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Monetary Policy and Real Estate Price Distortions: How Bank Lending Amplifies Housing Market Imbalances*

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Abstract

We empirically document deviations of residential real estate prices from fundamental values at the micro level and investigate their relationship with local bank lending growth during a period of unconventional monetary policy. Our findings indicate a positive relationship between credit growth and excessive price increases in real estate markets, with interest rate reductions further amplifying these credit-driven price distortions. Additionally, we provide evidence that banks' search-for-yield behavior explains the increase in lending, particularly among deposit-funded banks that experienced a squeeze of margins during the negative monetary policy rate period. This credit expansion, in turn, directly influences the real economy by fueling local housing markets. In our analysis, we exploit that the introduction of negative monetary policy rates affected banks differently depending on their ex-ante liquidity and relate micro-level real estate data to balance sheet information from locally operating banks and macroeconomic variables.

Keywords: residential real estate prices, housing bubbles, bank lending, search-for-yield, micro data, negative interest rates

JEL Classification: E44, E52, G21, R21, R31

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1 Introduction

Alongside with the expansionary monetary policy period of the last years and after years of severe demand overhang combined with inelastic supply at residential real estate markets, property prices increased significantly in many countries. While anecdotal evidence suggests that unconventional monetary policy has fueled house prices, empirical evidence remains scarce.

The Global Financial Crisis (GFC) demonstrated how increased bank lending can stimulate economic activity, but excessive lending and risk-taking can also lead to credit-driven distortions and financial instability (Diamond & Rajan, 2009; Justiniano et al., 2019). Mutually reinforcing boom-bust cycles in housing and credit markets further heighten the risk of financial fragility (Goodhart & Hofmann, 2008). Prior research suggests that financial instability is not driven solely by high house prices or nominal price changes but rather by deviations from fundamental values (Koetter & Poghsyan, 2010). Prolonged housing market imbalances can weaken the financial sector, as banks play a central role in mortgage lending. Empirical studies also show that housing-related credit growth is a strong predictor of financial crises and declining GDP growth (Jorda et al., 2016; Mian et al., 2018).

Following the GFC and the subsequent decrease in economic growth, central banks responded by cutting interest rates and implementing unconventional monetary policy measures to stimulate economic growth. Some, like the European Central Bank (ECB), even introduced negative monetary policy rates (NMPR). Economic literature suggests that banks respond differently to standard and non-standard monetary policies depending on factors such as their funding structure and liquidity. In particular, deposit-funded banks experience greater margin compression due to the zero lower bound on deposits, making them more vulnerable than banks that rely on wholesale funding (Heider et al., 2019). After exiting the period of very expansionary monetary policy, understanding how bank behavior was affected and its consequences for the real economy is crucial. This is particularly important for identifying potential future risks in times of rising interest rates, which could exert downward pressure on real house prices (Dieckelmann et al., 2023). Studies show a strong link between house price depreciation and residential mortgage defaults, underscoring the importance of monitoring these dynamics.

This paper examines whether banks facing external margin pressure from the introduction of NMPR contribute to distortions in residential real estate markets by driving local deviations of house prices from their fundamental values. To examine this, we empirically analyze the case of German savings banks and their relationship with the residential real estate market during the NMPR period. Specifically, we assess whether house prices deviated from their fundamental values – i.e., prices not driven by economic cycles – at the micro level during the period of unconventional monetary policy. In the second step, we analyze if these deviations are linked to local bank performances.

Germany provides an ideal setting for this study for several reasons: i) A good data availability allows a precise assessment of housing market dynamics, which is particularly important given regional heterogeneity. ii) Unconventional monetary policy was primarily designed to support dysfunctional markets in the euro area periphery while Germany's financial system and economic conditions remained sound (Bednarek et al., 2021; European Central Bank, 2012). Thus, monetary policy can be treated as exogenous, reducing endogeneity concerns. iii) Germany's unique banking system consists of a large number of small, locally operating banks, allowing to link local credit supply to local real estate prices. iv) The research question is particularly relevant to banks that rely heavily on deposit funding and mortgage lending due to limited investment opportunities, such as the German savings banks. v) Housing represents 62% of Germany's national wealth (Braun & Lee, 2021), and house prices have increased sharply in recent years. As real estate serves as a primary form of loan collateral, savings banks are particularly exposed to local real estate fluctuations. This also underlines the importance of the housing sector as a critical component for financial stability. vi) Reports indicate that during the NMPR period, German savings banks' margins declined, prompting record levels of new residential real estate lending. In 2020, new mortgage lending reached €67 billion, marking a 13.7% increase from the previous record in 2019 (Wagner, 2021). In response to growing financial stability concerns, the Federal Financial Supervisory Authority (BaFin) introduced a sectoral systemic risk buffer in 2023, requiring banks to hold an additional 2.0% of risk-weighted assets for loans secured by residential properties.

Our **empirical strategy** proceeds as follows. First, we calibrate a hedonic model using residential real estate listings data from 2010 to 2013 to establish a baseline. This model incorporates object-specific characteristics, including object condition, and regional controls to account for general heterogeneity across districts. Based on the estimated coefficients from this model, we predict a price for each property listed in the subsequent unconventional monetary policy period (2014-2021). The difference between the predicted and the actual listed price is interpreted as the deviation from the fundamental value, as this share of the price cannot be explained by object-specific characteristics or regional heterogeneities.

Next, we examine if these deviations can be explained by regional bank characteristics and regional time-varying socioeconomic variables. By matching real estate data with local bank balance sheet information, we explore the relationship between bank lending growth and regional house price deviations. Our findings indicate a positive correlation between lending growth and price deviations, suggesting that districts with stronger lending activity exhibit larger deviations from fundamental values.

Next, we dig deeper into explaining this observed correlation. To derive causal results, we make use of the fact that NMPR disproportionately impacted deposit-funded banks which faced a squeeze of their margins and a threat to their business models when the interest income decreased more than banks' funding costs (Heider et al., 2019). We employ a difference-in-differences approach, exploiting variation in banks' ex-ante liquidity levels to assess their heterogeneous responsiveness to NMPR. The results show that higher-liquidity banks increased lending more than lower-liquidity banks.

One plausible mechanism driving this behavior is that banks facing profit pressures increase lending to offset revenue losses. This would be an increase of credit irrespective of market participants' property price expectations and is therefore treated as an exogenous increase in credit supply. To test this, we examine the relationship between declining interest income, operating revenue, and subsequent loan growth. Our results confirm search-for-yield behavior as decreasing revenues lead to greater lending activity. The analysis to test if this relation is also relevant for the local real estate markets shows that local banks' smaller revenues and interest incomes explain a share of the deviation of residential real estate prices from their fundamental values in the subsequent year. Thus, bank behavior in response to NMPR-induced margin compression directly influences the real economy by inflating local housing markets.

This study makes three key **contributions**: First, we uncover overvaluation of residential property prices relative to fundamental values at micro level using a detailed real estate dataset. Second, we link bank lending to local house price deviations, demonstrate how local bank characteristics influence real estate price dynamics, and assess heterogeneous effects depending on the interest rate. Third, we contribute to the literature on bank behavior following a squeeze of margins and its side effects on the real economy, as our findings support the hypothesis that banks facing NMPR-induced profit constraints engage in search-for-yield behavior, contributing to credit-fueled house price distortions.

Our findings have at least two **policy implications**. First, banks experiencing margin compression may engage in riskier lending practices, potentially distorting the real economy and increasing financial stability risks. In the studied example, this search-for-yield behavior led to lending growth in regions where the most commonly used collateral – residential real estate – is not backed by fundamentals, heightening vulnerability to future downturns. Second, banking regulators should pay closer attention to liquidity-rich banks that traditionally appear stable. NMPR-induced profitability pressures could drive these institutions toward riskier lending strategies, necessitating enhanced supervision.

Rather than investigating the broader demand effects of expansionary monetary policy on real estate, our focus is on the explanation of the observed deviations from fundamental values as a side product of NMPR. One **challenge** in interpreting our results as causal is the confounding influence of the economic environment in which banks, firms, households, and the ECB operate. However, since the ECB sets monetary policy rates for the entire euro area, the economic conditions of single countries do not determine the ECB's policy decisions (Jiménez et al., 2012a). As our results are based on regional variations within one country in the Euro area, we do not see this as a threat to our empirical strategy. Furthermore, the economic environment influences (unobserved) credit demand, which together with (unobserved) bank credit supply determines the observed lending volume. Additionally, the ECB's policy rate also affects households' credit demand. This is a problem that several studies face that explore monetary-policy transmission, e.g., Bittner et al. (2022). We address this endogeneity issue by incorporating local demand controls to isolate the effect of bank lending on the residential real estate markets.

The remainder of the paper is organized as follows. Section 2 provides a review of the relevant literature and outlines our hypotheses. Section 3 discusses the data and the institutional setting. Section 4 presents our empirical strategy, the calibration of the hedonic model, as well as the regression analyses of the real estate price deviations and the search-for-yield channel. Section 5 concludes.

2 Literature

Our hypotheses build on the large literature examining the relationship between house prices and credit supply, the deviation of house prices from fundamental values and the formation of real estate bubbles, and the impact of ultra-loose monetary policy on bank performance and behavior.

2.1 The link between house prices and bank lending

There is a wide range of literature that studies the relationship between bank lending and house prices. On the one hand, several studies focus on **credit supply as an important determinant of house prices** (e.g. Mian & Sufi, 2009). A relaxation of credit constraints is associated with house price growth (Favilukis et al., 2017), a relationship supported by empirical findings (e.g. Di Maggio & Kermani, 2017; Favara & Imbs, 2015). For instance, Favara & Imbs (2015) exploit regulatory changes to identify an exogenous shift in credit supply,[4] showing that banking deregulation allowed for more favorable loan terms, leading to credit expansion and increased housing demand. Depending on construction elasticity, this resulted either in price increases or an expansion of the housing stock. Similarly, Mian et al. (2020) find that banking deregulation significantly affects housing markets by boosting household demand, which in turn influences house prices and residential construction. Examining geographical variation, Mian & Sufi (2022) further demonstrate that an exogenous increase in mortgage supply by specific lenders amplifies housing speculation and reinforces housing cycles.

Beyond U.S. data, the positive effect of mortgage credit supply on house prices has been observed in other countries as well (Barone et al., 2021). Blickle (2022) provides causal evidence linking local mortgage credit supply to house price growth, leveraging an exogenous deposit shock in Swiss cooperative mortgage banks ("Raiffeisen banks") following a 2008 capital flight from universal banks. Since these banks are restricted to lending within a narrow

[4] See Kroszner & Strahan (2014) for a detailed overview on literature that exploits deregulation in the US to derive causal results.

geographic region, the influx of mortgage credit led to localized house price increases. This finding underscores the direct impact of credit expansion on housing market distortions.

On the other hand, **rising house prices may also fuel credit expansion**, creating an upward feedback loop (Anundsen & Jansen, 2013). Real estate is the most commonly used form of collateral in lending, and as property values rise, banks face lower losses in case of borrower default. Through the balance sheet channel, higher house prices increase bank capital, enhancing their ability to extend credit (Goodhart & Hofmann, 2007; Oikarinen, 2009).

Several studies emphasize the **bi-directional relationship** between credit and house prices, as both markets are dependent on each other (Damen et al., 2016; Fitzpatrick & McQuinn, 2007; Gimeno & Martínez-Carrascal, 2010; Kelly et al., 2018; Shen et al., 2016). This relation might become **harmful** if unreasonable expectations drive house price booms, prompting excessive lending (Adelino et al., 2012; Foote et al., 2021; Mian & Sufi, 2009). Some studies further demonstrate that initial house price increases can be amplified through expectation-driven credit expansion, fueling further price surges (Herbst et al., 2024). However, when property prices decline, the value of loan recoveries falls below exposure at default, leading to more severe loan losses (Niinimäki, 2009). Thus, the positive reverse causality from mortgage amounts to house prices causes a mutually reinforcing mechanism between real estate and mortgage market booms and busts (Basten & Koch, 2015).

Concerning bank stability, increasing real estate prices alone can have positive and negative effects. On the one hand, increasing house prices may boost the economic value of bank capital by increasing the value of real estate owned by the bank and the value of collateral pledged by borrowers (collateral value hypothesis). This may lead to decreasing perceived risk of real estate lending, enhance bank stability, and further increases of real estate prices are likely to increase the credit supply (Herring & Wachter, 1999).

On the other hand, rising house prices can encourage excessive risk-taking. Flannery et al. (2022) document that, in the years preceding the Great Recession, surging housing demand contributed to bank asset growth. Moreover, as banks expect real estate prices to grow in the near future, they might extend credit to riskier borrowers, relying on rising property values to mitigate potential losses (Zurek, 2022). This behavior can expose banks to higher losses if prices return to fundamental levels (deviation hypothesis) (Koetter & Poghosyan, 2010; Öhman & Yazdanfar, 2018).

2.2 Deviation of house prices from their fundamental values

The relationship between credit and real estate prices becomes particularly significant during periods of rapid house price increases and rising household leverage, as housing-related credit growth is a strong predictor of financial crises and economic downturns (Jorda et al., 2016; Mian et al., 2017). A large body of research highlights the risks associated with **asset price bubbles** and the link between housing booms and financial instability. For instance, the U.S. credit crisis was primarily driven by the misallocation of investment into real estate (Diamond & Rajan, 2009). While ignoring real estate booms can have severe economic consequences, distinguishing between normal price increases and unsustainable housing bubbles remains a challenge (Crowe et al., 2013).

Like for any other asset, the prices for residential real estate are determined by supply and demand which depends on macroeconomic **fundamentals** like population growth and real income wealth (Koetter & Poghosyan, 2010). Other variables that are typically included as fundamental variables are interest rates, household income, unemployment, inflation (CPI), market rents, housing supply (Jacobsen & Naug, 2005), and demographic factors (Himmelberg et al., 2005). Thus, in a frictionless world, house prices should reflect economic cycles. However, there are various reasons for sustained positive deviations from long-run equilibrium prices since real estate is a non-standardized asset and the trading involves high transaction costs as well as slow supply responses (Koetter & Poghosyan, 2010). One major factor contributing to these deviations, and the central focus of our analysis, is bank lending.

Empirical research suggests that deviations from fundamental values, rather than nominal house price changes, are particularly relevant when assessing bank stability threats (Ayuso & Restoy, 2006; Calomiris & Mason, 2003); McCarthy & Peach, 2004). Koetter & Poghosyan (2010) estimate the probability of bank defaults based on regional house price developments and find that deviations from fundamental values increase banks' default risk, while nominal house price changes alone do not have a significant effect. In our study, we build upon their approach by calculating house price deviations from fundamental values at the micro level rather than relying on aggregate indicators. Our analysis covers the entire German market and focuses on the post-GFC period, allowing us to capture the effects of unconventional monetary policy.[5]

Several studies have analyzed house price deviations in Germany. For example, Kajuth et al. (2016) find that both single-family homes and apartments exceeded their fundamental values in Germany, but their dataset only extends to 2014 and does not cover the period of unconventional monetary policy. Our paper expands upon their approach by deriving price deviations at the micro level[6] and linking them to local bank performance and lending activity. Similarly, Zhu et al. (2017) de-link short-term house price dynamics from fundamental factors and underline that mortgage market characteristics play a critical role in the transmission of monetary policy. Unlike Koeniger et al. (2022) who show that the pass through of monetary policy shocks to rates of newly originated mortgages is heterogeneous, also within countries, we focus on the side effects of non-conventional monetary policy that might fuel local

[5] Koetter & Poghosyan (2010) only consider annual information on existing houses in 125 German cities with city-level information for the years 1995-2004 and analyze a period with decreasing mean house prices.
[6] Other studies that use micro level data in this context are e.g., Trojanek et al. (2023) who examine if Polish house prices are justified by fundamentals and link house prices to households' incomes and rents.

deviations of real estate prices.

Moreover, we include regionally constrained banks into our analyses, as their dependence on the economic well-being of their surrounding area is particularly strong and therefore makes them vulnerable to these dynamics (Koetter & Poghosyan, 2010; Öhman & Yazdanfar, 2018; Zurek, 2022). Brunnermeier et al. (2020) underline that in real estate booms, it is the small banks that experience larger increases in systemic risk due to their stronger focus on mortgage lending. With this paper we fill the gap in the literature on regional deviations of house prices from fundamentals and local bank lending.

2.3 Bank lending in times of negative monetary policy rates

Following the financial crisis and the subsequent economic slowdown, conventional monetary policy has been accompanied by a number of non-standard measures such as asset purchase programs, long-term refinancing operations or NMPR to further ease monetary conditions. Research shows that these measures affect banks and the real economy differently from conventional policies. During periods of unconventional monetary policy, traditional transmission mechanisms, such as the bank lending channel (Bernanke & Blinder, 1988; Bernanke & Gertler, 1995) and the bank balance sheet channel (Jiménez et al., 2012b; Kashyap & Stein, 2000), become less effective.

Recent studies instead highlight the **contractionary retail deposit channel**, which operates through banks' liability structures. Heider et al. (2019) find that the transmission of monetary policy through bank credit supply differs between positive and negative interest rate environments, with banks' funding structures playing a crucial role. When policy rates fall below zero, banks that rely heavily on deposit funding experience a decline in net worth, as deposit rates cannot be lowered proportionally due to the hard zero lower bound (ZLB). Since depositors could alternatively hold cash, banks have limited ability to pass negative rates onto retail deposits. This constraint is particularly relevant for banks with a high deposits-to-assets ratio.

Specifically for German banks, Bittner et al. (2022) document a weak pass-through of the ECB's rate cut to bank funding costs. However, loan rates remain more responsive to policy rate changes, leading to a decline in the spread between loan and deposit rates. This, in turn, reduces bank profitability and weakens the traditional balance-sheet channel. Bittner et al. (2022) model the augmented bank balance-sheet channel, showing that a weak pass-through to funding costs has both direct and indirect effects on credit supply. First, it directly tightens banks' financing constraints, as lower policy rates do not sufficiently reduce the cost of external financing. Second, it indirectly increases risk-taking, as tighter financing constraints reduce banks' incentives to maintain high lending standards, further amplifying financial fragility. They conclude that banks highly dependent on deposit funding experience a negative shock to their net interest margins when policy rates turn negative, making rate cuts in negative territory less expansionary than those in positive territory. This can weaken incentives for screening and monitoring borrowers, inducing banks' search-for-yield behavior of affected banks.

Demiralp et al. (2021) further confirm that banks increase risk-taking under NMPR. Their findings suggest that the expansionary effects of negative rates depend on banks' reliance on retail deposit funding and their excess liquidity holdings. Heider et al. (2021) argue that since NMPR widen the spread between low-yielding liquid assets and higher-yielding assets (such as loans), affected banks may shift from reserves to lending, increasing their exposure to riskier borrowers. Bottero et al. (2022) provide additional evidence of an expansionary portfolio rebalancing channel, showing that banks with higher pre-existing liquidity levels respond more strongly to NMPR by increasing credit supply, particularly to financially constrained firms. Schelling & Towbin (2022) further explain that lower interest rates incentivize banks to take on additional risks to maintain profitability through the risk-taking channel.

While there is substantial research on the impact of negative interest rates on banks and growing evidence on how unconventional monetary policy affects house prices (e.g. Rosenberg, 2019), no empirical study has linked deviations in residential real estate prices from fundamental values to the side effects of unconventional monetary policy through banks' portfolio rebalancing. Our paper aims to bridge this gap by examining how NMPR-induced changes in bank behavior contribute to real estate price distortions.

2.4 Derivation of the hypotheses

We contribute to the literature by relating the deviation of house prices from their fundamentals and bank lending in times of ultra-lose monetary policy. Based on the literature on real estate price bubbles and financial stability threats, we do not focus on real estate prices but on the deviation of prices from their fundamentals. To follow up on the literature on credit supply and house prices, we link the deviation of real estate prices from their fundamentals to bank lending. Thus, **hypothesis 1** states:

The deviation of real estate prices from fundamental values is positively correlated to the growth of bank lending.

Identifying causal effects in this relationship is challenging due to endogeneity concerns, as credit supply is not an exogenous variable. To address this, we draw on the literature on bank behavior under NMPR. Specifically, we exploit the fact that banks heavily reliant on deposit funding and holding higher liquidity face a profitability shock when interest rates turn negative. This pressure may incentivize them to engage in search-for-yield behavior by expanding lending. Accordingly, we propose **hypothesis 2**:

Banks that face decreasing profitability due to their higher exposure to the introduction of NMPR increase lending in the subsequent periods.

This would be an increase of credit supply that does not depend on market participants' property price expectations and allows us to derive a causal link from the banks' profitability to the local real estate markets via the banks' search-for-yield behavior. This leads to **hypothesis 3**:

In regions, where the banks' profitability decreases, the deviation of real estate prices from fundamental values increases in the following periods.

3 Data, descriptive statistics, and institutional setting

Germany provides an ideal setting for studying the impact of bank lending on the local residential real estate markets, as it allows the linkage of local bank balance sheet data with granular residential real estate data. This enables a detailed analysis of the relationship between credit supply and housing market developments at the regional level.

3.1 Data and descriptive statistics

For this study, we construct a unique data set that integrates micro-level sale price data for apartments and houses, local savings banks' balance sheet characteristics, and comprehensive socio-economic and regional information at the district-level. The use of micro-level data provides a more detailed perspective than aggregate time-series data, which is particularly important given the significant heterogeneity of housing markets across German regions.

3.1.1 Micro-level housing data

The micro-level housing data are obtained from the research data center FDZ Ruhr at the RWI (RWI - Leibniz Institute for Economic Research, 2023b, 2023d). These data are sourced from ImmobilienScout24, one of Germany's largest online real estate advertisement platforms. ImmobilienScout24 serves both private and commercial users, claims a market share of approximately 50%, and is used by 74.3% of real estate professionals to list properties (Statista, 2023). The dataset provides a systematic collection of all properties listed for sale on the platform, updated monthly. For our analysis, we use observations from January 2010 to December 2022. The dataset includes detailed information on *asking prices* and several object-specific value-determining characteristics, like the *number of rooms, living space, object condition*[7], as well as details concerning the location on the municipality level. For a

[7] The object condition can take the values of (1) first occupancy, (2) first occupancy after reconstruction, (3) reconstructed, (4) modernized, (5) like new, (6) completely renovated, (7) well kept, (8) needs renovation, (9) dilapidated but negotiable and (10) dilapidated.

comprehensive description of the dataset, see Boelmann & Schaffner (2019).

Our analysis focuses on apartments and houses listed for sale. The raw dataset provides a large number of observations, however, to ensure data quality, we exclude incomplete listings. Moreover, we only consider objects that have a valid postal code,[8] that were built in 1800 or later, with a minimum number of rooms of one, a reported living space of at least ten square meters, and that do not belong to the top or bottom 1% of price per square meter to remove extreme outliers. Studies using a similar dataset use comparable procedures for quality assurance (Baye & Dinger, 2024; Breidenbach, Eilers, et al., 2022; Deschermeier et al., 2016; Eilers, 2017).[9]

Table 1 provides summary statistics for the dataset. The average apartment for sale has three rooms, is located in a building that is 48 years old, has an average living space of 83.3 square meters, and is listed at an average sale price of 3,046.37 Euros per square meter. The average house has seven rooms, is 53 years old, has an average living space of 192 square meters, and is listed at an average price of 2,282.70 Euros per square meter.

While we acknowledge that asking prices may deviate from actual transaction prices, existing research suggests that they reliably reflect price trends. Dinkel & Kurzrock (2012) and Kholodilin et al. (2016) find that asking price data track market developments well. Lyons (2013) further supports this view, demonstrating that list prices serve as a leading indicator for sale prices, as sellers' expectations adjust immediately to market conditions, whereas final transaction prices take longer to reflect changes due to the time required for negotiations and closing processes. In declining markets, transaction prices are typically lower than asking

[8] The German postcode system is a pure number system consisting of five digits. By only considering objects in five-digit postcode areas, the quality of the observations considered should be ensured.

[9] Recent studies based on these data were for example published by Baye & Dinger (2024) and Breidenbach, Eilers, et al. (2022) analyzing the effects of rent control, Breidenbach, Cohen, et al. (2022), Pommeranz & Steininger (2021), Klick & Schaffner (2019), Eilers (2017), and Deschermeier et al. (2016) who focus on recent developments in the housing market for rentals and sales.

prices, as sellers may need to accept lower offers due to weaker demand (Lyons, 2013). However, during our observation period, housing prices exhibited a continuous upward trend, supporting the validity of using list prices as a proxy. Additionally, given the lack of comprehensive and reliable data on actual residential transaction prices in Germany, the use of ImmobilienScout24 data is justified. For a more detailed discussion of the dataset's representativeness, please consider Baye & Dinger (2024).

	Obs.	Mean	Std. Dev.	Min	P25	P50	P75	Max
Apartments and houses								
Age	4549158	50.517	37.053	1	22	44	65	222
Living space	4549158	140.031	102.478	10	76	115.89	170	9144
No. of rooms	4549158	4.861	3.131	1	3	4	6	25
Price (per sqm)	4549158	2647.873	1538.367	211.817	1497.736	2321.428	3485.425	9725
Apartments								
Age	2175340	47.745	35.665	1	22	42	60	222
Living space	2175340	83.359	39.066	10	59	76	98.16	1000
No. of rooms	2175340	2.885	1.139	1	2	3	3.5	10
Price (per sqm)	2175340	3046.368	1655.361	382.653	1786.619	2737.94	3984.821	9725
Houses								
Age	2373818	53.056	38.105	1	23	46	70	222
Living space	2373818	191.964	114.397	10	125	160	225	9144
No. of rooms	2373818	6.672	3.277	1	5	6	8	25
Price (per sqm)	2373818	2282.698	1321.096	211.817	1306.25	2000	2972.973	7231.347

Table 1: Descriptive statistics for residential real estate objects
This table shows the descriptive statistics for the used Immoblienscout24 data, averaged over the observation period of 2010-2022.

3.1.2 Bank-level data

We obtain detailed accounting data from Bureau van Dijk's Bank Focus database. To link residential real estate data with the balance sheet characteristics of local savings banks, we leverage a unique feature of the German banking sector: savings banks primarily operate within geographically defined administrative districts (Beck et al., 2022). These district boundaries typically align with the administrative districts used in regional data platforms such as Genesis and INKAR[10], allowing us to integrate local banking characteristics with socio-economic variables and micro-level housing data. We use the match between savings banks and the 401 administrative regions of Dinger et al. (2024), which is based on a list of savings banks and the administrative regions in which they operate, as provided by the German Savings Banks and Giro Association ("Deutscher Sparkassen- und Giroverband", DSGV). This approach enables us to aggregate savings bank balance sheet variables at the district level. In cases where a savings bank operates across multiple districts, we use hand-collected information on these multi-district banks and aggregated their balance sheet variables accordingly. This ensures that our dataset accurately reflects the regional distribution of banking activities. Descriptive statistics indicate substantial heterogeneity in credit growth across German districts (Figure 1), underscoring the importance of analyzing regional variations in bank lending and its impact on housing markets.

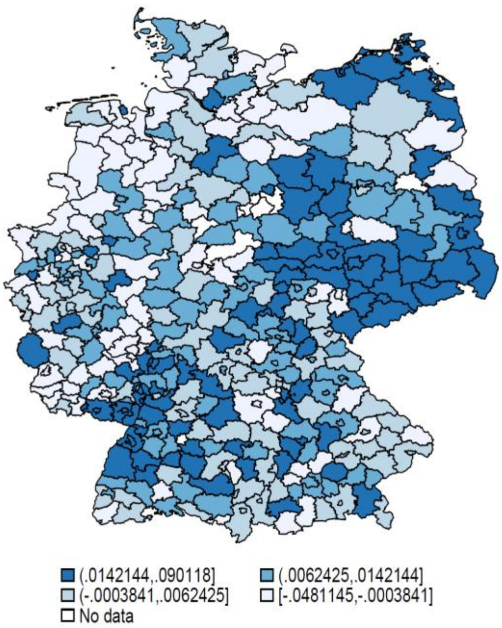


Figure 1: Distribution of credit growth of savings banks across Germany
This figure shows which regions were particularly affected by credit growth. The German districts are divided by color according to the quartiles of the mean of the growth rate of loans of local savings banks between 2014 and 2021. Districts in the quartile with the highest credit growth are marked in dark blue. The lighter the color, the

[10] Deviations from this principle can occur, as discussed in Dinger et al. (2024), if more than one savings bank operates in one district and if mergers allow one savings bank to be active in more than one administrative region.

lower is the average credit growth.

3.1.3 District-level data

To capture regional characteristics, local economic activity, and socioeconomic factors at the municipality and district levels[11], we use data from the Genesis regional data platform, maintained by the German Federal Statistical Office (Statistisches Bundesamt). Additionally, we incorporate data from the German Federal Institute for Research on Building, Urban Affairs, and Spatial Development, which provides indicators of spatial and urban development through the INKAR database.

Our dataset covers all 401 administrative districts (Kreise) in Germany, with data available at an annual frequency. This district-level information allows us to account for regional heterogeneity in economic conditions.

3.2 Housing market and banking system

Germany provides an interesting case for studying the relationship between deviations in real estate markets and bank lending, as property price developments vary significantly across regions. Despite Germany's relatively low homeownership rate – 46.5% in 2019 (German Federal Statistical Office, 2021)) – housing still accounts for 62% of the national wealth (Braun & Lee, 2021).

Figure 2 presents the average price per square meter across German districts from 2010 to 2013. As expected, the metropolitan areas, particularly Munich, Berlin, Frankfurt and the Rhine-Main metropolitan area, Stuttgart, Hamburg and the Rhineland, exhibit the highest property prices. These regional differences reflect structural disparities in economic development and

[11] Municipalities are cities or towns with an own local government, they define the lowest level of territorial division in Germany. In Germany exist more than 11,000 municipalities in 401 districts. The German districts are at an intermediate level of administration between the German federal states and the municipality governments. Cities with more than 100,000 inhabitants do not usually belong to a district, but form their own district.

population growth rates. In contrast, eastern Germany, characterized by weaker economic conditions, generally has lower residential real estate prices.

During the period of unconventional monetary policy, the heterogeneity at the German housing markets increases, as Figure 3 shows. Although prices in the least expensive quartile increase significantly as well, the difference between the lower und the upper quartile widens between 2014 and 2022. Analyzing the relation of local housing markets and local bank characteristics on a regional level exploiting the cross-sectional variance seems crucial in this context. On the one hand, from a financial stability perspective, housing market imbalances at the regional level can contribute to systemic risks. On the other hand, as Beraja et al. (2019) emphasize, regional segmentation in housing markets makes local house price shocks a key determinant of monetary policy transmission.

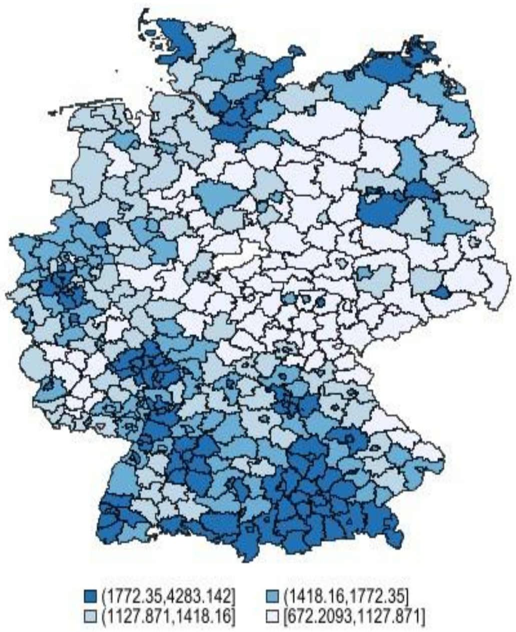


Figure 2: Price per square meter (mean)
This figure shows the distribution of the quartiles of the average price per square meter (in Euro) across German districts in from 2010-2013. Districts in the quartile with the highest price are marked in dark blue. The lighter the color, the less expensive is the price per square meter. The figure is based on prices of residential real estate offered for sale at ImmobilienScout24 (RWI - Leibniz Institute for Economic Research, 2023d, 2023b).

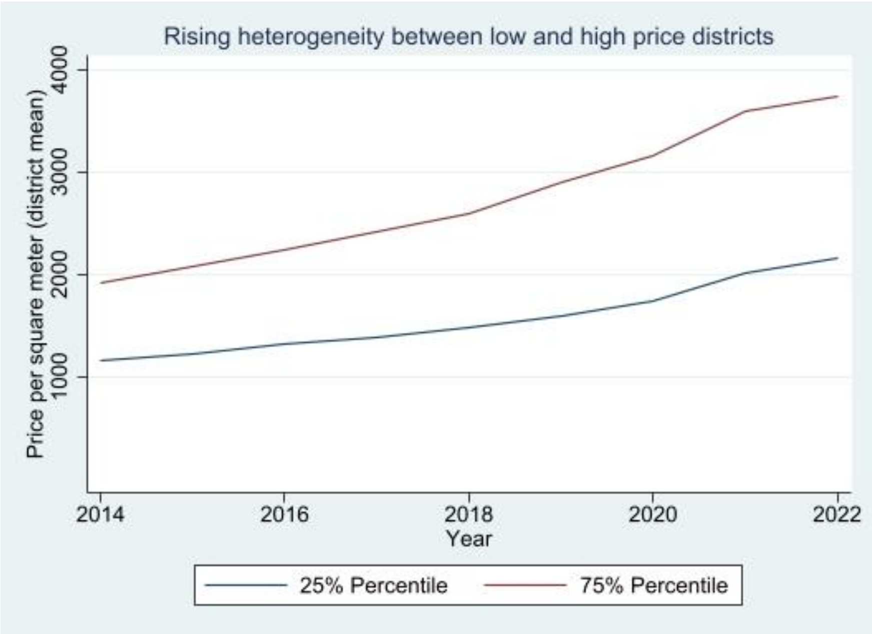


Figure 3: Rising difference between lower and upper price per square meter quartile
This figure shows the evolution of the least and most expensive 25% of the average price per square meter over 2014 to 2022. The figure is based on prices of residential real estate offered for sale at ImmobilienScout24 (RWI - Leibniz Institute for Economic Research, 2023d, 2023b).

The German **banking sector** consists of three pillars, the private commercial banks, savings banks and cooperative banks. Unlike private commercial banks, which operate nationwide and for which cross-regional data is unavailable, savings banks and cooperative banks are geographically constrained, conducting business primarily within their respective administrative districts (Bednarek et al., 2021). These small, regionally focused banks play a critical role in real estate lending, originating approximately half of all mortgage loans in Germany (Zurek, 2022). Specifically, as local lenders, the savings banks alone originated one third of all housing loans in the last 40 years. As among others Conrad (2008) highlights, their localized business model makes them particularly relevant for studies incorporating regional economic factors.

The scope of savings banks, which are present throughout the whole country, typically matches the 401 administrative districts, whereas the area of activity of cooperative banks is smaller than an administrative district. However, the number of cooperative banks has been decreasing significantly and several mergers take place across administrative districts (Beck et al., 2022; Dinger et al., 2024). Given that savings banks have larger regional market shares than cooperative banks, and their operational areas generally correspond to urban or rural districts (similar to Metropolitan Statistical Areas), we focus our analysis on savings banks. While bank mergers occurred rarely during the study period, we follow Blickle (2022) in treating merged banks as a single entity throughout the sample period. This approach ensures consistency in our identification strategy, which relies on the regional restriction of savings banks' lending activities. Because branch locations influence local credit distribution, savings banks' geographic constraints provide an opportunity to study the localized transmission of bank lending to real estate markets.

From a financial stability perspective, understanding the relationship between **savings banks' lending behavior and local real estate market developments** is crucial. These banks are particularly dependent on the economic conditions of their respective regions. Brunnermeier et al. (2020) underline that in real estate booms, it is the small banks that experience larger increases in systemic risk due to their stronger focus on mortgage lending. If real estate prices are high, they are particularly exposed to the risk of falling real estate prices and vulnerable to taking on additional risks, as they are heavily engaged in real estate related lending (Zurek, 2022). Since savings banks are mainly deposit-funded, they are considered to be particularly stable in times of financial stress. However, after the introduction of NMPR, they struggled with decreasing interest margins which are a particularly important component of their business model. In 2020, they originated €67 billion in new residential real estate loans, a 13.7% increase over their previous record in 2019 (Wagner, 2021).

4 Empirical analyses

4.1 Empirical strategy and identification of causal effects

Empirical strategy

This paper empirically examines the question if banks with a lower profitability following an introduction of NMPR contribute to residential real estate market distortions by driving local price deviations from fundamental values. Specifically, we examine whether such deviations can be detected at the micro level during the period of unconventional monetary policy and whether they are systematically linked to local bank performance.

First, we proxy the deviation of real estate prices from their fundamental values on micro-level in three steps: (i) We estimate a hedonic pricing model using a set of variables reflecting property quality, location, and other price-relevant characteristics. This model is calibrated using data from a base period (2010–2013).[12] (ii) Based on the estimated hedonic model, we predict the potential sale price for each property listed during the unconventional monetary policy period (2014–2021). (iii) The deviation from the fundamental value is proxied by the difference between the actual listed price and the predicted price for each property. The calculation of the deviation is the preparatory work for our main analysis.

To relate the deviations on micro level to local bank variables, we exploit the local scope of savings banks and link the real estate price deviations to local bank lending and real economic circumstances (see results in Table 2). Through this analysis, we test *hypothesis 1* which states that bank lending growth is positively correlated with the deviation of real estate prices from fundamental values. However, from this analysis alone, a causal interpretation is not possible because the provision of credit is not an exogenous variable.[13] To derive causal results, we

[12] We choose this period since the German residential real estate market has recovered from the Great Financial Crisis in 2010, however, as the German Council of Economic Experts claims in 2013, despite the revitalization, the prices do not show signs of overheating from a macroeconomic perspective (Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung, 2013).

[13] Kuchler et al. (2023) emphasize that a causal interpretation of empirical estimates requires credit expansions that are independent of the variation in market participants house price expectations. Credit supply responds to the

exploit the heterogeneous responsiveness of banks to NMPR depending on their ex-ante level of liquid assets.

Since NMPR put pressure on the yields of bank liquid assets, higher yielding assets such as loans become more attractive (Bottero et al., 2022). Deposit-funded banks, in particular, face profit margin compression and business model risks under NMPR (Heider et al., 2019). To compensate for lost profits, these banks may increase lending as part of a search-for-yield strategy (Wagner, 2021), potentially driving an exogenous increase in credit supply independent of property price expectations. To test this mechanism, also formulated in *hypothesis 2*, we estimate a difference-in-differences (DiD) model to examine whether banks with higher ex-ante liquidity increased lending more during the NMPR period compared to banks with lower pre-existing liquidity.

We then explore the underlying reasons for this behavior by testing whether banks with higher ex-ante liquidity experienced a decline in profitability, as measured by operating revenue and net interest income, following the introduction of NMPR. Additionally, we assess whether changes in bank lending behavior are systematically linked to previous-period declines in revenue or net interest income.

Since the total loans variable reported in banks' balance sheets include various types of lending (corporate loans, consumer credit, and mortgage lending), we examine whether the decline in operating revenue and net interest income specifically affects local housing markets. To do so, we estimate the relationship between real estate price deviations and those performance indicators. This allows us to test *hypothesis 3*, which states that in regions where bank

price of assets which may be used as collateral and therefore depends endogenously on the current and expected economic conditions.

profitability declines, real estate price deviations from fundamental values increase in the following period.

Addressing identification challenges

Several endogeneity concerns arise when attempting to identify causal effects: i) The macroeconomic environment in which banks, firms, households, and the ECB operate may confound the results, as concerns on the exogeneity of NMPR might arise. However, we treat NMPR as exogenous in this context, as these unconventional monetary policy measures were primarily aimed at restoring liquidity in euro-area periphery countries, rather than addressing Germany's relatively stable financial and economic conditions (Bednarek et al., 2021; European Central Bank, 2012). ii) The policy rate's effect on mortgage rates could influence household credit demand, introducing another potential confounder. To mitigate this issue, we incorporate several local demand factors into our analysis. iii) Furthermore, mortgage lending might not be exogenous, as local credit supply may be affected by local real estate price developments. To address this, we use the ex-ante liquidity to identify the banks' heterogeneous exposure to NMPR. Additionally, we include lagged bank performance variables to identify potential subsequent search-for-yield behavior.

Our identification strategy is largely driven by cross-sectional variation. Germany provides a unique empirical setting, as deviations from fundamental real estate values and potential housing market bubbles are unlikely to develop symmetrically across the country. For identification, we exploit heterogeneity in the banking environment. The introduction of NMPR served as an external shock that affected regionally constrained banks differently based on their ex-ante liquidity levels. We test whether this shock incentivized a search-for-yield response, leading to increased credit supply in subsequent periods and, in turn, influencing local real estate price deviations.

4.2 Hedonic model

Calibration and application of the hedonic model

To estimate the deviation of residential real estate prices from their fundamental values, we compare the listed price of a property with its predicted sale price derived from a hedonic model. This approach allows us to exploit the micro dimension of our dataset and to control for object-specific characteristics, enabling a more accurate assessment of price deviations beyond macroeconomic trends.

We calibrate a hedonic pricing model using a rich set of variables that reflect the quality, location, and further object-specific characteristics of each property:

$$price_i = \beta X_i + \delta D_{d,t} + A_d + \epsilon_i \qquad (1)$$

Here, $price_i$ is the log of the price per square meter of property i and X_i includes a rich set of key property characteristics. Specifically, we include the log of the dwellings' age, calculated from the difference of the object's year of construction and the year of sale, the log of the number of rooms, a vector of dummy variables that indicate the object condition, as well as a vector of dummy variables for housing type (apartment, single-family home, etc.). As Reusens et al. (2023) underline, price increases in the last years were not only driven by exaggerations at the housing markets but also by significant quality increases, it is important to include the object condition into our hedonic model. In addition, we include district fixed effects (A_d) since e.g., Oikarinen et al., (2018) show that house price cycles around long-term fundamental price levels generally are highly synchronized across metropolitan areas, but there are substantially greater differences between more distant cities and Koetter & Poghosyan (2010) underline that price developments vary across the German regions due to structural disparities in economic development and population growth rates. Moreover, we include region-specific characteristics $D_{d,t}$ for district (*Kreis*) d in year t which cover information if the dwelling is located in a city or rural district, in Western or Eastern Germany and the local population density.

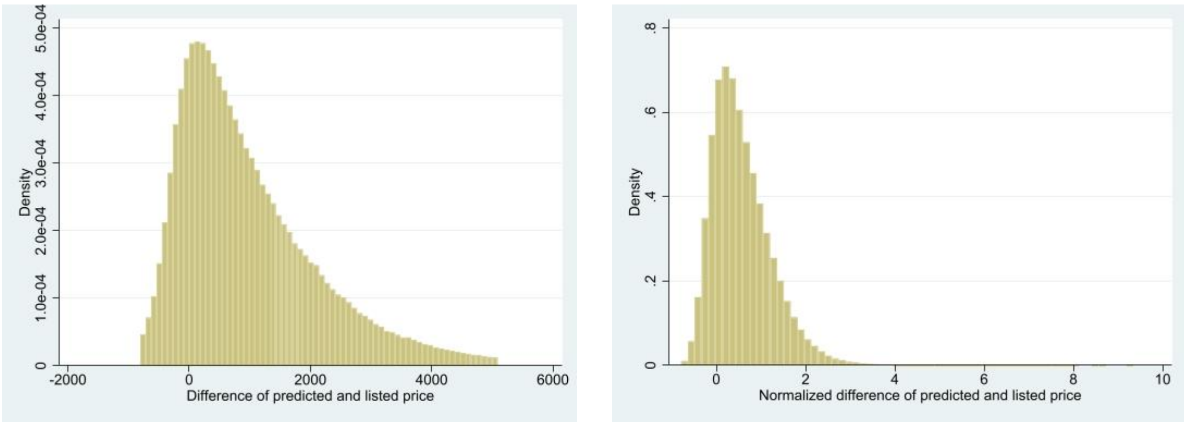
We estimate the hedonic model with the sales data of the years 2010 to 2013 to capture the separate contribution of each of the object- and region-specific characteristics to the price. The results are presented in the appendix (Table A1). Based on the calibrated model, we predict a potential quality-adjusted sale price ($\widehat{p_i}$) for each object i listed for sale in the years of 2014 to 2021, the period of unconventional monetary policy. Robust standard errors are clustered at municipality level to account for spatial dependencies in pricing. Similar models have been used in previous studies, including Kholodilin & Mense (2012) and Diewert et al. (2015).

Measuring deviation from fundamental value

To quantify deviations from fundamental values, we calculate the difference between the listed price (p_i) and the predicted price ($\widehat{p_i}$) for each property. The histogram of the difference of the listed and the predicted price ($p_i - \widehat{p_i}$) (Figure 4, Panel A) shows that the hedonic model calibrated on 2010 to 2013 data mostly underestimates the residential real estate prices from the unconventional monetary policy period, indicating sustained price growth.

Since the deviation of the predicted quality-adjusted price will be the endogenous variable in the following empirical analyses, we normalize the difference of the predicted and the listed price. We calculate the deviation rate $\left(\frac{p_i - \hat{p}_i}{\widehat{p_i}}\right)$ by dividing the difference of the listed price (p_i) and the predicted price ($\widehat{p_i}$) by the predicted price ($\widehat{p_i}$). Figure 4 (Panel B) presents the distribution of the deviation rate, revealing heterogeneous price deviations across Germany (Figure 5).

Despite controlling for regional characteristics and district fixed effects – which account for expected differences in price levels (e.g., Munich's historically high prices) – we still observe unexplained price increases, for example in Munich. From a financial stability perspective, this dispersion in price deviations is particularly relevant. Unlike general price-level changes, deviations from fundamental values significantly increase a bank’s probability of distress (Koetter & Poghosyan, 2010). Therefore, in the next stage of our analysis, we examine the relationship between real estate price deviations, local bank characteristics, and macroeconomic factors to assess their broader economic implications.



(A) (B)

Figure 4: Distribution of the difference (A) and the normalized difference (B) between the predicted and the listed price per square meter

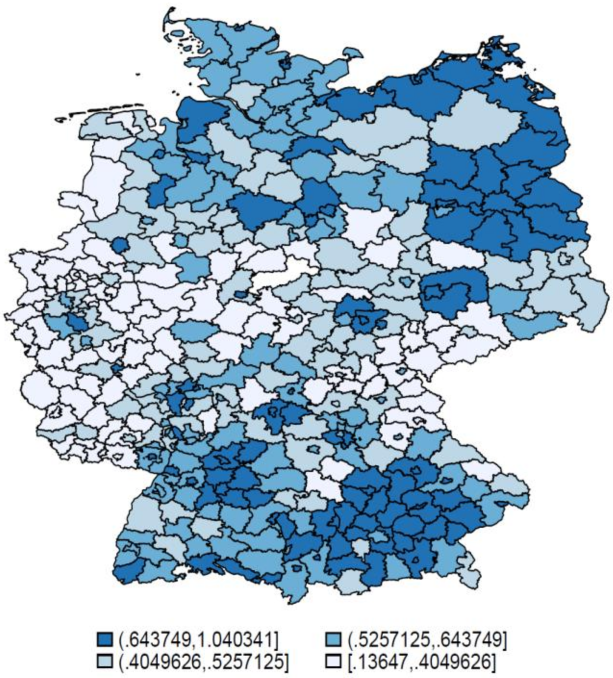


Figure 5: Distribution of residential real estate price deviations across Germany
This figure shows the which regions where particularly affected by residential real estate price deviations. The German districts are divided by color according to the quartiles of the mean of the normalized deviation of residential real estate prices from fundamental values between 2014 and 2022 estimated for the base period (2010-2013) by district. The highest mean deviation is marked in dark blue. The lighter the marking, the lower is the average deviation.

4.3 The link of real estate price deviations and bank lending

In this second-stage analysis, we study which proportion of the deviation between the listed price p_i and the predicted sale price $\widehat{p_i}$ that we find on micro level can be explained by macroeconomic conditions and local banking characteristics. Our baseline regression model is specified as follows:

$$\frac{p_i - \hat{p}_i}{\widehat{p_i}} = \alpha + \gamma \Delta\, Loans_{d,t} + \beta_1 m_t + \beta_2 t_t + \delta X_{d,t} + \epsilon_{i,d,t} \qquad (2)$$

The dependent variable is the deviation rate of property i, i.e., the difference of the listed price (p_i) and the predicted price $(\widehat{p_i})$ normalized by the predicted price $(\widehat{p_i})$. The coefficient γ captures the effect of the annual growth rate of loans issued by savings banks in district d $(\Delta\, Loans)$. Moreover, we add a time trend (t_t) to control for the time interval between the base period (2010-2013) in which $\hat{p}$ was calibrated and the period when object i is listed. This coefficient also allows to control for the positive average growth rate of prices in Germany. Furthermore, we include the mortgage rate m_t, capturing the cost of borrowing.

We account for the macroeconomic fundamentals in $X_{d,t}$ which include the district-level demand and supply factors[14]. Specifically, we incorporate the annual growth rate of GDP per employee $(\Delta\, GDP_{d,t})$, capturing income-driven demand effects, the annual growth rate of the number of employees $(\Delta\, Employees_{(d,t)})$, reflecting labor market-driven housing demand, and the annual growth rate of newbuilt living space $(\Delta\, Living\ space_{d,t})$, representing supply-side responses.

Main findings

Table 2 presents the estimation results. Column 1 shows that higher loan growth is significantly associated with greater deviations of real estate prices from fundamental values. This supports Hypothesis 1, indicating that districts with stronger credit growth experience larger price

[14] Due to market imperfections and supply rigidities, real estate prices are driven by demand factors such as income, population growth, and mortgage rates (Koetter et al., 2010; Iossifov et al., 2008; Hilbers et al., 2008).

deviations beyond what can be explained by property-specific and macroeconomic factors. These findings suggest that a portion of observed price deviations is funded by local banks.

The control variables mostly yield the expected signs. House price deviations increase when incomes rise (proxied by GDP per employee) and when employment levels grow, consistent with demand-driven price pressures. Higher growth in newly built housing stock reduces price deviations, confirming the expected demand-supply dynamics. The estimated coefficient for the time trend (t_t) confirms that deviations increase over time, capturing the positive national trend in housing prices between 2014 and 2021.

However, one surprising result is the positive sign of the mortgage rate coefficient, whereas economic theory suggests that lower interest rates should drive higher asset prices. To explore this further, we introduce an interaction term between mortgage rates and loan growth in Column (2). The results in Col. 2 confirm that in districts with higher loan growth, real estate price deviations increase. If mortgage rates decrease (as observed between 2014 and 2021), the positive coefficient of the mortgage rate variable suggests a downward deviation of house prices. However, the interaction term between mortgage rates and credit growth reveals a much stronger effect. The coefficient of this interaction is ten times larger in magnitude than the direct effect of mortgage rates and has a negative sign. This suggests that falling interest rates alone do not contribute to housing market distortions. Instead, deviations from fundamental values amplify only when declining mortgage rates are associated with increased credit growth. These findings highlight a key regional heterogeneity in German housing markets: while interest rates declined nationwide, lending growth was not uniform across districts. This divergence may help explain why housing price dispersion widened during the NMPR period.

Relative cost of mortgages and its effect on price deviations

In Columns (3) and (4), we replace the mortgage rate with the spread between mortgage rates and the policy rate, capturing the relative cost of mortgage credit compared to other financial products. The results indicate that when mortgage credit becomes cheaper relative to alternative investments, price deviations slightly decrease. However, when we interact the mortgage-policy rate spread with credit growth (Column 4), we find that cheaper mortgages combined with rising loan volumes lead to stronger price deviations from fundamental values. This suggests that loose monetary policy alone is not enough to fuel housing market distortions, but when coupled with increased bank lending, it significantly contributes to price misalignments.

We document the robustness of our results, presented in the Appendix, to incorporating a proxy for house price growth expectations to control for speculative demand (Table B1) and to including additional covariates (Table B2). Moreover, several subsample analyses confirm the consistency of the results across different regions (Tables B3-B4) and an aggregated panel data estimation shows that the results are not driven by overrepresented districts (Table B5).

Table 2 VARIABLES	(1)	(2)	(3)	(4)
$\Delta\ \boldsymbol{Loans}$	0.576*** (0.221)	2.752** (1.159)	0.534** (0.221)	4.674** (1.946)
$\Delta\ \boldsymbol{Loans\ x\ Mortgage\ Rate}$		-1.182** (0.553)		
$\Delta\ \boldsymbol{Loans\ x}\ (\boldsymbol{Mortgage\ Rate - Policy\ Rate})$				-1.892** (0.832)
Mortgage Rate	0.127*** (0.00933)	0.161*** (0.0205)		
Mortgage Rate – Policy Rate			0.0498*** (0.0135)	0.119*** (0.0349)
$\Delta\ GDP\ per\ employee$	0.345*** (0.0947)	0.344*** (0.0937)	0.414*** (0.0981)	0.409*** (0.0971)
$\Delta\ Number\ employees$	1.403*** (0.373)	1.546*** (0.392)	1.451*** (0.384)	1.606*** (0.402)
$\Delta\ Living\ space$	-5.810*** (1.280)	-5.908*** (1.294)	-5.435*** (1.319)	-5.550*** (1.332)
Trend	0.0128*** (0.000399)	0.0127*** (0.000366)	0.0116*** (0.000391)	0.0115*** (0.000375)
Constant	-0.363*** (0.0304)	-0.423*** (0.0500)	-0.185*** (0.0385)	-0.338*** (0.0879)

Observations	3,568,723	3,568,723	3,568,723	3,568,723
R-squared	0.236	0.236	0.235	0.236

Table 2: Regression of real estate price deviations

This table presents the results of the OLS regression modelling the determinants of real estate price deviations described in Equation (2) using micro data. The dependent variable is the deviation rate of object i, i.e., the difference of the actual listed price actual price (p_i) and the predicted price ($\widehat{p_i}$) normalized by the predicted price ($\widehat{p_i}$). In Col. 1, the first explanatory variable is the yearly growth rate of all loans that the savings banks granted in each district ($\Delta\, Loans$). The macroeconomic fundamentals we account for are the mortgage rate m_t, the yearly growth rate of GDP per employee ($\Delta\, GDP_{d,t}$), the yearly growth rate of the number of employees ($\Delta\, Employees_{d,t}$) and the yearly growth rate of newbuilt living space ($\Delta\, Living\ space_{d,t}$) for each district. We add a time trend (t_t) in our equation to control for the time interval between the base period in which $\hat{p}$ was calibrated and the period in which object i is offered.

In Col. 2, we add the interaction term of yearly growth rate of the loans granted in each district ($\Delta\, Loans$) and the mortgage rate to Equation (2). In Col. 3, we substitute the mortgage rate with the difference of the mortgage rate and the policy rate and also add an interaction term with $\Delta\, Loans$ in Col. 4.

The sample covers the observation period from 2014 to 2021. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

4.4 Search-for-yield channel

To derive causal evidence for the search-for-yield motive, we exploit the heterogeneous responsiveness of banks to NMPR in a three-step empirical approach. First, in a difference-in-differences analysis, we test whether banks with higher ex-ante liquidity increased lending more than banks with lower liquidity after the introduction of NMPR. Then, we examine whether banks with higher ex-ante liquidity experienced declining profits (operating revenue and net interest income) following NMPR. Third, we estimate if changes in the lending behavior of banks with an ex-ante high liquidity can be related to the banks' revenue or interest income of the pre-period.

Finally, building on these results, we assess the impact of this search-for-yield behavior on local real estate prices, investigating whether declining bank profitability contributes to deviations in housing prices from fundamental values.

Identifying the impact of NMPR on bank lending

To determine whether ex-ante liquidity levels influenced changes in bank lending behavior during the NMPR period, we estimate the following difference-in-differences model:

$$\Delta\left(\frac{Loans}{Total\ assets}\right)_{b,t} = \alpha + \beta_1\left(LiquidityDummy_{b,2013} \times NMPR_t\right)$$
$$+ \beta_2\, LiquidityDummy_{b,2013} + \beta_3\, NMPR_t$$

$$+ \beta_4\, Deposits_{b,t} + A_t + \varepsilon_{b,t} \qquad (3)$$

The dependent variable is the growth rate of loans as a share of total assets of bank b in year t. $LiquidityDummy_{b,2013}$ is a dummy variable that defines the treatment group and is 1 for banks with above-median ex-ante liquidity (measured as the difference between total loans and total deposits in 2013), and $NMPR_t$ is a dummy variable that indicates the NMPR period (2014-2021). $Deposits_{b,t}$ controls for changes on the liability side using either customer deposits as a share of total assets or the growth or customer deposits as a share of total assets. Moreover, we control for year fixed effects with A_t capturing macroeconomic trends. This specification exploits the cross-sectional variation in banks' ex-ante exposure to NMPR, proxied by their liquidity levels.

The estimation results show a significant positive coefficient of the difference-in-differences estimator β_1 (Table 3, Columns 1–4), indicating that banks with higher ex-ante liquidity increased lending more after NMPR than those with lower liquidity. Specifically, defining the treatment group as banks with above-median ex-ante liquidity, we find that these banks expanded their loan ratio by 1.2 percentage points during the NMPR period. When restricting the sample to banks in the top and bottom quartiles of liquidity (Table 3, Columns 5–8) [15], the coefficients increase in magnitude, reinforcing the conclusion that high-liquidity banks responded more aggressively to NMPR by expanding credit supply.

Exploring drivers of increased lending

To understand why high-liquidity banks expanded lending, we test whether they experienced declining profitability following the introduction of NMPR. We estimate the following difference-in-differences model:

$$\sigma_{b,t} = \alpha + \beta_1\left(LiquidityDummy_{b,2013} \times NMPR_t\right)$$

[15] Here, $LiquidityDummy_{b,2013}$ equals 1 if the liquidity of bank b is as high that it belongs to the largest 25% quartile in 2013 and banks whose liquidity belongs to the smallest quartile are the control group.

$$+\beta_2\ LiquidityDummy_{b,2013} + \beta_3\ NMPR_t\ + A_t + \varepsilon_{b,t} \quad (4)$$

separately for $\sigma_{b,t} = \left\{\frac{Operating\ revenue}{Total\ assets}; \frac{Net\ interest\ income}{Total\ assets}\right\}$, representing two alternative profitability measures.

The results presented in Table 4 confirms that banks with higher ex-ante liquidity experienced significant declines in both operating revenue and net interest income after the introduction of NMPR. We estimate different specifications: Columns 1, 2, 5, and 6 use the full sample, defining the treatment group as banks with above-median liquidity, and Columns 3, 4, 7, and 8 restrict the sample to banks in the highest and lowest liquidity quartiles, strengthening identification. The findings suggest that high-liquidity banks faced greater profit pressures under NMPR, likely due to declining interest margins on their liquid assets.

Linking profit declines of high-liquidity banks to lending behavior

Next, we test for the subsample of high-liquidity banks whether lower profitability in the pre-period was associated with higher lending growth in the subsequent period, indicating a search-for-yield response. We estimate:

$$\Delta\left(\frac{Loans}{Total\ assets}\right)_{b,t} = \alpha + \beta\ \sigma_{b,t-1} + A_t + D_d + \epsilon_{b,t} \quad (5)$$

separately for $\sigma_{b,t-1} = \left\{\frac{Operating\ revenue}{Total\ assets}; \frac{Net\ interest\ income}{Total\ assets}\right\}$ which measures the lagged profitability. Since the dependent variable is the growth rate of the share of loans on total assets of bank b in year t, we avoid to estimate the autoregressive relation of loans and the revenue or the interest income to total assets. If banks with a smaller operating revenue or net interest income in relation to their total assets indeed increase their lending in the subsequent period, the coefficient of β will be negative. Additionally, we add district (D_d) and time fixed effects (A_t) in the OLS regression, controlling for macroeconomic conditions, and cluster the standard errors on district level.

Table 5 shows that banks with lower operating revenue and interest income in the previous year expanded lending more strongly in the subsequent period. (Table 5, Col. 1-4). The negative and significant β suggests that declining profitability drives increased credit supply, consistent with a search-for-yield strategy.[16] Overall, these findings support *hypothesis 2*, confirming that banks facing declining profitability due to their higher exposure to NMPR, increase lending in the subsequent periods to compensate for revenue losses.

Linking search-for-yield behavior to housing market distortions

Since the total loans variable from the balance sheets of the local savings banks is rather aggregated, it does not allow to distinguish between bank lending to local firms in form of corporate loans, consumer credits or mortgage lending. Thus, we test whether the observed lending behavior specifically impacts local housing markets. We re-estimate Equation (2) (from Section 4.3), incorporating lagged operating revenue and net interest income as additional regressors.

Table 6 shows that smaller operating revenues and net interest incomes in the previous year are associated with higher deviations of real estate prices from fundamental values. These findings confirm *hypothesis 3* and demonstrate that search-for-yield behavior in response to NMPR margin compression directly impacts local housing markets. The mechanism appears to work through increased bank lending, which amplifies real estate price misalignments.

To put our findings into a nutshell, our empirical analysis provides strong evidence that banks with higher ex-ante liquidity expanded lending more after NMPR (Table 3). These banks faced significant declines in profitability (Table 4) and lower profitability drove increased lending in the subsequent period (Table 5). Moreover, this lending expansion contributed to local housing

[16] When we include the full sample into the estimation, we still find significant estimates, however, the coefficients are smaller. Thus, also banks that face decreasing revenues or income for other reasons increase lending in the subsequent period.

market distortions (Table 6). Taken together, these findings confirm the search-for-yield hypothesis, showing that profit-constrained banks respond to NMPR by increasing credit supply, fueling deviations in real estate prices from fundamental values.

Table 3	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathrm{LiquidityDummy}_{2013} \times \mathrm{NMPR}$	**0.0118*** (0.00311)**	**0.0123*** (0.00310)**	**0.0114*** (0.00309)**	**0.0116*** (0.00309)**	**0.0174*** (0.00480)**	**0.0181*** (0.00476)**	**0.0186*** (0.00464)**	**0.0189*** (0.00465)**
$\mathrm{LiquidityDummy}_{2013}$	-0.00274 (0.00297)	-0.00419 (0.00297)	-0.000241 (0.00276)	-0.000520 (0.00275)	0.00212 (0.00486)	-0.00111 (0.00492)	0.00331 (0.00401)	0.00302 (0.00401)
NMPR	-0.0231*** (0.00188)	-0.0279*** (0.00355)	-0.0202*** (0.00181)	-0.0231*** (0.00339)	-0.0234*** (0.00277)	-0.0305*** (0.00504)	-0.0218*** (0.00248)	-0.0264*** (0.00491)
$\frac{\text{Customer deposits}}{\text{Total assets}}$	0.00928 (0.0157)	0.0251 (0.0164)			-0.00243 (0.0228)	0.0224 (0.0246)		
$\Delta \frac{\text{Customer deposits}}{\text{Total assets}}$			0.280*** (0.0367)	0.267*** (0.0354)			0.293*** (0.0533)	0.286*** (0.0506)
Constant	0.0135 (0.0110)	0.00527 (0.0114)	0.0156*** (0.00174)	0.0205*** (0.00260)	0.0195 (0.0152)	0.00702 (0.0164)	0.0135*** (0.00242)	0.0202*** (0.00389)
Observations	3,113	3,113	3,113	3,113	1,550	1,550	1,550	1,550
Number of banks	287	287	287	287	142	142	142	142
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Treatment group	Liquidity_2013 > p(50)	Liquidity_2013 > p(50)	Liquidity_2013 > p(50)	Liquidity_2013 > p(50)	Liquidity_2013 > p(75)	Liquidity_2013 > p(75)	Liquidity_2013 > p(75)	Liquidity_2013 > p(75)
Control group	Liquidity_2013 < p(50)	Liquidity_2013 < p(50)	Liquidity_2013 < p(50)	Liquidity_2013 < p(50)	Liquidity_2013 < p(25)	Liquidity_2013 > p(25)	Liquidity_2013 < p(25)	Liquidity_2013 > p(25)

Table 3: Difference-in-differences analysis of ex-ante high liquidity banks' lending in the NMPR period

This table presents the results of the difference-in-differences analysis described in Equation (3) using bank-level data. The dependent variable is the growth rate of loans to total assets of bank b in year t. The sample covers the observation period from 2010 to 2021. In Col. 1-4 the whole sample is analyzed, while in Col. 5-8 only those banks that belong to the smallest and largest quartile in terms of liquidity are included. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table 4	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\mathbf{LiquidityDummy_{2013} \times NMPR}$	**-0.00114*** **	**-0.00110*** **	**-0.00133*** **	**-0.00130*** **	**-0.00116*** **	**-0.00112*** **	**-0.00109*** **	**-0.00106*** **
	(0.000299)	(0.000300)	(0.000468)	(0.000470)	(0.000249)	(0.000250)	(0.000381)	(0.000381)
$\mathrm{LiquidityDummy_{2013}}$	0.000732*	0.000709*	0.000861	0.000835	0.000232	0.000210	-0.000385	-0.000410
	(0.000404)	(0.000406)	(0.000630)	(0.000633)	(0.000369)	(0.000370)	(0.000580)	(0.000582)
NMPR	-0.00395***	-0.00967***	-0.00371***	-0.00949***	-0.00390***	-0.00905***	-0.00381***	-0.00895***
	(0.000193)	(0.000274)	(0.000261)	(0.000390)	(0.000167)	(0.000227)	(0.000222)	(0.000316)
Constant	0.0296***	0.0303***	0.0296***	0.0302***	0.0202***	0.0207***	0.0206***	0.0212***
	(0.000279)	(0.000309)	(0.000407)	(0.000452)	(0.000239)	(0.000253)	(0.000345)	(0.000373)
Observations	3,388	3,388	1,680	1,680	3,388	3,388	1,680	1,680
Number of banks	286	286	141	141	286	286	141	141
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Treatment group	Liquidity_2013 > p(50)	Liquidity_2013 > p(50)	Liquidity_2013 > p(75)	Liquidity_2013 > p(75)	Liquidity_2013 > p(50)	Liquidity_2013 > p(50)	Liquidity_2013 > p(75)	Liquidity_2013 > p(75)
Control group	Liquidity_2013 < p(50)	Liquidity_2013 < p(50)	Liquidity_2013 < p(25)	Liquidity_2013 < p(25)	Liquidity_2013 < p(50)	Liquidity_2013 < p(50)	Liquidity_2013 < p(25)	Liquidity_2013 < p(25)
Dependent var	Operating revenue	Operating revenue	Operating revenue	Operating revenue	Net interest income	Net interest income	Net interest income	Net interest income

Table 4: Difference-in-differences analysis of ex-ante high liquidity banks' revenue and interest income in the NMPR period
This table presents the results of the difference-in-differences analysis described in Equation (4) using bank-level data. The dependent variable is the operating revenue over total assets (Col. 1-4) and the net interest income over total assets (Col. 5-8) of bank b in year t. The sample covers the observation period from 2010 to 2021. In Col. 1, 2, 5, and 6, the whole sample is analyzed, while in Col. 3, 4, 7, and 8, only those banks that belong to the smallest and largest quartile in terms of liquidity are included. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table 5 VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\left(\frac{\textbf{Operating revenue}}{\textbf{Total assets}}\right)_{t-1}$	**-1.767***** (0.479)	**-3.132***** (0.804)			**-1.502***** (0.317)	**-2.075***** (0.517)		
$\left(\frac{\textbf{Net interest income}}{\textbf{Total assets}}\right)_{t-1}$			**-2.024***** (0.686)	**-4.289***** (0.976)			**-1.848***** (0.399)	**-2.590***** (0.596)
Constant	0.0597*** (0.0140)	0.107*** (0.0238)	0.0476*** (0.0137)	0.0999*** (0.0199)	0.0511*** (0.00935)	0.0644*** (0.0154)	0.0436*** (0.00815)	0.0535*** (0.0120)
Observations	1,152	1,152	1,152	1,152	2,906	2,906	2,906	2,906
Number of banks	144	144	144	144	364	364	364	364
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	No	Yes	No	Yes	No	Yes	No	Yes
Sample	Liquidity_2013 > median	Liquidity_2013 > median	Liquidity_2013 > median	Liquidity_2013 > median	full	full	full	full

Table 5: Regression of bank loans

This table presents the results of the OLS regression described in Equation (4) using bank-level data. The dependent variable is loans to total assets of bank b. We estimate Equation (4) separately for $\sigma_{b,t-1} = \frac{Operating\ revenue}{Total\ assets}$ (Col. 1-3) and for $\sigma_{b,t-1} = \frac{Net\ interest\ income}{Total\ assets}$ (Col. 4-6). We add year (Col. 2 and 5) as well as year and district fixed effects (Col. 3 and 6). The sample covers the observation period from 2014 to 2022. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table 6 VARIABLES	(1)	(2)
$\left(\frac{\boldsymbol{Operating\ revenue}}{\boldsymbol{Total\ assets}}\right)_{\boldsymbol{d,t-1}}$	**-4.919****	
	(2.316)	
$\left(\frac{\boldsymbol{Net\ interest\ income}}{\boldsymbol{Total\ assets}}\right)_{\boldsymbol{d,t-1}}$		**-9.447*****
		(2.953)
Mortgage rate	-0.226***	-0.229***
	(0.0331)	(0.0295)
$\Delta\ GDP\ per\ employee$	0.369***	0.391***
	(0.0953)	(0.0962)
$\Delta\ Number\ employees$	3.249***	3.253***
	(0.531)	(0.515)
$\Delta\ Living\ space$	-7.107***	-6.813***
	(1.627)	(1.539)
Trend	0.0106***	0.0102***
	(0.000417)	(0.000432)
Constant	0.489***	0.543***
	(0.0631)	(0.0778)
Observations	3,015,500	3,015,500
R-squared	0.215	0.216

Table 6: Regression of price deviations on bank revenue and income

This table presents the results of the OLS regression modelling the determinants of real estate price deviations similar to Equation (2) using micro data. For this analysis, we substitute the growth rate of loans with a revenue and an income variable: $\frac{p_i - \hat{p}_i}{\hat{p}_i} = \alpha + \gamma r_{d,t-1} + \beta_1 m_t + \beta_2 t_t + \delta X_{d,t} + \epsilon_{i,d,t}$ with $\sigma_{b,t-1} = \left\{\frac{Operating\ revenue}{Total\ assets}; \frac{Net\ interest\ income}{Total\ assets}\right\}$. The dependent variable is the deviation rate of object i, i.e., the difference of the actual listed price actual price (p_i) and the predicted price ($\hat{p}_i$) normalized by the predicted price ($\hat{p}_i$). In Col. 1, the first explanatory variable is the lagged share of the operating revenue on the total assets of the local savings banks aggregated to district level. The macroeconomic fundamentals we account for are the mortgage rate m_t, the yearly growth rate of GDP per employee ($\Delta\ GDP_{d,t}$), the yearly growth rate of the number of employees ($\Delta\ Employees_{d,t}$) and the yearly growth rate of newbuilt living space ($\Delta\ Living\ space_{d,t}$) for each district. We add a time trend (t_t) in our equation to control for the time interval between the base period in which $\hat{p}$ was calibrated and the period in which object i is offered.

In Col. 2, we use the lagged net interest income to total assets as income variable in Equation (2).

The sample covers the observation period from 2015 to 2021. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

5 Conclusion

This paper provides new evidence of a causal link between declining bank profitability and exaggerated real estate price increases. Our findings show that banks facing margin compression due to external factors fuel residential real estate markets, driving local deviations of prices from their fundamental values. We investigate this question by empirically analyzing the case of German savings banks during a period of unconventional monetary policy and their interactions with local housing markets.

We demonstrate that regional deviations of residential real estate prices from fundamental values can be explained by a combination of local macroeconomic conditions and bank characteristics. Specifically, our results reveal a positive correlation between bank lending growth and deviations in housing prices, an effect that is amplified in periods of declining interest rates.

Also, we dig deeper into explaining increased loan growth in regions where the most commonly used collateral – residential real estate – is not backed by fundamental values. To identify the mechanisms behind this relationship, we exploit the introduction of negative monetary policy rates (NMPR) as an external shock that affected locally operating banks heterogeneously based on their ex-ante liquidity levels. Our empirical analysis provides strong evidence that high-liquidity banks expanded lending more after NMPR, as these banks faced significant declines in profitability. Additionally, this lower profitability drove increased lending in the subsequent period, which contributed to local real estate market distortions. Taken together, these findings confirm the search-for-yield hypothesis, showing that profit-constrained banks respond to NMPR by increasing lending, fueling deviations in real estate prices from fundamental values.

Our findings have important financial stability implications, particularly in the context of rising interest rates following prolonged periods of negative monetary policy rates. Policymakers and financial regulators should closely monitor regional housing markets and their interactions with mortgage lenders, as local banks may be particularly vulnerable to price corrections. Given the heterogeneous nature of these developments across regions, aggregated monitoring approaches may not be sufficient to identify localized risks. Instead, granular, region-specific oversight may be necessary to detect emerging vulnerabilities in residential real estate markets.

Future research could benefit from more detailed bank-level data, particularly on mortgage rates and lending conditions at the institution level. In our study, we assume that mortgage rates are a function of the monetary policy rate and that all savings banks apply a similar premium on the policy rate, as bank-specific mortgage rate data are not available. Relaxing this assumption with more granular data would allow for an even more precise analysis. Additionally, future studies could explore the role of local competition between banks, which we do not directly observe in our dataset, but which may influence lending dynamics and pricing behavior.

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Appendix

A Calibration of hedonic model

This table presents the results of the OLS regression modelling the determinants of real estate price deviations described in Equation (1). The dependent variable is the log of the price per square meter. The sample covers the observation period from 2010 to 2013. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Calibration of hedonic model: VARIABLES y = log price per square meter	(1)
Age (ln_age)	-0.0841***
	(0.0192)
Number of rooms (ln_zimmeranzahl)	-0.0143
	(0.0251)
Object condition dummy variables (Reference category: First occupancy):	
First occupancy after reconstruction	0.271***
	(0.0866)
Like new	0.0140
	(0.0984)
Reconstructed	-0.0717
	(0.117)
Modernised	-0.143
	(0.122)
Completely renovated	-0.114
	(0.119)
Well kept	-0.137
	(0.118)
Needs renovation	-0.428***
	(0.117)
By arrangement	-0.289***
	(0.101)
Dilapidated	-0.570***
	(0.123)
House type dummy variables (Reference category: Single-family / semi-detached house)	
Terraced house	0.0804***
	(0.00452)
Terraced house (middle unit)	0.0258***
	(0.00878)
Terraced house (end unit)	-0.0166
	(0.0171)
Bungalow	-0.0335**
	(0.0146)
Farmhouse	0.0249**
	(0.0114)
Castle	0.174***
	(0.0101)
Mansion	-0.0360*
	(0.0197)
Two-family house	0.450***
	(0.149)
Block of flats	0.336***
	(0.0102)
Other property for living	-0.198***
	(0.0116)
Special property	-0.0831***

	(0.00768)
Flat type dummy variables (Reference category: Attic flat)	
Ground floor flat	0.133***
	(0.0238)
Flat	-0.0114
	(0.00755)
Raised ground floor flat	0.0331
	(0.0344)
Loft	-0.0395**
	(0.0166)
Maisonette	-0.0369***
	(0.0143)
Penthouse	0.139***
	(0.0274)
Souterrain	0.0684***
	(0.00721)
Flat with terrace	0.279***
Region type dummy variables	
Urban area	0.128***
	(0.0233)
Populized rural area	0.0485***
	(0.00973)
Sparsely populated rural area	0.0204**
	(0.00867)
West Germany	7.121***
	(0.127)
Population density	0.000128***
	(1.41e-05)
District FE	Yes
Observations	2,512,485
R-squared	0.998

B Robustness analyses

To ensure the robustness of our results to the inclusion of expectations, additional covariates and the overrepresentation of highly populated districts, we estimate several additional specifications of our baseline equation and also conduct subsample analyses to check if the results are driven by specific regions or types of housing.

Since house price **expectations** causally affect investment decisions (Armona et al., 2019), it is crucial to check if the results from our baseline specification hold when we include expectations into our estimation. To proxy house price expectations, we use the moving average of the three-year growth rate of the price per square meter ($\frac{1}{3}\sum_{t-2}^{t} \Delta$ ($price\ per\ square\ meter_{d,t}$) since local price trends have very strong predictive power for local house expectations in the short run (Gohl et al., 2024). Table B1 shows that the results from our baseline specification are robust and that positive price expectations increase deviations from fundamental values.

Furthermore, we confirm the robustness of our results by including the **additional covariates** inflation, measured with the consumer price index, and local market rents. We do not include the consumer price index in our baseline specification to avoid an overidentification in the time dimension. Our baseline results are robust to this additional covariate, only the relative price of mortgages, measured by the difference of the mortgage rate and the policy rate, loses significance (Table B2, Col. 3 and 4). Moreover, the results are robust to adding the yearly average rent per square meter[17] per district as a covariate (Table B2, Col. 5 to 8), a variable that may also be included as fundamental (Koetter & Poghosyan, 2010).

The analyses of various **subsamples** shows that the results are particularly relevant for larger houses and apartments (Table B3). The deviation of residential real estate prices of smaller

[17] Market rents per square meter are based on data from ImmobilienScout24 (RWI - Leibniz Institute for Economic Research, 2023c, 2023a).

objects, either with one or two rooms (Table B3, Col. 1 and 2) or objects that belong to the lower quartile in terms of living space (Table B3, Col. 5 and 6), are not associated with an increase of the local loan volume. However, the results suggest that larger properties, either with more rooms (Table B3, Col. 3 and 4) or more living space (Table B3, Col. 7 and 8), are more dependent on credit financing. One explanation for this could be that smaller properties are more likely to be targeted by speculators (Depken et al., 2009) who do not fund their activities with mortgages of local savings banks. However, this underlines the relevance of our results since the total price of larger properties is higher than the one of smaller objects. Therefore, banks are particularly vulnerable to defaults in this segment. Furthermore, the results of the subsample analyses show that especially price deviations of properties in rural areas are credit-driven (Table B4).

To check if an overrepresentation of observations from highly-populated districts, e.g., in the metropolitan area of Cologne, where Sparkasse Köln Bonn operates, drive the results from previous analyses, we conduct a district-level **panel data analysis**. The panel is constructed by taking the mean of the deviation rate $\left(\frac{p_i-\hat{p}_i}{\widehat{p_i}}\right)$ of all objects i in district d and year t. The estimations (Table B5, Col. 1-4) confirm the results from the micro data analyses. In districts with a higher deviation of real estate prices from their fundamental values, credit growth is higher. Higher credit growth combined with decreasing interest rates is associated with higher price deviations on district level, too. Control variables that show an increasing demand are associated with upward deviations from fundamental prices and increasing supply proxied by an increase of living space is associated with downward deviations. Our results are also robust to the inclusion of the consumer price index (CPI) as an additional covariate (Table B5, Col. 5-8).

Table B1: Inclusion of price expectations

This table presents the results of the OLS regression modelling the determinants of real estate price deviations described in Equation (2) where we added the price expectations proxied by the moving average of the growth rate of the price per square meter ($\frac{1}{3}\sum_{t-2}^{t} \Delta\, price\ per\ square\ meter_{d,t}$). The sample covers the observation period from 2014 to 2021. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table B1 VARIABLES	(1)	(2)	(3)	(4)
$\boldsymbol{\Delta\ Loans}$	**0.432****	**3.135*****	**0.389****	**5.435*****
	(0.182)	(1.064)	(0.183)	(1.791)
$\boldsymbol{\Delta\ Loans\ x\ Mortgage\ Rate}$		**-1.470*****		
		(0.512)		
$\boldsymbol{\Delta\ Loans\ x\ (Mortgage\ Rate - Policy\ Rate)}$				**-2.308*****
				(0.769)
Mortgage Rate	0.144***	0.187***		
	(0.0106)	(0.0202)		
Mortgage Rate – Policy Rate			0.0602***	0.144***
			(0.0134)	(0.0328)
$\Delta\ GDP\ per\ employee$	0.248***	0.245***	0.326***	0.318***
	(0.0860)	(0.0844)	(0.0875)	(0.0857)
$\Delta\ Number\ employees$	1.024***	1.195***	1.075***	1.256***
	(0.354)	(0.372)	(0.365)	(0.383)
$\Delta\ Living\ space$	-4.126***	-4.216***	-3.752***	-3.859***
	(1.035)	(1.035)	(1.070)	(1.068)
Trend	0.0117***	0.0115***	0.0104***	0.0103***
	(0.000366)	(0.000333)	(0.000356)	(0.000339)
Price expectations	1.915***	1.952***	1.889***	1.928***
	(0.154)	(0.154)	(0.154)	(0.155)
Constant	-0.474***	-0.551***	-0.281***	-0.469***
	(0.0336)	(0.0516)	(0.0394)	(0.0851)
Observations	3,568,723	3,568,723	3,568,723	3,568,723
R-squared	0.245	0.246	0.244	0.245

Table B2: Inclusion of additional covariates

This table presents the results of the OLS regression modelling the determinants of real estate price deviations described in Equation (2) where we added the consumer price index (CPI) as additional covariate. The dependent variable is the deviation rate of object i, i.e., the difference of the actual listed price actual price (p_i) and the predicted price ($\widehat{p_i}$) normalized by the predicted price ($\widehat{p_i}$). We add the consumer price index (CPI_t) and the average rent per square meter ($Rent\ per\ square\ meter_{d,t}$) as covariates to test the robustness of our results. The sample covers the observation period from 2014 to 2021. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table B2 VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\boldsymbol{\Delta\ Loans}$	**0.609*** **	**2.519** **	**0.585** **	**3.903* **	**0.645*** **	**3.219*** **	**0.607*** **	**5.273*** **
	(0.228)	(1.242)	(0.229)	(2.084)	(0.212)	(1.137)	(0.213)	(1.906)
$\boldsymbol{\Delta\ Loans\ x\ Mortgage\ Rate}$		**-1.055* **				**-1.398*** **		
		(0.605)				(0.532)		
$\boldsymbol{\Delta\ Loans\ x\ (Mortgage\ Rate - Policy\ Rate)}$				**-1.531* **				**-2.133*** **
				(0.899)				(0.805)
Mortgage Rate	0.0689***	0.103***			0.115***	0.155***		
	(0.0126)	(0.0258)			(0.0110)	(0.0241)		
Mortgage Rate – Policy Rate			0.00940	0.0664			0.0423***	0.120***
			(0.0156)	(0.0403)			(0.0161)	(0.0411)
$\Delta\ GDP\ per\ employee$	0.190**	0.209**	0.211**	0.231***	0.495***	0.495***	0.559***	0.554***
	(0.0928)	(0.0886)	(0.0922)	(0.0881)	(0.111)	(0.110)	(0.119)	(0.117)
$\Delta\ Number\ employees$	1.692***	1.808***	1.783***	1.896***	-0.149	0.0101	-0.105	0.0618
	(0.372)	(0.391)	(0.381)	(0.399)	(0.379)	(0.410)	(0.377)	(0.406)
$\Delta\ Living\ space$	-5.511***	-5.658***	-5.174***	-5.315***	-3.044	-3.141*	-2.674	-2.791
	(1.386)	(1.414)	(1.438)	(1.463)	(1.880)	(1.897)	(1.952)	(1.968)
Trend	0.00895***	0.00922***	0.00774***	0.00811***	0.0112***	0.0109***	0.0100***	0.00992***
	(0.000687)	(0.000746)	(0.000635)	(0.000726)	(0.000605)	(0.000553)	(0.000609)	(0.000585)
CPI	0.0319***	0.0283***	0.0358***	0.0319***				
	(0.00432)	(0.00481)	(0.00410)	(0.00468)				
Rent per square meter					0.0393***	0.0395***	0.0394***	0.0396***
					(0.00711)	(0.00699)	(0.00714)	(0.00703)
Constant	-3.187***	-2.912***	-3.408***	-3.173***	-0.591***	-0.663***	-0.424***	-0.597***
	(0.387)	(0.413)	(0.369)	(0.386)	(0.0513)	(0.0622)	(0.0514)	(0.0965)
Observations	3,531,967	3,531,967	3,531,967	3,531,967	3,568,723	3,568,723	3,568,723	3,568,723
R-squared	0.238	0.239	0.238	0.238	0.256	0.256	0.255	0.256

Table B3: Subsample analyses – Small vs. large objects

This table presents the results of the OLS regression modelling the determinants of real estate price deviations described in Equation (2) using micro data for different subsamples. The dependent variable is the deviation rate of object i, i.e., the difference of the actual listed price actual price (p_i) and the predicted price ($\widehat{p_i}$) normalized by the predicted price ($\widehat{p_i}$). In Col. 1 and 2, the sample covers only properties with one or two rooms. In Col. 3 and 4, all properties with four or more rooms are included in the sample. In Col. 5 and 6, the lower quartile in terms of living space is included which means all properties with a maximum living space of less than 76 square meters. In Col. 7 and 8, the upper quartile in terms of property size is included, i.e. all objects with a living space of more than 170 square meters.
The sample covers the observation period from 2014 to 2021. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table B3	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y = deviation of real estate price from fundamental value	No. of rooms < 3	No. of rooms < 3	No. of rooms > 3	No. of rooms > 3	Living space < 76	Living space < 76	Living space > 170	Living space > 170
$\boldsymbol{\Delta\ Loans}$	**-0.0868**	**0.519**	**0.740*****	**3.257*****	**-0.0859**	**0.0577**	**0.589*****	**2.704*****
	(0.507)	(2.217)	(0.202)	(1.005)	(0.498)	(2.151)	(0.192)	(0.819)
$\boldsymbol{\Delta\ Loans\ x\ Mortgage\ Rate}$		**-0.329**		**-1.366*****		**-0.0782**		**-1.155*****
		(1.026)		(0.484)		(0.996)		(0.416)
Mortgage Rate	0.0531***	0.0639*	0.157***	0.194***	0.0664***	0.0689*	0.134***	0.163***
	(0.0193)	(0.0386)	(0.0113)	(0.0199)	(0.0187)	(0.0377)	(0.0128)	(0.0174)
$\Delta\ GDP\ per\ employee$	0.531***	0.534***	0.293***	0.286***	0.502***	0.503***	0.381***	0.374***
	(0.180)	(0.177)	(0.0915)	(0.0920)	(0.162)	(0.160)	(0.0946)	(0.0951)
$\Delta\ Number\ employees$	2.296***	2.335***	1.043***	1.208***	2.254***	2.263***	1.232***	1.379***
	(0.743)	(0.725)	(0.342)	(0.355)	(0.705)	(0.685)	(0.331)	(0.339)
$\Delta\ Living\ space$	0.216	0.173	-8.510***	-8.583***	0.298	0.288	-8.550***	-8.610***
	(1.716)	(1.682)	(1.512)	(1.521)	(1.760)	(1.729)	(1.177)	(1.181)
Trend	0.0126***	0.0126***	0.0127***	0.0125***	0.0129***	0.0129***	0.0114***	0.0112***
	(0.000511)	(0.000497)	(0.000389)	(0.000370)	(0.000511)	(0.000499)	(0.000305)	(0.000309)
Constant	-0.189***	-0.209**	-0.432***	-0.497***	-0.232***	-0.237***	-0.400***	-0.452***
	(0.0567)	(0.0917)	(0.0323)	(0.0468)	(0.0571)	(0.0904)	(0.0336)	(0.0398)
Observations	638,660	638,660	2,302,199	2,302,199	816,230	816,230	940,607	940,607
R-squared	0.272	0.272	0.215	0.216	0.276	0.276	0.174	0.174
Subsample	No. of rooms < 3	No. of rooms < 3	No. of rooms > 3	No. of rooms > 3	Living space < 76	Living space < 76	Living space > 170	Living space > 170

Table B4: Subsample analyses – City vs. rural area

This table presents the results of the OLS regression modelling the determinants of real estate price deviations described in Equation (2) using micro data for different subsamples. The dependent variable is the deviation rate of object i, i.e., the difference of the actual listed price actual price (p_i) and the predicted price ($\hat{p}_i$) normalized by the predicted price ($\hat{p}_i$). In Col. 1 and 2, the sample covers only properties that are located in a city. In Col. 3 and 4, all properties from rural areas are included in the sample. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table B4 Y = deviation of real estate price from fundamental value	(1) City	(2) City	(3) Rural area	(4) Rural area
Δ ***Loans***	**0.432**	**5.230**	**0.627*** **	**1.935** **
	(0.654)	(3.684)	(0.194)	(0.893)
Δ ***Loans x Mortgage Rate***		**-2.579**		**-0.713***
		(1.737)		(0.414)
Mortgage Rate	0.0866***	0.170***	0.134***	0.154***
	(0.0128)	(0.0628)	(0.0117)	(0.0168)
Δ *GDP per employee*	0.163	0.205**	0.577***	0.566***
	(0.100)	(0.0903)	(0.130)	(0.130)
Δ *Number employees*	1.739*	2.016**	1.147***	1.237***
	(0.899)	(1.009)	(0.369)	(0.366)
Δ *Living space*	-3.215	-3.712	-5.676***	-5.676***
	(2.692)	(2.812)	(0.996)	(0.999)
Trend	0.0126***	0.0124***	0.0126***	0.0125***
	(0.00101)	(0.000874)	(0.000320)	(0.000343)
Constant	-0.231***	-0.387**	-0.390***	-0.423***
	(0.0686)	(0.161)	(0.0306)	(0.0392)
Observations	1,024,175	1,024,175	2,544,548	2,544,548
R-squared	0.267	0.270	0.224	0.225
Subsample	City	City	Rural area	Rural area

Table B5: Panel analyses

This table presents the results of the OLS regression modelling the determinants of real estate price deviations described in Equation (2) using micro data. The dependent variable is the mean of deviation rates of all objects i in district d in year t. In Col. 1, the first explanatory variable is the yearly growth rate of all loans that the savings banks granted in each district ($\Delta\ Loans$). The macroeconomic fundamentals we account for are the mortgage rate m_t, the yearly growth rate of GDP per employee ($\Delta\ GDP_{d,t}$) , the yearly growth rate of the number of employees ($\Delta\ Employees_{d,t}$) and the yearly growth rate of newbuilt living space ($\Delta\ Living\ space_{d,t}$) for each district. We add a time trend (t_t) in our equation to control for the time interval between the base period in which $\hat{p}$ was calibrated and the period in which object i is offered.
In Col. 2, we add the interaction term of yearly growth rate of all loans that the savings banks granted in each district ($\Delta\ Loans$) and the mortgage rate to Equation (2).
The sample covers the observation period from 2014 to 2021. Robust standard errors clustered for districts are displayed in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%-level, respectively.

Table B5 VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ ***Loans***	0.541***	2.444***	0.489***	4.060***	0.563***	1.686**	0.537***	2.266*
	(0.162)	(0.768)	(0.162)	(1.270)	(0.166)	(0.788)	(0.166)	(1.298)
Δ ***Loans x Mortgage Rate***		-1.064***				-0.632*		
		(0.369)				(0.382)		
Δ ***Loans x (Mortgage Rate − Policy Rate)***				-1.656***				-0.806
				(0.544)				(0.559)
Mortgage Rate	0.0988***	0.130***			-0.0148	0.00989		
	(0.00947)	(0.0146)			(0.0152)	(0.0222)		
Mortgage Rate – Policy Rate			-0.00864	0.0537**			-0.0809***	-0.0472
			(0.0131)	(0.0248)			(0.0156)	(0.0293)
Δ *GDP per employee*	0.480***	0.470***	0.540***	0.525***	0.260***	0.268***	0.267***	0.274***
	(0.0871)	(0.0860)	(0.0941)	(0.0922)	(0.0773)	(0.0780)	(0.0777)	(0.0783)
Δ *Number employees*	1.673***	1.736***	1.814***	1.873***	1.854***	1.883***	1.993***	2.016***
	(0.256)	(0.257)	(0.265)	(0.265)	(0.260)	(0.261)	(0.268)	(0.269)
Δ *Living space*	-5.033***	-5.048***	-4.516***	-4.539***	-3.812***	-3.901***	-3.374***	-3.449***
	(0.738)	(0.733)	(0.741)	(0.735)	(0.738)	(0.734)	(0.741)	(0.737)
Trend	0.0123***	0.0121***	0.0109***	0.0109***	0.00576***	0.00605***	0.00506***	0.00534***
	(0.000210)	(0.000228)	(0.000199)	(0.000204)	(0.000661)	(0.000685)	(0.000516)	(0.000547)
CPI					0.0475***	0.0445***	0.0493***	0.0467***
					(0.00457)	(0.00499)	(0.00387)	(0.00434)
Constant	-0.310***	-0.360***	-0.0513	-0.186***	-4.420***	-4.192***	-4.425***	-4.252***
	(0.0242)	(0.0324)	(0.0332)	(0.0587)	(0.396)	(0.424)	(0.337)	(0.360)
Observations	3,045	3,045	3,045	3,045	3,029	3,029	3,029	3,029
R-squared	0.722	0.724	0.720	0.722	0.729	0.730	0.730	0.730