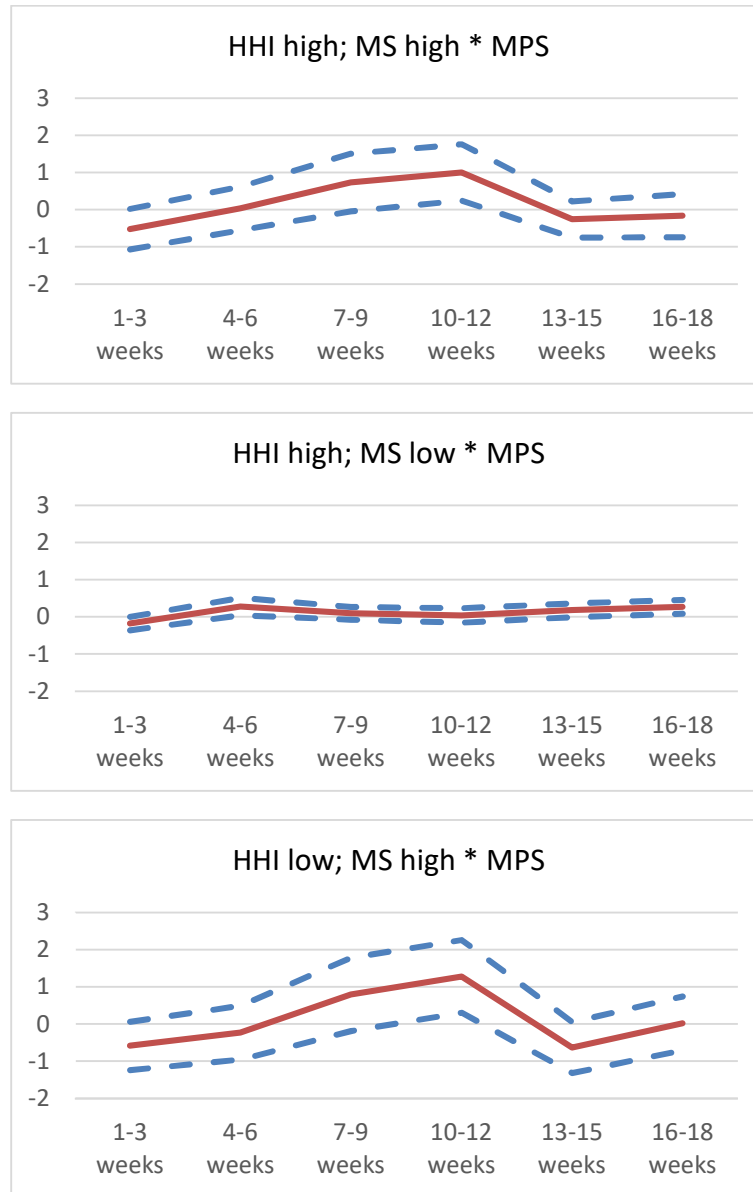
The impact of regional market concentration on the pass-through, as discussed in the previous section, was assessed using a window consisting of two weeks (14 days) before and three weeks (21 days) after a monetary policy surprise. However, it is also important to consider how this impact evolves over a longer period. To explore this, the estimation of specification (1) in Table 5 is repeated multiple times, each time shifting the post-period by three weeks. Thus, instead of examining two weeks before and three weeks after a monetary policy surprise, the periods are redefined to include two weeks before and 4-6 weeks, 7-9 weeks, 10-12 weeks and 13-15 weeks after the monetary policy surprise. This approach allows for the assessment of the effect of regional market concentration on the pass-through over a total period of approximately three and a half months. This methodology is somewhat related to the local projections approach to difference-in-differences studies suggested by Dube, Girardi, Jordà and Taylor (2023). Note that in this setting, pre- and post-periods may overlap. Consequently, an observation can appear twice in an estimation (once in the pre-period of a monetary policy period and at the same time in the post-period of an earlier monetary policy period).

The evolution of the effect of regional market concentration and bank-specific market shares on the pass-through is shown in Figure 1. The results are presented for the specification with bank fixed effects on the bank-sector-country-period level, corresponding to column 2 of Table 5. The three graphs represent the three settings for which results are provided in Table 5. They depict the difference in the pass-through of a monetary policy surprise in each respective setting relative to the setting “low HHI, low market share”. As shown in the figure, the initially muted response for banks with high market shares (top and bottom panels) is short lived. In the subsequent weeks, the relative strength of the pass-through increases substantially, which contradicts H2. Eventually, it returns close to zero.

Therefore, the marginal effect of an increase of the HHI on the average pass-through, as shown in the upper panel of Figure 4, is also short lived. Examining the same picture for weeks 16 to 18 after the monetary policy surprise, shown in the lower panel, yields a picture that is similar to the one for the pass-through of the 3-month Euribor in Figure 3.²⁶ Considering the findings in Section 6, these results appear inconsistent with H2.

²⁶ The picture for the pass-through of the 3-month Euribor remains largely unchanged when considering a longer period. This is achieved by replacing contemporaneous Euribor by values lagged by 1,2,...,6 months in the model underlying the results in Table 3.

Figure 1: Dynamic evolution of the effect of market concentration and bank-specific market shares on the pass-through of monetary policy surprises to lending rates (point estimates and 90% confidence interval)



Note: Figures show the dynamic evolution of coefficients from Table 5, column 2, with the “post-period” time window being shifted to the weeks after the monetary policy decision indicated on the x-axis. Note furthermore that the results for 1-3 weeks are those displayed in the table in column 2. MS stands for market share, MPS stands for monetary policy surprise.

9 Robustness

Banks' deposit market power can lead to biased coefficients when assessing the impact of market concentration on lending rates. This is because deposit market power may be correlated with loan market concentration if loan and deposit market concentration coincide and deposit market concentration drives deposit market power (see Drechsler et al., 2017; Kho, 2025). If banks in a highly concentrated loan market tend to have lower funding costs due to market power in the deposit market and pass these lower costs on to their borrowers, the estimated effect of market power in the loan market on lending rates may be downward biased if a measure of deposit market power is omitted. Another concern relates to the size of the regions. The average size of NUTS-3 regions in terms of land surface differs between countries. To homogenize the size of regions, it may be useful to remove countries with very small or vary large average region size from the sample. Furthermore, as discussed in Section 6, the effects of market concentration on the level of lending rates tend to differ between regional and non-regional banks. Consequently, pass-through estimations are repeated separately for both types of banks. For non-regional banks, bank-country averages of the regional market share are used, as these appear to be more relevant for the level of lending rates for this type of bank (see Table 9).

To measure deposit market power, the deposit beta at the bank level is included in the estimations (following the reasoning in Drechsler et al., 2017) along with an interaction term between the deposit beta and the deposit share. To address endogeneity concerns, the bank-level deposit betas are calculated for the period from March to August 2011, which was the last monetary policy tightening before the one in 2022 and 2023. These betas are defined as the change in the aggregate rate on deposits of the non-financial private sector (non-financial corporations and households) of a bank, as reported in the iMIR dataset, divided by the change in the monetary policy rate in this period (0.5 percentage points).²⁷

To address the issue of heterogeneous regional sizes, estimations are re-run to exclude countries where the average NUTS-3 regions size is either very small or very large. The fact that results throughout the paper are qualitatively rather similar when NUTS-2

²⁷ The deposit beta observed during the monetary policy tightening in 2011 is highly significant in explaining the deposit beta during the monetary policy tightening between June 2022 and October 2023. In bank-level regressions with country fixed effects, the respective t-statistic is around 10. The simple correlation between the two betas amounts to roughly 0.5. Note that the scaling by the change in the monetary policy rate is done solely to make the variable more easily interpretable. Since all values are scaled in the same manner, this scaling does not affect the results regarding the coefficients on the market concentration measures.

regions are considered instead of NUTS-3 regions suggests that results are not overly sensitive to the definition of the relevant market. Nevertheless, it is worthwhile examining whether the results change in samples with a more homogenous market size.

Table 10 (Annex IV) shows that results related to the level of interest rates (as reported in Table 2, column 1) are quite stable. Including the deposit slightly reduces the effect of bank-specific regional market shares (column 3 vs. column 1). This picture also emerges when comparing the results in column 3 with results from estimations without deposit betas, limited to banks reporting in iMIR (column 2 vs. column 3; deposit betas cannot be calculated for banks not reporting in iMIR).

The benchmark results for the pass-through of the 3-month Euribor (Table 3, column 3) suggested that regional market concentration does not affect this pass-through. This picture prevails when the deposit beta is added to the estimations²⁸ (Annex VI, Table 11, column 2) or when the sample is split into regional and non-regional banks, with country-average market shares used for the estimations involving non-regional banks (Table 11, columns 5 and 6). When the region size is homogenized by removing countries where the average NUTS-3 region size is either very small or large, the results suggest that the pass-through is stronger when regional bank market shares are higher (Table 11, columns 3 and 4). Those findings are similar to those in Table 2, column (1), which, as discussed above, contradict H2.

The robustness of the results concerning the pass-through of monetary policy surprises is analysed in Table 12 (Annex IV). When the sample is limited to banks in iMIR, and the deposit beta along with its interaction with the deposit share is included, or when the region size is homogenized by excluding countries where the average NUTS-3 region size is either very small or very large, the results remain qualitatively similar (Table 12, columns 2-4). As observed in the benchmark regression (Table 5, column 2) the results suggest a muted pass-through in cases of a high bank-specific market share, although this finding is not statistically significant. The picture changes when regional and non-regional banks are analysed separately, using average market shares on the bank-country level for non-regional banks. For regional banks, the negative association between higher market shares and strength of the pass-through disappears, whereas it becomes almost implausibly large for non-regional banks and bank-country average market shares, with standard errors becoming very large as well. This aligns with the findings in Table 10, which indicate that the effect of market shares on the level of lending rates is most pronounced when considering non-regional banks and bank-country average market

²⁸ Bank fixed effects fully account for the effect of the deposit beta and its interaction with the deposit share, so both variables are included solely as an interaction with the 3-month Euribor.

shares. Examining the evolution of the effect of bank-country average market shares over time for non-regional banks reveals a pattern similar to that depicted in Figure 1, though the effect of higher market shares on the pass-through becomes more negative in the later periods. Overall, the results do not suggest that the relationship between monetary policy transmission and bank market shares changes significantly when the focus is shifted to average market shares for non-regional banks.

10 Conclusion

This paper examines the influence of regional market concentration in the NFC loan market on lending rates in the euro area. Loan level data from the AnaCredit dataset is used in two ways: to construct measures of regional market concentration and to evaluate the impact of regional market concentration on bank lending rates. The granular loan level data allows for controlling for a broad spectrum of loan characteristics and for saturating the econometric models with a wide range of fixed effects. These fixed effects capture borrower-related characteristics and absorb factors such as national-level legal restrictions to the entry of new banks. Additionally, bank fixed effects can be incorporated, which among other things absorb market power measures on the bank level, such as the Lerner index.

The results indicate that banks charge higher lending rates in regions where their own market share is high. This finding supports the notion that higher regional bank market concentration translates to greater market power for banks in the loan market. However, this outcome is only observed when variation between banks is not accounted for through bank fixed effects. The results do not suggest that this market power, derived from market structure, significantly impeded the monetary policy pass-through to lending rates during the monetary policy tightening in 2022 and 2023. If anything, there are indications that this form of market power hampered the short-run pass-through of the unexpected component of monetary policy.

A limitation of the analysis should be emphasized: The drawback of identifying an effect at the micro-level through a wide range of fixed effects is that it becomes inherently challenging to draw conclusions about aggregate effects. Within the context of this paper, it remains unclear how strongly a potential impact of higher market concentration in one or several regions spills over to other regions and subsequently affects lending rates at the national or euro area level.

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Annex Ia: A simple model

Monopolistic case:

The loan demand function for the monopolistic bank is:

$$\bar{x} = \alpha - \gamma \bar{r} \quad (\text{A1})$$

Here $\bar{x}$ is the demand the monopolistic bank faces, $\bar{r}$ is its lending rate and $\alpha, \gamma > 0$. With f as the monopolistic bank's marginal cost, which is assumed to be closely related to the policy rate or market rates, its profit P can be written as:

$$P_i = (\bar{r} - f)(\alpha - \gamma \bar{r}) \quad (\text{A2})$$

The profit maximising lending rate for the monopolistic bank is:

$$\bar{r}_{Mon} = \frac{\alpha + \gamma f}{2\gamma} \quad (\text{A3})$$

Obviously, the pass-through from funding costs to lending rates (the derivative of $\bar{r}_{Mon}$ with respect to f) for the monopolistic bank is:

$$PT_{Mon} = \frac{1}{2} \quad (A4)$$

Competitive case:

Assume now that, instead of having a monopolistic bank, the market is divided among a large number of small banks. These banks possess some market power, represented by the parameter β , which is inversely related to the degree of market power.²⁹ Depart from the following loan demand function for bank i :

$$x_i = \alpha - \beta(r_i - \bar{r}) - \gamma\bar{r} \quad (A5)$$

Here x_i is the demand faced by bank i , r_i is the lending rate it charges, $\bar{r}$ is the aggregate lending rate in the market and $\alpha, \beta, \gamma > 0$. Furthermore, $\beta > \gamma$ to ensure that an increase (decrease) in the aggregate rate increases (decreases) loan demand for bank i if the lending rate of bank i remains unchanged.³⁰ Assume that bank i considers the aggregate lending rate $\bar{r}$ to be given. This setup corresponds to the one in Baglioni (2007). Additionally, assume f to be banks' marginal cost. The profit P_i for bank i can then be written as:

$$P_i = (r_i - f)(\alpha - \beta(r_i - \bar{r}) - \gamma\bar{r}) \quad (A6)$$

The solution of the profit maximization problem yields the optimal lending rate for bank i , r_i^* :

$$r_i^* = \frac{\alpha + (\beta - \gamma)\bar{r} + \beta f}{2\beta} \quad (A7)$$

As can be seen, r_i^* is a positive function of the aggregate lending rate (as $\beta > \gamma$). Assume now that every bank faces the identical optimization problem so that: $r_i^* = \bar{r}, \forall i$. The aggregate lending rate then is obtained by replacing r_i^* by $\bar{r}$ in Equation (A7) and solving for $\bar{r}$.

$$\bar{r}_{comp} = \frac{\alpha + \beta f}{(\beta + \gamma)} \quad (A8)$$

This yields the pass-through of a change in funding costs to lending rates in the competitive case:

²⁹ In fact, the market structure assumed here is a variant of “monopolistic competition”. To avoid confusion in terminology, this case is simply referred to as the “competitive case”, as opposed to the “monopolistic case” in the previous part.

³⁰ Setting $\beta = \gamma$ would simply result in the monopolistic case discussed above.

$$PT_{Comp} = \frac{\beta}{(\beta + \gamma)} \quad (A9)$$

Effect of competition on the level of lending rates and the lending rate pass-through:

Equations (A8) and (A9) for the competitive case can be directly compared to the corresponding Equations (A3) and (A4) for the monopolistic case:

$$\bar{r}_{Comp} - \bar{r}_{Mon} = \frac{\alpha + \beta f}{(\beta + \gamma)} - \frac{\alpha + \gamma f}{2\gamma} = \frac{\alpha(\gamma - \beta) + \gamma f(\beta - \gamma)}{2\gamma(\beta + \gamma)} \quad (A10)$$

$$PT_{Comp} - PT_{Mon} = \frac{\beta}{(\beta + \gamma)} - \frac{1}{2} = \frac{\beta - \gamma}{2(\beta + \gamma)} > 0 \quad (A11)$$

As can be seen from Equation (A10), the lending rate in the competitive case is lower than in the monopolistic case. If funding costs f were sufficiently high, this picture would reverse. However, the respective threshold for f is $\frac{\alpha}{\gamma}$. If funding costs increased beyond this threshold, there would be no more banking activity in either the monopolistic or the competitive case: if banks set the lending rate equal to or higher than this threshold, loan demand will be zero or negative (as can immediately be seen from Equations (A1) and (A5)). If banks set the lending rate lower, they will incur losses as the price will be below the constant marginal cost. The pass-through from funding costs to lending rates is unambiguously stronger in the competitive case according to Equation (A11).

The exact same picture emerges when the degree of market power within the competitive model is altered. A decline in banks' market power due to an increase in competition with other banks can be understood as an increase in β . To see the impact of such an increase, consider the derivative of $\bar{r}_{Comp}$ with respect to β :

$$\frac{\partial \bar{r}_{Comp}}{\partial \beta} = \frac{(f\gamma - \alpha)}{(\beta + \gamma)^2} \quad (A12)$$

The expression in Equation (A12) is negative for relevant values of f (again the threshold is $\frac{\alpha}{\gamma}$), implying that an increase in β is associated with a lower aggregate lending rate. Higher values of β strengthen the pass-through from funding costs to lending rates. This can be immediately seen by looking at the derivative of the pass-through with respect to β , which is positive:

$$\frac{\partial PT_{Comp}}{\partial \beta} = \frac{\gamma}{(\beta + \gamma)^2} > 0 \quad (A13)$$

Annex Ib: Extension of the simple model

Assume now that there are two types of banks in the competitive case, differing in the demand function they face. One type can be thought of as being smaller and possessing less market power. This first type of banks faces the following loan demand function:

$$x_{i,1} = \alpha_1 - \beta_1(r_i - \bar{r}) - \gamma\bar{r} \quad (A14)$$

The second type of larger banks has more market power, as conveyed through the loan demand function which is:

$$x_{j,2} = \alpha_2 - \beta_2(r_j - \bar{r}) - \gamma\bar{r} \quad (A15)$$

Assume that $\alpha_2 = \alpha_1 + \Delta_\alpha$ with $\Delta_\alpha > 0$ and $\beta_2 = \beta_1 - \Delta_\beta$ with $\Delta_\beta > 0$. Hence, the second type of banks face a higher loan demand through α and, at the same time, their loan demand is less sensitive to deviation of the lending rate they charge from the average lending rate. For simplicity, assume that the impact of the level of the average lending rate captured by the parameter γ is the same for both types of banks and that $\beta_1 > \beta_2 > \gamma$. Furthermore, r_1^*, r_2^* are the optimal lending rates for both types of banks (i.e. the lending rates that imply profit maximization). As banks of one type are identical, all banks of the same type charge the same lending rate. Furthermore, let w_1 be a weight which the first type of banks receives in the calculation of the average lending rate. This weight might depend on the market share of this type of banks or on the subjective importance potential borrowers attach to the lending rate of these banks when calculating a “benchmark” lending rate against which they compare the lending rate of a particular bank. To keep the model simple, this weight is assumed to be exogenously given:

$$\bar{r} = w_1 r_1^* + (1 - w_1) r_2^* \quad (A16)$$

Assume again that each bank does not take into account the impact of their own lending rate on the average lending rate. In the first step, optimal lending rates can be expressed as a function of the average lending rate $\bar{r}$. With $tp = 1, 2$ denoting the type of banks:

$$r_{tp}^* = \frac{\alpha_{tp} + \beta_{tp}f}{2\beta_{tp}} + \frac{(\beta_{tp} - \gamma)}{2\beta_{tp}} \bar{r} \quad (A17)$$

Using both Equations in (A17) together with (A16) and solving for $\bar{r}$ yields:

$$\bar{r} = \frac{\frac{1}{2}f + w_1 \frac{\alpha_1}{2\beta_1} + (1 - w_1) \frac{\alpha_2}{2\beta_2}}{\frac{1}{2} + w_1 \frac{\gamma}{2\beta_1} + (1 - w_1) \frac{\gamma}{2\beta_2}} \quad (\text{A18})$$

Hence, we can write the lending rates for both types of banks as functions of the model parameters and the funding costs:

$$r_{tp}^* = \frac{\alpha_{tp}}{2\beta_{tp}} + \left(\frac{\beta_{tp} - \gamma}{2\beta_{tp}} \right) \left(\frac{w_1 \left(\frac{\alpha_1}{2\beta_1} \right) + (1 - w_1) \left(\frac{\alpha_2}{2\beta_2} \right)}{\frac{1}{2} + w_1 \left(\frac{\gamma}{2\beta_1} \right) + (1 - w_1) \left(\frac{\gamma}{2\beta_2} \right)} \right) + \left(\frac{1}{2} + \frac{(\beta_{tp} - \gamma)}{2\beta_{tp} + w_1 \left(\frac{2\gamma\beta_{tp}}{\beta_1} \right) + (1 - w_1) \left(\frac{2\gamma\beta_{tp}}{\beta_2} \right)} \right) f \quad (\text{A19})$$

To keep the following considerations simple, two illustrative markets are compared: one less concentrated market L , where lending rates of the first type of banks are decisive for the average lending rate, so that $w_1 = 1$ and $\bar{r} = r_1^*$. And one highly concentrated market H , where lending rates of the second type of banks drive the average lending rate, so that $w_1 = 0$, $1 - w_1 = 1$ and $\bar{r} = r_2^*$. Note that this implies that $f \leq \alpha_1/\gamma$, otherwise, banks of the first type would either incur losses or face a negative demand in the less concentrated market. Furthermore, a lower bound for the funding cost is assumed which is set at zero for convenience so that $0 \leq f \leq \alpha_1/\gamma$. The coefficients $\alpha_1, \alpha_2, \beta_1$ and β_2 are allowed to vary between both types of markets.

With these assumptions, all four lending rates (two types of banks times two markets) are determined. They can be divided into in a constant part and a “pass-through part” that captures the effects of funding costs on lending rates. Consider the less concentrated market first. Using (A19) with $w_1 = 1$ yields:

$$r_{1L}^* = \frac{\alpha_{1L}}{\beta_{1L} + \gamma} + \frac{\beta_{1L}}{\beta_{1L} + \gamma} f; \quad (\text{A20})$$

$$r_{2L}^* = \frac{\alpha_{2L}(\beta_{1L} + \gamma) + \alpha_{1L}(\beta_{2L} - \gamma)}{2\beta_{2L}(\beta_{1L} + \gamma)} + \left(\frac{1}{2} + \frac{\beta_{1L}(\beta_{2L} - \gamma)}{2\beta_{2L}(\beta_{1L} + \gamma)} \right) f$$

Note that for banks of the first type the solution is identical to (A8), as the maximization problem is the same. In the highly concentrated market with $w_1 = 0$ we get:

$$r_{1H}^* = \frac{\alpha_{1H}(\beta_{2H} + \gamma) + \alpha_{2H}(\beta_{1H} - \gamma)}{2\beta_{1H}(\beta_{2H} + \gamma)} + \left(\frac{1}{2} + \frac{\beta_{2H}(\beta_{1H} - \gamma)}{2\beta_{1H}(\beta_{2H} + \gamma)}\right)f; \quad (A21)$$

$$r_{2H}^* = \frac{\alpha_{2H}}{\beta_{2H} + \gamma} + \frac{\beta_{2H}}{\beta_{2H} + \gamma}f$$

Based on (A20) and (A21) it is possible to assess the differences in lending rates and pass-throughs. Differences in lending rates depend on the value of the funding costs and differences in the pass-through. In a first step, the mark-ups for $f=0$ can be considered. With $\Delta_\alpha > 0$ and $\Delta_\beta > 0$, it turns out that lending rates are higher for the second type of banks in both markets:

$$\begin{aligned} & \frac{\alpha_{2L}(\beta_{1L} + \gamma) + \alpha_{1L}(\beta_{2L} - \gamma)}{2\beta_{2L}(\beta_{1L} + \gamma)} - \frac{\alpha_{1L}}{\beta_{1L} + \gamma} \\ &= \frac{\alpha_{2L}\beta_{1L} - \alpha_{1L}\beta_{2L} + \alpha_{2L}\gamma - \alpha_{1L}\gamma}{2\beta_{2L}} > 0 \\ & \frac{\alpha_{2H}}{\beta_{2H} + \gamma} - \frac{\alpha_{1H}(\beta_{2H} + \gamma) + \alpha_{2H}(\beta_{1H} - \gamma)}{2\beta_{1H}(\beta_{2H} + \gamma)} \\ &= \frac{\alpha_{2H}\beta_{1H} - \alpha_{1H}\beta_{2H} + \alpha_{2H}\gamma - \alpha_{1H}\gamma}{2\beta_{1H}} > 0 \end{aligned} \quad (A22)$$

As can be seen from (A20) and (A21), differences in the pass-through depend solely on differences between $\beta_{1L}, \beta_{2L}, \beta_{1H}$ and β_{2H} . Given $\Delta_\beta > 0$ in both markets, it follows that the pass-through is stronger for the first type of banks in both markets:

$$\begin{aligned} & \frac{\beta_{1L}}{\beta_{1L} + \gamma} - \left(\frac{1}{2} + \frac{\beta_{1L}(\beta_{2L} - \gamma)}{2\beta_{2L}(\beta_{1L} + \gamma)}\right) = \frac{(\beta_{1L} - \beta_{2L})\gamma}{2\beta_{2L}(\beta_{1L} - \gamma)} > 0 \\ & \left(\frac{1}{2} + \frac{\beta_{2H}(\beta_{1H} - \gamma)}{2\beta_{1H}(\beta_{2H} + \gamma)}\right) - \frac{\beta_{2H}}{\beta_{2H} + \gamma} = \frac{(\beta_{1H} - \beta_{2H})\gamma}{2\beta_{1H}(\beta_{2H} - \gamma)} > 0 \end{aligned} \quad (A23)$$

This implies that the positive difference in lending rates of banks of the second and banks of the first type declines as funding costs increase from 0.

The relations of lending rates and pass-through across markets depend on the values of $\alpha_{1L}, \alpha_{2L}, \beta_{1L}$ and β_{2L} relative to those of $\alpha_{1H}, \alpha_{2H}, \beta_{1H}$ and β_{2H} . Whether the pass-through is lowest for banks of the second type in the highly or less concentrated market depends on the values of $\beta_{1L}, \beta_{2L}, \beta_{2H}$ and γ . The pass-through is lowest for the second type of banks in the highly concentrated market if:

$$\left(\frac{1}{2} + \frac{\beta_{1L}(\beta_{2L} - \gamma)}{2\beta_{2L}(\beta_{1L} + \gamma)}\right) - \frac{\beta_{2H}}{\beta_{2H} + \gamma} > 0$$

$$\Rightarrow \beta_{2H} - \beta_{2L} < \frac{(\beta_{1L} - \beta_{2L})(\beta_{2L} - \gamma)}{(\beta_{1L} + \beta_{2L})} \quad {}^{31} \quad (A24)$$

The right-hand side expression of the second equation in (A24) is positive. This implies that the pass-through is lowest for the second type of banks in highly concentrated markets if $\beta_{2H} \leq \beta_{2L}$. The pass-through is lowest for the second type of banks in less concentrated markets if the difference between β_{2H} and β_{2L} is sufficiently positive.

Furthermore, from (A20) and (A21) it can be seen that the lending rate charged by banks of the second type in the highly (less) concentrated market is higher than the one charged by banks of the second type in the less (highly) concentrated market if α_{2H} (α_{2L}) is sufficiently high. Likewise, the lending rate charged by banks of the first type in the highly (less) concentrated market is higher than the one charged by banks of the first type in the less (highly) concentrated market if α_{1H} (α_{1L}) is sufficiently high.

³¹ This inequality can be shown to hold by extending each fraction in the first equation to the lowest common denominator $2\beta_{2L}(\beta_{1L} + \gamma)(\beta_{2H} + \gamma)$ and then rearranging terms in the numerator.

Annex II: Results for the NUTS-2 level

Table 6: Effect of regional HHI and bank-specific market shares on the level of lending rates (see Table 2 for corresponding results on the NUTS-3 level)

	(1)	(2)	(3)	(4)
HHI high; MS high	0.7099*** (0.2722)	0.0788 (0.0923)	0.0727 (0.0909)	0.0678 (0.0958)
HHI high; MS low	0.1324* (0.0759)	0.064 (0.0829)	0.075 (0.0799)	0.0609 (0.0846)
HHI low; MS high	0.8333*** (0.3013)	0.0142 (0.0699)	0.0028 (0.0659)	0.0031 (0.0721)
Number of Observations	1,053,365	1,053,202	1,052,097	1,046,558
Loan level controls	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes
Bank variables	Yes	No	No	No
FE: size x sec x coun x y/m	Yes	Yes	Yes	Yes
FE: bank x coun	No	Yes	No	No
FE: bank x sec x coun	No	No	Yes	No
FE: bank x coun x y/m	No	No	No	Yes

Note: MS stands for market share, av. for average, FE for fixed effect, sec for sector, reg for region, y/m for year/month, coun for country. Standard errors based on residuals clustered at the regional level and at the bank level in parentheses. Effects relative to setting “HHI low, MS low”.

Table 7: Effect of regional HHI and bank-specific market shares on the pass-through of the 3-month Euribor to lending rates (see Table 3 for corresponding results on the NUTS-3 level)

	(1)	(2)	(3)	(4)
HHI high; MS high * 3M Euri	0.0628 (0.0622)	0.0048 (0.0314)	0.0096 (0.0318)	-0.0358 (0.0239)
HHI high; MS low * 3M Euri	-0.0074 (0.0301)	-0.0262** (0.0132)	-0.023* (0.0135)	-0.035** (0.0164)
HHI low; MS high * 3M Euri	0.1096 (0.074)	0.0287 (0.0455)	0.033 (0.045)	-0.016 (0.023)
Number of Observations	1,053,365	1,053,202	1,052,097	1,046,558
Loan level controls	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes
Bank variables	Yes	No	No	No
FE: size x sec x coun x y/m	Yes	Yes	Yes	Yes
Bank variables x Euribor	Yes	Yes	Yes	No
FE: bank x coun	No	Yes	No	No
FE: bank x sec x coun	No	No	Yes	No
FE: bank x coun x y/m	No	No	No	Yes

Note: MS stands for market share, Euri for the 3-month Euribor, av. for average, FE for fixed effect, sec for sector, reg for region, y/m for year/month, coun for country. Standard errors based on residuals clustered at the regional level and at the bank level in parentheses. Coefficients show magnitude of interaction with 3-month Euribor relative to setting “HHI low, MS low”.

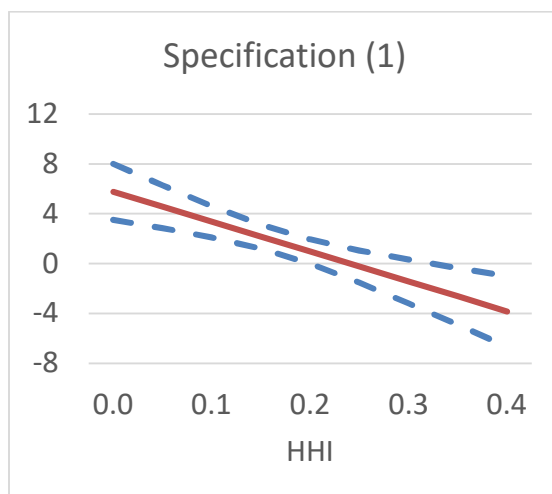
Table 8: Effect of regional HHI and bank-specific market shares on the pass-through of monetary policy surprises to lending rates (see Table 5 for corresponding results on the NUTS-3 level)

	(1)	(2)	(3)
HHI high; MS high * MPS	-0.621 (0.4335)	-0.6589 (0.4338)	-0.2838 (0.4109)
HHI high; MS low * MPS	-0.2345 (0.2811)	-0.2259 (0.2842)	-0.5483* (0.2846)
HHI low; MS High * MPS	-0.6965 (0.4839)	-0.7703 (0.4906)	-0.0444 (0.3579)
Number of observations	752,873	742,437	749,131
Loan level controls	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes
FE: size x sec x coun x per x pre/post	Yes	Yes	Yes
FE: bank x coun x per	Yes	No	No
FE: bank x sec x coun x per	No	Yes	No
Bank variables x per x pre/post	Yes	Yes	No
FE: bank x coun x per x pre/post	No	No	Yes

Note: MS stands for market share, MPS stands for monetary policy surprise, av. for average, FE for fixed effect, sec for sector, reg for region, per for period, coun for country. Per x pre/post indicates variation on the level of all pre- and post-periods (i.e. all 14-day periods before and all 21-day periods after a monetary policy meeting). Standard errors based on residuals clustered at the regional level and at the bank-period level in parentheses. Coefficients show strength of pass-through of monetary policy surprises relative to the setting “HHI low, MS low”.

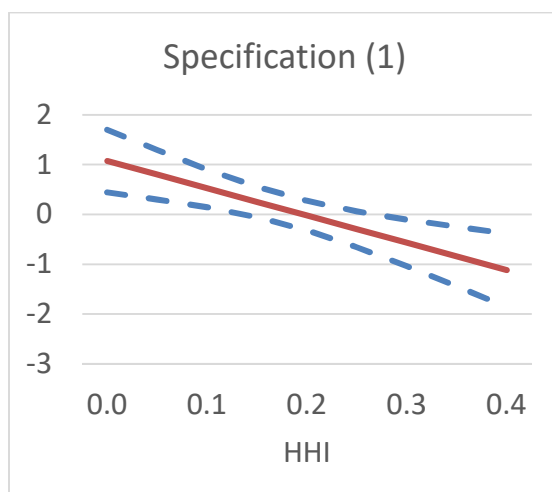
Annex III: Marginal effects of increase in the HHI on regional averages

Figure 2: Marginal effect of an increase in the HHI on the regional weighted average of mark-ups as a function of the level of the HHI (point estimates and 90% confidence interval).



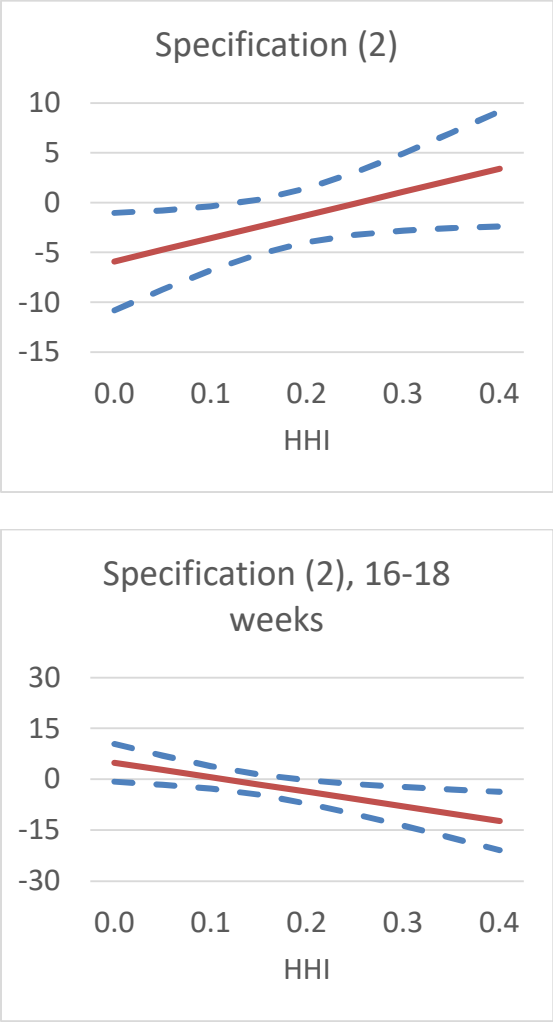
Note: The figure shows the marginal effect of an increase of the HHI on the average regional mark-up. An average over all banks weighted by bank-specific market shares is considered. Results are based on the results underlying Table 2.

Figure 3: Marginal effect of an increase in the HHI on the average pass-through from the 3-month Euribor to lending rates as a function of the level of the HHI (point estimates and 90% confidence interval).



Note: The figure shows the marginal effect of an increase of the HHI on the average regional pass-through from the 3-month Euribor to lending rates. An average over all banks weighted by bank-specific market shares is considered. Results are based on the results underlying Table 3.

Figure 4: Marginal effect of an increase in the HHI on the average pass-through from a monetary policy surprise to lending rates as a function of the level of the HHI (point estimates and 90% confidence interval).



Note: Figure shows the marginal effect of an increase of the HHI on the average regional pass-through from a monetary policy surprise (to 3-month OIS rate) to lending rates. An average over all banks weighted by bank-specific market shares is considered. Results are based on the results underlying Table 5 and Figure 1.

Annex IV: Further results

Table 9: Effect of regional HHI and bank-specific market shares on the level of lending rates, regional and non-regional banks, bank-country-averages

	(1) Regional	(2) Regional	(3) Non- regional	(4) Non- regional	(5) Non- regional av. MS
HHI high; MS high	0.2429*** (0.0825)	0.1685** (0.068)	0.4971*** (0.1763)	-0.0289 (0.1327)	1.2186*** (0.2825)
HHI high; MS low	0.164** (0.0732)	0.097 (0.0707)	0.0983*** (0.0331)	0.1184*** (0.0289)	0.1533*** (0.0411)
HHI low; MS high	0.1565* (0.0889)	0.0158 (0.0744)	0.6647*** (0.2187)	-0.04 (0.1222)	1.3461*** (0.2838)
# Observations	210,701	210,616	759,484	208,771	758,004
Loan level controls	Yes	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes	Yes
Bank variables	Yes	Yes	Yes	Yes	Yes
FE: size x sec x coun x y/m	Yes	Yes	Yes	Yes	Yes
Bank level HHI and MS	No	Yes	No	Yes	Yes/No

Note: MS stands for market share, av. for average, FE for fixed effect, sec for sector, reg for region, y/m for year/month, coun for country. Results in “Non-regional av. MS” column are based on estimations where bank-region-specific market shares have been replaced by bank-country-specific market shares that are volume-weighted averages over all regional markets. Standard errors based on residuals clustered on the regional level and the bank level in parentheses. Effects relative to setting “HHI low, MS low”. A bank is defined as regional if the proportion of its loan volume in the most important region exceeds the 10th percentile of the distribution of this proportion across all banks.

Table 10: Effect of regional HHI and bank-specific market shares on the level of lending rates, further estimations

	(1) Bench- mark	(2) iMIR- sample	(3) iMIR- sample + dep. beta	(4) Ex small reg countries	(5) Ex large reg countries
HHI high; MS high	0.524*** (0.121)	0.4111*** (0.1568)	0.306*** (0.1035)	0.5844*** (0.157)	0.5771*** (0.15)
HHI high; MS low	0.121*** (0.0371)	0.1141** (0.0537)	0.0575** (0.0285)	0.159*** (0.0431)	0.211*** (0.0522)
HHI low; MS high	0.654*** (0.1475)	0.5336** (0.2167)	0.3708** (0.1576)	0.6823*** (0.1917)	0.7643*** (0.2091)
Number of Observations	1,011,316	830,047	830,047	803,912	791,714
Loan level controls	Yes	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes	Yes
Bank variables	Yes	Yes	Yes	Yes	Yes
FE: size x sec x coun x y/m	Yes	Yes	Yes	Yes	Yes

Note: MS stands for market share, av. for average, FE for fixed effect, sec for sector, reg for region, y/m for year/month, coun for country, dep. beta for deposit beta. First column reproduces results from Table 2, column 1 for convenience. Second column presents results based on sample that includes only banks reporting in iMIR. Third column adds two bank-level variables to estimation: deposit beta (defined as change in aggregate rate on deposits of non-financial private sector relative to change in monetary policy rate) for the period from March to August 2011 and interaction of deposit beta with deposit share. Fourth column excludes countries where NUTS-3 regions are small on average (Belgium, Germany, Netherlands). Fifth column excludes countries where NUTS-3 regions are large on average (Finland, France, Ireland, Spain, Slovakia and all smaller countries comprising the Baltic countries, Cyprus, Luxemburg and Malta). Effects relative to setting “HHI low, MS low”.

Table 11: Effect of regional HHI and bank specific market shares on the pass-through of the 3-month Euribor to lending rates, further estimations

	(1) Bench- mark	(2) IMIR- sample + dep. beta	(3) Ex small reg countries	(4) Ex large reg countries	(5) Regional Banks	(6) Non- reg banks and av. MS
HHI high; MS high * 3M Euri	0.02 (0.0228)	-0.0028 (0.0233)	0.0376 (0.0311)	0.0789** (0.0324)	-0.0099 (0.0158)	0.024 (0.0636)
HHI high; MS low * 3M Euri	-0.001 (0.0091)	0.0058 (0.0078)	0.0025 (0.0144)	0.0049 (0.0076)	-0.0261 (0.023)	0.0026 (0.0111)
HHI low; MS high * 3M Euri	0.0321 (0.0321)	0.007 (0.0352)	0.0801* (0.0413)	0.0999*** (0.0377)	0.0256 (0.0242)	0.0381 (0.0691)
Number of Observations	1,009,943	829,901	791,088	454,421	245,557	761,644
Loan level controls	Yes	Yes	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes	Yes	Yes
Bank variables	No	No	No	No	No	No
FE: size x sec x coun x y/m	Yes	Yes	Yes	Yes	Yes	Yes
Bank variables x Euribor	Yes	Yes	Yes	Yes	Yes	Yes
FE: bank x coun	No	No	No	No	No	No
FE: bank x sec x coun	Yes	Yes	Yes	Yes	Yes	Yes

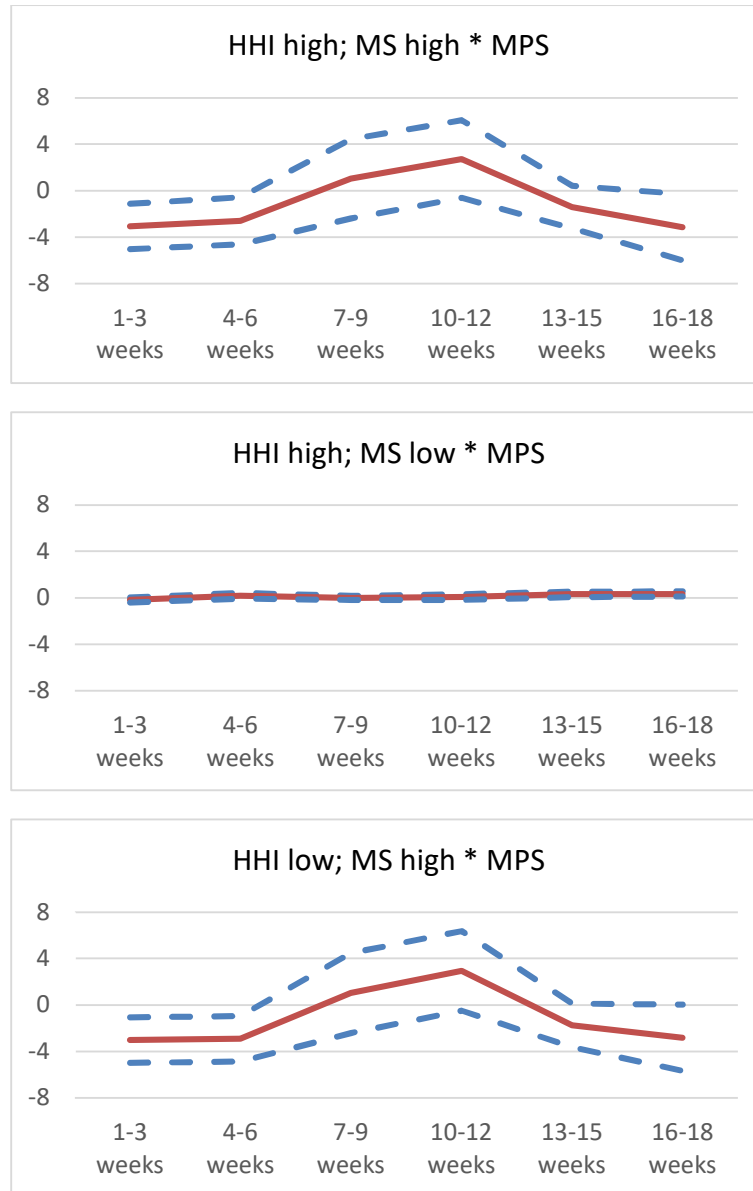
Note: MS stands for market share, av. for average, Euri for the 3-month Euribor, FE for fixed effect, sec for sector, reg for region, y/m for year/month, coun for country, dep. beta for deposit beta. First column reproduces results from Table 3, column 3 for convenience. Second column presents results based on sample that includes only banks reporting in iMIR with two bank-level variables added to estimation: deposit beta (defined as change in aggregate rate on deposits of non-financial private sector relative to change in monetary policy rate) for the period from March to August 2011 and interaction of deposit beta with deposit share. Third column excludes countries where NUTS-3 regions are small on average (Belgium, Germany, Netherlands). Fourth column excludes countries where NUTS-3 regions are large on average (Finland, France, Ireland, Spain, Slovakia and all smaller countries comprising the Baltic countries, Cyprus, Luxemburg and Malta). Fifth column includes only regional banks, defined as banks for which the proportion of their loan volume in the most important region exceeds the 10th percentile of the distribution of this proportion across all banks. Sixth column includes only non-regional banks, and bank-region-specific market shares have been replaced by bank-country-specific market shares, which are volume-weighted averages across all regional markets. Coefficients show magnitude of interaction with 3-month Euribor relative to setting “HHI low, MS low”.

Table 12: Effect of regional HHI and bank-specific market shares on the pass-through of monetary policy surprises to lending rates, further estimations

	(1) Bench- mark	(2) IMIR- sample + dep. beta	(3) Ex small reg countries	(4) Ex large reg countries	(5) Regional Banks	(6) Non- reg banks + av. MS
HHI high; MS high * MPS	-0.5204 (0.3306)	-0.3816 (0.3517)	-0.3552 (0.2968)	-0.4567 (0.3721)	0.1449 (0.3034)	-3.0693*** (1.179)
HHI high; MS low * MPS	-0.1782 (0.1104)	-0.0876 (0.152)	-0.0052 (0.152)	-0.1775 (0.1705)	0.2696 (0.3513)	-0.1793 (0.1321)
HHI low; MS high * MPS	-0.5854 (0.3932)	-0.1391 (0.4094)	-0.2275 (0.3158)	-0.6278* (0.3804)	0.1469 (0.332)	-3.0123** (1.1858)
Number of Observations	709,798	590,974	562,908	311,481	168,001	539,613
Loan level controls	Yes	Yes	Yes	Yes	Yes	Yes
Reg variables	Yes	Yes	Yes	Yes	Yes	Yes
FE: size x sec x coun x per x pre/post	Yes	Yes	Yes	Yes	Yes	Yes
FE: bank x coun x per	No	No	No	No	No	No
FE: bank x sec x coun x per	Yes	Yes	Yes	Yes	Yes	Yes
bank variables x per x pre/post	Yes	Yes	Yes	Yes	Yes	Yes

Note: MS stands for market share, MPS stands for monetary policy surprise, av. for average, FE for fixed effect, sec for sector, reg for region, per for period, coun for country, dep. beta for deposit beta. Per x pre/post indicates variation on the level of all pre- and post-periods (i.e. the 14-day periods before and 21-day periods after a monetary policy meeting). First column reproduces results from Table 5, column 2 for convenience. Second column presents results based on sample that includes only banks reporting in iMIR with two bank-level variables added to estimation: deposit beta (defined as change in aggregate rate on deposits of non-financial private sector relative to change in monetary policy rate) for the period from March to August 2011 and interaction of deposit beta with deposit share. Third column excludes countries where NUTS-3 regions are small on average (Belgium, Germany, Netherlands). Fourth column excludes countries where NUTS-3 regions are large on average (Finland, France, Ireland, Spain, Slovakia and all smaller countries comprising the Baltic countries, Cyprus, Luxemburg and Malta). Fifth column includes only regional banks, defined as banks for which the proportion of their loan volume in the most important region exceeds the 10th percentile of the distribution of this proportion across all banks. Sixth column includes only non-regional banks, and bank-region-specific market shares have been replaced by bank-country-specific market shares, which are volume-weighted averages across all regional markets. Coefficients show magnitude of interaction with monetary policy surprise relative to setting “HHI low, MS low”.

Figure 5: Dynamic evolution of the effect of market concentration and bank-specific market shares on the pass-through of monetary policy surprises to lending rates (point estimates and 90% confidence interval); non-regional banks and average regional market shares at the bank-country level



Note: Figures show the dynamic evolution of coefficients from Table 12, column 6, with the “post-period” time window being shifted to the weeks after the monetary policy decision indicated on the x-axis. Note furthermore that the results for 1-3 weeks are those displayed in the table in column 6. MS stands for market share, MPS stands for monetary policy surprise.