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Filippa Ahlström
Nadja Jakobsson
Axel Hedström
David Stenvall

Department of Management and Engineering – Division of Economics

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Division of Economics
Department of Management and Engineering
Linköping University
SE-581 83 Linköping
Sweden

Dynamic Effects of Monetary Policy and Mortgage Spreads on Housing Markets: Evidence from Swedish Regions

Filippa Ahlström [a], Nadja Jakobsson [a], Axel Hedström [a], and David Stenvall [a]*

Abstract

This paper examines the regional effects of monetary policy and mortgage spread shocks on Swedish housing prices and transaction volume, with primary focus on regional market dynamics from national shocks. By analyzing policy rate shocks and mortgage spread shocks, this study provide insights into their distinct impacts on Sweden's regional housing markets. Utilizing local projections and high-frequency identified monetary policy shocks, this study highlights that monetary policy shocks and fluctuations in mortgage spreads exert a noticeably greater influence on large metropolitan regions, partly due to elevated housing prices. Nevertheless, the effect is still present in less populated areas in Sweden but with more modest magnitudes, indicating that smaller regions are also susceptible to these macroeconomic forces.

Keywords: *Mortgage spread, regional housing market, monetary policy, high-frequency shock identification*

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[a] Division of economics, Department of Management and Engineering (IEI), Linköping University Linköping, Sweden.

*Corresponding author: Department of Management and Engineering (IEI), division of Economics, Linköping University, 581 83 Linköping, Sweden. Telephone (corresponding author): +46 013 28 1779, Fax: +46 13 28 89 09. ORCID: 0000-0003-4729-8011

E-mail addresses: filippa.ahlstrom@liu.se (Ahlström. F), nadja.jakobsson@liu.se (Jakobsson. N), axel.hedstrom@liu.se (Hedström. A), david.stenvall@liu.se (Stenvall. D)

1 Introduction

Sweden's housing market offers an interesting perspective for international comparisons, considering the short-term mortgage maturities, the considerable variations in household debt, and the heterogenous house price development between less urbanized areas and metropolitan regions. The house prices in Sweden have on average increased by over 300 percent since beginning of the 1990s, something that, in turn, has prompted discussions about issues of macroeconomic stability (e.g., Claussen, 2013; Gustafsson et al., 2016), youth affordability (Olsén Ingefeldt and Thell, 2019), and household indebtedness (e.g., Finocchiaro et al., 2011; Thedéen, 2017)[1]. The rise in Swedish house prices has been steeper than in most other European countries (Engerstam, 2021). Sweden's prolonged period of negative policy rates has frequently been cited in the media as a key driver of this increase. However, recent academic studies reject the notion of overvaluation, instead attributing the long-term price growth to fundamentals such as income and mortgage interest rates (see e.g., Claussen, 2013; Bjellerup and Majtorp, 2019; Svensson, 2024).

Monetary policy decisions can affect the economy and the housing market through several channels; the most apparent connection is through banks' mortgage rates. Changes in the policy rate impact on the overnight interbank rates for banks, which subsequently influences other market interest rates across the economy (Sveriges Riksbank, 2024). According to Fransson and Tysklind (2016), there is a greater pass-through between the Swedish policy rate and market rates on loans with shorter durations than for loans with longer duration. Since many Swedish households have either floating rate mortgage loans, or mortgage rates that are fixed on a 1-2 year period, it is reasonable to expect a stronger effect of monetary policy shocks on Swedish housing prices[2]. This has also been confirmed by studies examining how monetary policy has influenced house prices at the national level in Sweden (e.g., Rosenberg, 2019; Wilhelmsson, 2020). The policy rate, however, is not the only factor influencing mortgage rates. As Eidestedt et al. (2020) clarify that, mortgage rates can be broken down into several components. These components include a risk-free component (the policy rate), a risk

[1] According to Statistics Sweden's property price index, single-family house prices increased by 355% between 1990 and 2023.

[2] As reported in Eidestedt et al. (2020), approximately 60 percent of Swedish mortgages consist of loans with variable mortgages rates.

premium, and banks profit margins[3]. Shifts in mortgage rates can therefore result from changes in any of these components. It is thus evident that a mortgage spread shock, as defined in Walentin (2014), does not necessarily capture the same information as a monetary policy shock; instead, it could reflect changes in the risk premium in the mortgage market[4]. Although mortgage spreads are an important indicator of financial stress, they are rarely considered in analyses of housing markets (Davis et al., 2011).

It is well-documented that both monetary policy and mortgage spread shocks influence housing markets on a national level, but fewer studies have examined their regional effects. While there are a few country-specific studies on regional responses of housing markets to monetary policy shocks, there is a lack of research analyzing how, for example, shocks affect different regions in the mortgage market. Various factors likely contribute to how differences in the regional housing markets in Sweden respond to mortgage spread and monetary policy shocks. National Board of Housing, Building and Planning (2022) identifies key drivers of regional housing market differences, such as population growth and industrial development. Although population flows are challenging to capture in macroeconomic studies that are focused on short-term effects, it can indirectly influence short-term variations by affecting housing supply elasticities. As shown by Oikarinen et al. (2015), city populations are negatively associated with size of the housing supply elasticity, and this type of elasticity can directly influence how regions respond to monetary policy shocks (Aastveit and Anundsen, 2022). There are also considerable regional variations in housing price trends. Between 1990 and 2023, nominal house prices in Skåne County increased by over 420 percent, compared to just over 200 percent in Norrbotten County[5]. Another factor that could support the hypothesis of regional variation in responses to mortgage spread and monetary policy shocks is the differences among the regions with regard to household debt. In a recent mortgage market report by the Financial Supervisory Authority (FI, 2024), the debt-to-income ratio is reported to be much larger among new borrowers in metropolitan areas. In 2023, over 11 percent of new borrowers in metropolitan Stockholm had a debt-to-income ratio exceeding 450 percent, which is a

[3] As stated in Eidestedt et al. (2020), the risk premium emerges when banks fund their borrowing through covered bonds. These bonds are the most prevalent financing too for mortgages in Sweden.
[4] Walentin (2014) investigates the effects of mortgage spread shocks on US macroeconomic variables using an SVAR analysis, with the mortgage spread defined as the difference between a mortgage rate and a government bond rate.
[5] Note that these figures are based on Statistics Sweden's housing price index, which only includes single-family houses and therefore excludes condominiums.

substantially higher proportion than in other regions[6]. Cross-country evidence suggests that monetary policy can have a stronger impact on housing-related variables in countries with high versus low mortgage debt to GDP, and that certain macroeconomic variables are more affected by monetary policy in the context of higher household debt (Calza et al., 2013; Kim and Lim, 2020).

Research on monetary policy and housing is centred on national-level analyses, while regional studies remain scarce (Gupta & Kabundi, 2010; Fischer et al., 2021; Aastveit & Anundsen, 2022; Baradaran Motie & Zeng, 2024; Costello et al., 2015; Tsai, 2015; Margaris, 2024; Battistini et al., 2024). That furthermore have not adopted current identification strategies that is increasingly common in macro, such as high-frequency shock identification e.g. Amberg et al. (2022). Most of the literature also concentrates on house prices, overlooking other market variables. Notable exceptions include Gupta & Kabundi (2010), Fischer et al. (2021) and Sun & Ping Tsang (2018), which also analyse rents or housing starts. Vargas-Silva (2008) uses sign restricted VARs to show that monetary policy shifts housing starts in several U.S. regions. The literature on transaction volumes examines either "ripple effects" between regions (Tsai, 2014; Tsai, 2018) or national responses to interest rate shocks (Hort, 2000; Oikarainen, 2012; Wit et al., 2013). Theory and empirical evidence agree that volumes adjust faster than prices (Berkovec & Goodman, 1996; Hort, 2000; Oikarainen, 2012).

On the national level in Sweden there is a few studies that have examined shocks to mortgage spreads (Walentin, 2014) or monetary policy shocks (Rosenberg, 2019; Wilhelmsson, 2020). On the regional housing markets in Sweden there are a few studies that has explored the relationship between policy shock and regional housing markets. Hort (2000) studied Sweden's regional housing market, but it only reports aggregate effects, and the field have developed more suitable high-frequency identification strategies. Yang et al. (2010) employed a multivariate persistence method and a simple proxy for central bank policy, namely the 6-month government bond yield. That method provides a long-term total effect of an aggregate monetary policy shock on each local housing market, but it does not capture the dynamic effects following a shock. Although, Yang et al. (2010) argues against VAR-models, since it requires identifying restrictions and assumptions regarding the endogeneity or exogeneity of variables

[6] This can be compared with the average of 5.3 percent for all regions, see Financial Supervisory Authority (FI, 2024).

within the system. However, with the more recent approach to identifying monetary policy shocks, i.e., the high-frequency/external instrument approach, this critique is no longer valid.

This study hence aims to bridge the gap in the literature of carefully studying Sweden's regional housing market dynamics and how they are affected by mortgage spread shocks. We use quarterly dataset spanning from 1998 to 2019 for prices and transaction volumes and how they are impacted in each region using impulse responses from local projection method by Jorda (2005). The monetary policy shocks are identified based on the high-frequency approach outlined in Amberg et al. (2022). Regarding the effects of mortgage spread shocks, we adopt a two-step approach. The mortgage spread shocks are identified using a structural VAR-model (SVAR-model) with a set of national macroeconomic variables, according to the methodology of Walentin (2014). The shocks from the first step are subsequently extracted and used in the local projection estimations.

At the Swedish national level, we find that a policy-rate shock depresses the market immediately, whereas a mortgage-spread shock has a delayed impact. This matches the directional findings of Wallentin (2014), although that study detected an immediate mortgage-spread response. The sold volumes show an immediate decline from both shocks, similar to Hort (2000). Sweden's regional market the policy rate shock has stronger immediate effect on regional housing prices in the metropolitan regions and especially Stockholm, while the smaller regions have weaker and delayed response. The mortgage-spread shock shows no immediate effect in any region, but the effect is steadily declining and become significant after several periods for all regions except for the northern and less densely populated regions. Hence, there is larger regional heterogeneity in the response of mortgage-spread shocks. Both policy rate and mortgage-spread shocks show immediate and negative impact on sales volumes. With the largest responses in the larger Swedish regions, with the northern region showing mostly insignificant impact of both shocks. The results were directionally stable for policy rate and mortgage-spread shocks using different model specifications, but mortgage-spread shocks were more sensitive for different model specifications and had more muted response in some model set ups.

Our main findings suggest that when policymakers assess the policy-rate effects, they should look beyond Stockholm's short-term response and factor in the longer-lasting impacts observed in other regions.

2 Related literature

2.1. Mortgage spread shocks and housing markets

Mortgage spreads have been included or discussed in earlier macroeconomic studies since the late 2000s (e.g., Iacoviello and Minetti, 2008; Hubbard and Mayer, 2009; Musso et al., 2011), but the mortgage spread was first examined as a distinct type of shock in Walentin (2014). Walentin (2014) uses a SVAR-model to examine how it affects several macroeconomic variables (consumption, GDP, CPI, and the policy interest rate) as well as housing-specific variables (housing investments and housing prices). The mortgage spread shock is identified based on a Cholesky decomposition. The study is primarily based on U.S. data, but the same SVAR-specification is also estimated for UK and Sweden in the supplementary analyses. From the SVAR-analysis, the author shows that a shock in the spread has significant effects on house prices, residential investment, GDP and consumption. An increase in mortgage spreads negatively impacts house prices in all three countries, but the effect is greater in Sweden, as measured by variance decompositions.

A few other studies have also examined how mortgage spread shocks affect the housing market. Cheng and Chiu (2020) investigate how macroeconomic variables in the U.S. are affected by mortgage spread shocks by applying a non-linear VAR model, i.e., a smooth-transition VAR (STVAR). Their results suggest that a sudden increase in the mortgage spread has a negative impact on house prices and housing starts, but that the effect is stronger during recessions rather than expansions. Another paper, Horvath and Rothman (2021), instead focuses on how mortgage spread shocks from the U.S. affect macroeconomic variables in other countries. The authors estimate a panel VAR-model with block-exogeneity restrictions and focus on the impact on emerging market economies. They find that a shock that increases the U.S. mortgage spread significantly decreases house prices in emerging markets.

2.2. Monetary policy shocks and regional housing markets

Studies analyzing how monetary policy shocks affect housing markets are plentiful (see e.g., Iacoviello, 2002; Giuliodori, 2005; Smets and Jarociński, 2008; Iacoviello and Minetti, 2008; Elbourne, 2008; Musso et al., 2011; Calza et al., 2013; Rahal, 2016; Nocera and Roma, 2017;

Robstad, 2017; Rosenberg, 2019)[9]. The general conclusion from the literature is that both house prices and housing investments tend to react strongly negatively to sudden increases in the policy rate. However, notably the older literature primarily used Cholesky decomposition to identify monetary policy shocks, while in more recent literature on monetary policy shocks it is common to use either sign restrictions or external instruments identified using high-frequency approaches[10].

As regard to the literature on monetary policy and regional housing markets, it is mainly focused on the U.S. housing market. Baffoe-Bonnie (1998) is one of the earlier studies that examined how interest rate shocks affect regional housing market variables, both house prices and the number of houses sold. Using VAR-models, the author finds that national mortgage interest rate shocks have a strong impact on U.S. regions, with the number of houses sold in these regions decreasing almost immediately. Fratantoni and Schuh (2003) use U.S. quarterly regional data spanning from 1986 to 1996 and a heterogeneous-agent VAR (HAVAR) model in order to study responses of household income, housing investment, and house prices to a monetary policy shock. Their findings show that both housing investment and housing appreciation decline as a response to monetary policy tightening, but the peak effect varies significantly across different regional housing markets. Vargas-Silva (2008a) uses a sign-restricted VAR-approach to examine the effects of monetary policy on U.S. national and regional housing market variables. The author finds that housing starts of the four US census regions react negatively to a monetary policy tightening, but the results are only significant for a few horizons and vary across regions. Several studies have used factor-based VAR models, namely factor-augmented VAR models (FAVAR), to examine regional housing market effects. For instance, Vargas-Silva (2008b) uses this type of model and finds that housing starts in the four U.S census regions react negatively to monetary policy shocks, with a stronger response of the Midwest. Furthermore, Gupta and Kabundi (2010) use a FAVAR model focusing on regional housing price inflation and its responses to monetary policy shock. While the authors

[9] Since we primarily analyze regional markets in this article, we focus mainly in this section on studies that examine monetary policy and regional housing markets.

[10] Only a few have examined how monetary policy shocks identified with high-frequency/external instrument approaches affect the housing market, with the exception of Dias and Duarte (2019). It is, however, commonly used to study the effect of monetary policy shocks on other macroeconomic variables. (e.g., Nakamura and Steinsson; 2013; Gertler and Karadi, 2015; Lakdawala, 2019; Altavilla et al., 2019; Holm-Hadulla and Thürwächter, 2021; Amberg et al., 2022; Fanelli and Marsi, 2022).

find the effect on housing price growth rates to be generally negative over the impulse horizon, some U.S. Census divisions show a positive response on impact.

Fischer et al. (2021) use a Bayesian version of FAVAR-model to study the effect of a monetary policy shock, identified based on a high-frequency approach, on housing prices micropolitan statistical areas in the U.S. Similar to the studies mentioned earlier, they find significant heterogeneity, which the authors argue can be explained by differences in regulatory settings and disparities with regard to supply elasticities across regions. Supply elasticities in particular are a topic that other studies have highlighted as being of special importance for understanding how monetary policy shocks affect regional housing markets. For example, Aastveit and Anundsen (2022) find that the reaction of house prices to expansionary monetary policy shocks differs across U.S metropolitan areas, depending on whether the supply is elastic or inelastic. House prices react more to this sort of shock in regions with inelastic supply. Furthermore, Baradaran Motie and Zeng (2024) find non-linear impacts of monetary policy shocks on certain city-specific housing price volatilities in the U.S.

A few studies have focused on regional housing markets outside the U.S. For example, regional heterogeneity in house price responses to monetary policy shocks has also been confirmed with VAR models and data from Australia in Costello et al. (2015). There are also two studies from the UK. The first, Tsai (2015), focuses on monetary policy and regional housing bubbles. The more recent one, Margaris (2024), uses a FAVAR model. Again, the results of the latter confirm the heterogeneous effects of monetary policy on regional housing prices, but interestingly, these effects cannot be explained by factors commonly associated with regional housing supply elasticities. Instead, Margaris (2024) argues that the heterogeneity is related to differences in housing affordability across regions.

A recent study by Battistini et al. (2024) uses annual NUTS2 and NUTS1 data from the euro area to explain how monetary policy affects housing prices, construction activity and other macroeconomic variables. Using a structural panel VAR model and expansionary monetary policy shocks identified based on the high-frequency surprise approach, they find that loan-to-value ratios and homeownership rates of the regions to be positively related to the housing price response of the regions, thus suggesting that tenure status and mortgage market structure may be important determinants. Their result also indicates that indebtedness (i.e., the loan-to-income ratio) is of less importance in explaining the responses of the housing sector.

Lastly, and most relevant to our study, Yang et al. (2010) investigate how regional housing prices in Sweden were affected by monetary policy during the period 1991–2002. Based on a persistence shock method and using the 6-month Treasury bill as a proxy for monetary policy, the authors find large heterogeneity across the included regions. Interestingly, they find that monetary policy is of greater importance for the larger regions Stockholm, Gothenburg and Malmö. Furthermore, the authors also argue that interest rate shocks are "relatively unimportant" for regions outside these three largest ones, even though the effects are statistically significant in most regions.

3. Data and methodological framework

3.1 Empirical setup

This study uses local projections (LP) to investigate the impact of mortgage spread shocks and monetary policy shocks on regional Swedish housing markets. LP was introduced in Jordà (2005) and has since been widely used in the literature to estimate impulse response functions with beforehand identified shocks (e.g., Furceri et al., 2019; Pizzuto, 2020; Chen and Tillmann, 2020; Jordà and Taylor, 2024).

The impulse responses from local projections are computed by running regression models for each individual horizon k, where $k = 0,1 \dots K$. Similarly to Furceri et al. (2019) and Pizutto (2020), the LPs are estimated separately for each individual region and the impulse responses are then estimated from the following $K + 1$ regressions:

$$y_{t+k} = \mu^k + \beta^k \varepsilon_t + \delta_1^k x_{t-1} + \cdots + \delta_p^k x_{t-p} + \theta_1^k y_{t-1} + \cdots + \theta_p^k y_{t-p} + \varphi^k t + v_{t+k}^k \qquad (1)$$

In Eq. 1, y is either the region-specific log real house prices or log number of house transactions (volume). The shock of interest, ε, is either a monetary policy shocks series or the mortgage rate shock. Furthermore, β^k is the horizon specific impulse response coefficient, showing the sensitivity of a specific regional housing market variable to any of the aggregate shocks. Although the LPs are estimated separately with regional housing market data, the shocks (ε) are common to all regions. We also include lagged employment data, $[x_{t-1}, \dots, x_{t-p}]$, and lags of the dependent variable, $[y_{t-1}, \dots, y_{t-p}]$, as regional control variables. In the baseline estimations, we include 2 lags.

With local projection regressions and VAR-analysis in general, it is common to estimate the impulse responses with the dependent variable in level (e.g., Jordà, 2005; Jordà and Taylor, 2025). However, the house price series are clearly non-stationary, as they show a clear upward trend. Although lag-augmented local projections with non-stationary data have been shown to be a valid approach in large samples (Montiel Olea and Plagborg-Møller, 2021), the sample size in this study is quite short. To alleviate potential issues with a non-stationary dependent variable, we include a linear trend, t, in our estimations[11]. Also, a number of robustness checks were implemented, and results are available in section 5.3, that for instance use the long-difference approach described in Jordà and Taylor (2024)[12].

3.2 Monetary policy shock identification

The monetary policy shocks are constructed following the same procedure as in Amberg et al. (2022). The first step is to extract high-frequency surprises, which are later used to instrument the policy interest rate in Sweden. While it is common in the literature with U.S. data to create a surprise series by measuring the changes in interest rate future contracts during a short time window around the FED policy rate announcement, (e.g., Gertler and Karadi, 2015), similar data is not available for Sweden. Amberg et al. (2022) instead creates a series of surprises using daily changes in the one-month treasury bill yield on monetary policy announcement days. Moreover, the authors follow the procedure described in Jarociński and Karadi (2020), in order to clean the surprises from scenarios where market participants reacts to revealed information about the future state of the economy rather than to the interest rate changes themselves. This is practically achieved by forcing the surprise series to be zero on announcement days when changes in the treasury bill rate and stock market returns are either both positive or both negative. In this paper, we follow the same approach when calculating our surprises[13].

[11] We have also tried using detrended house prices in a first step by regressing the prices on a trend. However, the results from the detrended variables are almost identical to those from our chosen approach, which instead includes the trend directly in the local projection estimations.

[12] Jordà and Taylor (2025) refer to the long-difference approach as their preferred specification for applied work. Therefore, we closely follow the specifications in Jordà and Taylor (2025) by adopting the following setup as our long-difference specification: $y_{t+k} - y_{t-1} = \mu^k + \beta^k \varepsilon_t + \delta_1^k \Delta x_{t-1} + \cdots + \delta_p^k \Delta x_{t-p} + \theta_1^k \Delta y_{t-1} + \cdots + \theta_p^k \Delta y_{t-p} + v_{t+k}^k$. Here, p is the chosen lag length and x represents the log of regional employment. The first difference notation implies that Δx_{t-1} is the difference in log regional employment between period $t-1$ and $t-2$, while Δx_{t-p} is the change between periods $t-p$ and $t-p-1$.

[13] We also follow Amberg et at. (2022) by setting the surprise for February 11, 2016, to the two-day change in the T-bill yield.

After identifying the surprises, Δi_m^{Tbill}, we run the following regression model,

$$\Delta i_m^{Rate} = \beta_0 + \beta_1 \Delta i_m^{Tbill} + \varepsilon_m \quad (2)$$

where Δi_m^{Rate} is the change in the policy interest rate on announcements days. Similar to Amberg et al. (2022), the values used for the monetary policy shock are the predicted values from this regression, $\widehat{\Delta i_m^{Rate}}$. Since the regression is only performed using observations from meeting days, we use these predicted values and additionally fill in months without monetary policy announcements with zeros to create a shock that can be used in the estimations. Once the monthly shock is constructed, we can, similar to Amberg et al. (2022), aggregate it to a lower frequency (quarterly) by simply summing the monthly values

Regarding the identification of the monetary policy announcement days, it is not always entirely clear which days constitute monetary policy decisions or not. In our selection process, we primarily rely on press releases published on the Riksbank's website, which were cross-checked against the dates used by Amberg et al. (2022). As a secondary source, we also searched for terms such as "Riksbank" and "repo rate" in the historical web archives of news articles available from one of Sweden's largest daily newspapers, *Svenska Dagbladet*.

Amberg et al. (2022) use the year 1999 as the starting point for their monetary policy shock based on the argument that from this year onward, the Riksbank began communicating its monetary policy decisions on a regular basis. We therefore choose our starting point close to this year but extend the shock period by one year back to 1998, which is the first year for which regional data on the number of houses sold are available. We also extend the shock forward until the end of 2019[14].

[14] There are some press releases on the Riksbank's website stating that the repo rate was left unchanged (such as on May 7, May 21, July 2 and August 2 for year 1999). Amberg et al. (2022) did not include these as dates of announcements according to their replication files. There is also nothing written about these monetary policy decisions in the newspaper (*Svenska Dagbladet*) the day after the decisions, nor are these dates listed as monetary policy decision meetings for the Executive Board at the following link: https://archive.riksbank.se/sv/Webbarkiv/Publicerat/Pressmeddelanden/1999/Direktionsmoten/. According to a press release about the monetary policy process in 1999 on the Riksbank's website (https://archive.riksbank.se/pagefolders/2000/nr02.pdf), it is stated that the Executive Board should devote eight to ten meetings per year to more comprehensive monetary policy analysis and assessment. Furthermore, the press release states that decisions about the repo rate should be based on the discussions held at these special monetary policy meetings. Hence, our interpretation is that these "extra" press releases in 1999, were not related to ordinary monetary policy decisions, but instead were released as formalities without any significance for markets or household financial decisions. We

3.3 Mortgage spread shock

In order to derive regional mortgage spread shock a two-step approach was used. First, to isolate the mortgage spread shock from other aggregate shocks a VAR-model was estimated using only national level variables. Following Walentin (2014) the VAR-model is estimated with variables in levels for mortgage spread and policy rate and log levels for real GDP and consumer price index (CPIF). The model is estimated with 4 lags; hence the data starts from 1997Q1 to align the shock with the regional data starting in 1998Q1. The identification strategy for the VAR-model follows Walentin (2014) and Cheng and Chiu (2020) that orders the mortgage spread after real GDP and consumer price index, but before the policy interest rate, and is using a Cholesky decomposition. We therefore assume that the Swedish policy interest rate could be contemporaneously affected by mortgage spread shocks. This model does not include any housing variables as that would deprave the objective to investigate the effect of mortgage spread shocks on the regional housing markets.

In the second step the mortgage spread shock is extracted from the national level VAR model and used in the LPs to derive the effect on the regional housing markets[15]. Each region is separately estimated in regressions as specified in Eq.1. Here the housing market and employment data are region specific, but the extracted mortgage spread shock is the same for all regions. This strategy of first extracting the shock using a VAR model and then estimating the impulse responses using local projection has also been applied in several other studies (e.g., Chen and Tillmann, 2021; Finck and Rudel, 2023). There are several reasons why this two-step procedure is preferred. First of all the VAR model would be too large if all regional variables were included in a single model. Estimating separate VAR models for each region with the mortgage spread included as an endogenous variable, without imposing further restrictions, this would allow the mortgage rate shock to vary between regions. Since the shock will change with the feedback from the regional variables (see, for example, the discussion in Lastrapes, 2006). The LP instead treat each individual region as too small to independently influence the

therefore use the same announcement dates for 1999 as Amberg et al. (2022) and, consequently, do not include these dates when constructing our surprise series.

[15] As described in Kilian and Lütkepohl (2017), the reduced form residuals e_t are related to the structural residuals ε_t by $e_t = P_0^{-1}\varepsilon_t$, where P_0^{-1} is the structural impact matrix. We use this relationship to extract the structural mortgage spread shock.

national macroeconomic variables or the mortgage spread and ensure that the effect is from the same shock.

3.4 Data, transformations and summary statistics

All data is collected for Sweden and the sample period covers the period Q1 1998 to Q4 2019. The period is selected based on both the availability of the number of housing transactions, but also because this period is appropriate for identification of the high-frequency monetary policy shocks as described before.

Regarding the housing market data used in this study, our baseline estimations are based on regional housing price indices collected from Statistics Sweden. These indices measure price developments for Sweden's eight national areas (NUTS 2). Unlike measuring price developments with average prices—which are sensitive to factors such as the condition and size of the sold properties—the property price index is based on a more sophisticated methodology, where prices are weighted according to the property's tax-assessed value (Statistics Sweden, 2025)[16]. These price indices are constructed using prices reported in property deeds to the Swedish Tax Agency, and because such information is not reported for individual sales of tenant-owned apartments, the indices from Statistics Sweden only include information on price developments for permanent single-family houses (one- and two-dwelling buildings). The housing price indices are retrieved as nominal indices but have been deflated with CPIF and seasonally adjusted before use. The second housing dataset used in our baseline estimations includes data on the number of sold homes each quarter. This dataset is also based on statistics for single-family houses only and is likewise retrieved from Statistics Sweden.

As a regional control variable in each set of LPs, we use data on the number of unemployed individuals in each national area. We have compiled this by summing up the number of unemployed individuals across the counties that belong to a given national area. The resulting series has subsequently been seasonally adjusted. Unemployment data for each county was obtained from the Swedish Public Employment Service (Arbetsförmedlingen).

To identify the monetary policy shock, we use three different data series. For the surprise series, we use the yield on a 1-month treasury bill, which we collect from the Riksbank's website. The policy rate (formerly known as the repo rate) is also obtained from the same authority's website.

[16] However, a drawback is that the property price index, unlike average prices, is not available for more high-resolution geographical areas in Sweden, such as counties.

To implement the procedure described in Jarociński and Karadi (2020), we use stock market (log) returns for OMX Stockholm. This return series has been calculated based on a stock price index retrieved from Datastream[17].

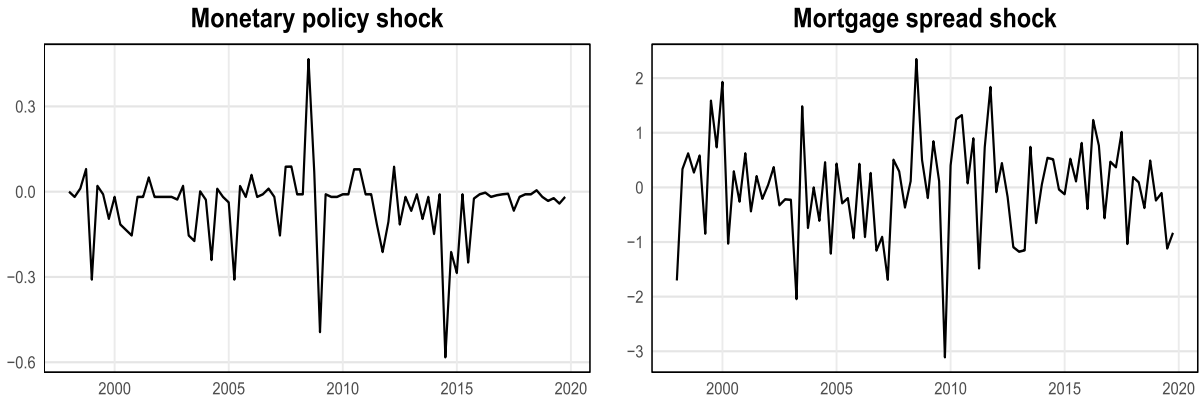
To create a mortgage spread series, we first need data on mortgage rates. For this purpose, we use historical mortgage rates downloaded from the website of SBAB (2024). Mortgage rates from the bank SBAB have also been used in previous research to represent the Swedish mortgage market (see, e.g., Svensson, 2024). In the baseline estimations, we use the mortgage rate for a 24-month (2 years) fixation period[18]. The mortgage spread is calculated by subtracting the 2-year government bond yield from the mortgage rate series. The government bond data was obtained from the Riksbank. The series for real GDP and CPIF used in the mortgage spread shock extraction were retrieved from Statistics Sweden.

Figure 1 presents the monetary policy and mortgage spread shocks used in the local projections. We note that some of the largest movements in the monetary policy shock series stem from increases in the central bank policy rate in proximity to the start of the financial crisis, as well as from the subsequent rate cuts following the outbreak in the last quarter of 2008. As regards the mortgage spread shock, significant movements were observed for the years preceding the dot-com crash and during the financial crisis period.

Figure 1. Monetary policy and mortgage spread shocks

[17] We use the Datastream symbol SWSEALI.

[18] The interest rates reported by SBAB are, however, not at regular intervals. In cases where there are two mortgage rate observations for a single quarter, we use the most recent one. If there is no new mortgage rate notation for a given quarter, we use the rate reported for the previous quarter.



Notes: The monetary policy shock is derived from the high-frequency approach by Amberg et al. (2022). The mortgage spread shocks are derived from a first-stage VAR model (Cholesky decomposition) using mortgage rates from SBAB (2024) for a 24-month fixation period.

Table 1 displays descriptive statistics for the seasonally adjusted real housing price dataset. For interpretability, we present the data as quarterly growth rates instead of log level as used in the estimations. From this table, we notice that the average growth rates have been higher in the areas that encompasses the larger cities, such as Stockholm, West Sweden (Gothenburg) and South Sweden (Malmö). However, we do not find the same relationship in terms of volatility. Instead, the most northern regions of the country, together with Stockholm, exhibit the largest average quarterly fluctuations. We also observe that the national index for housing prices in Sweden primarily reflects the price developments in the more populous regions.

Table 1: Descriptive statistics of housing price dataset

Regions	Mean (%)	SD (%)	Max (%)	Min (%)	Correlation with NAT
National (NAT)	1.17	1.39	4.28	-2.54	1
Stockholm (STH)	1.30	2.16	5.83	-3.98	0.9
East Middle Sweden (EMS)	1.13	1.38	4.32	-1.91	0.80
Småland and the islands (SMI)	1.03	1.52	4.28	-2.01	0.57
South Sweden (SSE)	1.21	1.65	5.09	-2.98	0.78
West Sweden (WSE)	1.27	1.63	6.71	-2.30	0.87

North Middle Sweden (NMS)	0.98	1.62	6.77	-2.74	0.43
Middle Norrland (MN)	0.82	2.40	6.53	-4.88	0.35
Upper Norrland (UN)	0.86	2.27	5.12	-8.23	0.47

Notes: The table presents the data in terms of quarterly growth rates of the seasonally adjusted real house prices. SD is an abbreviation for standard deviation.

Table 2 presents summary statistics for the quarterly number of house transactions. Not surprisingly, it is in the metropolitan regions that the highest number of transactions takes place. As a measure of volatility, we use the coefficient of variation instead of the standard deviation, as this measure allows for more fair comparison of the number of houses sold given the differing population sizes of the areas. Based on this, we can conclude that Stockholm stands out in terms of quarterly fluctuations in the number of houses sold.

Table 2: Descriptive statistics for number of sold homes

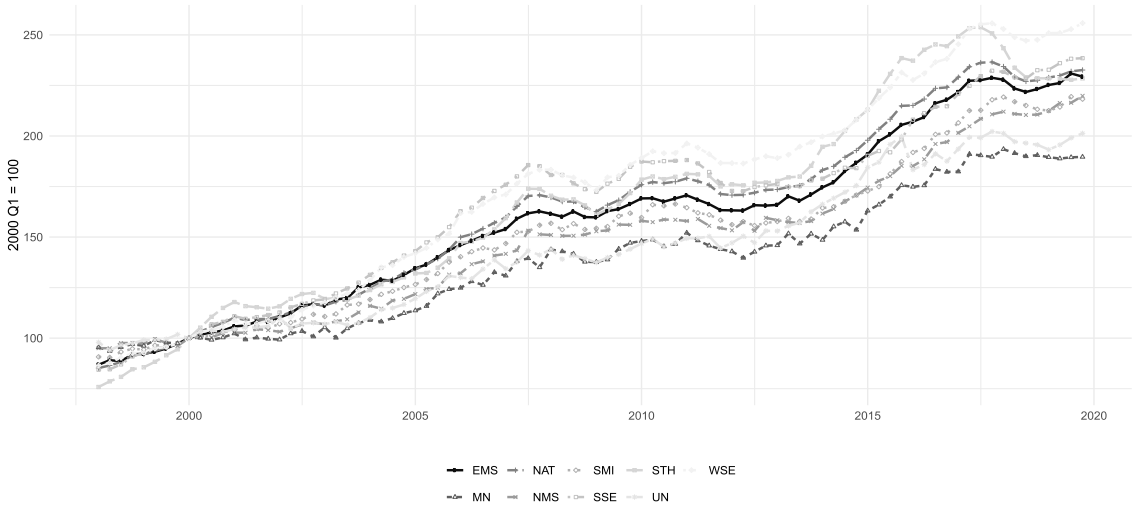
Regions	Mean	CV (%)	Max	Min
National (NAT)	13635	7.64	16991	11607
Stockholm (STH)	2107	10.37	2690	1663
East Middle Sweden (EMS)	2302	7.47	2791	1955
Småland and the islands (SMI)	1437	9.29	1828	1178
South Sweden (SSE)	2314	9.84	3050	1821
West Sweden (WSE)	2715	7.11	3475	2314
North Middle Sweden (NMS)	1413	8.69	1795	1172
Middle Norrland (MN)	593	9.68	811	441
Upper Norrland (UN)	754	9.08	922	592

Notes: The table presents the data for the seasonally adjusted number of houses sold each quarter. CV is an abbreviation for coefficient of variation.

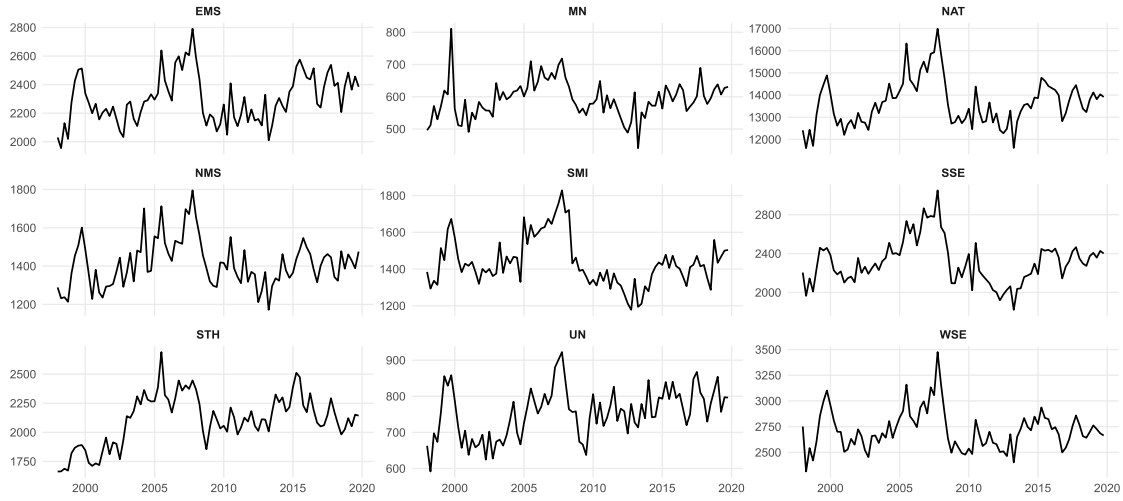
Figure 2 shows the historical development of house prices (Figure 2A) and the number of houses sold (Figure 2B). From this figure, we can generally observe that housing prices have increased steadily over time across all regions. A few periods of modest price declines can be recognized, such as during the financial crisis in the last quarter of 2008, in 2011, and in the first quarters of 2018. As regards the number of houses sold, most regions show a rising trend until the end of 2007, followed by a decline and a subsequent period of more irregular fluctuations.

Figure 2. Main housing market data

a. National and regional real house prices



b. Number of sold houses



Notes: Figure 1a shows the quarterly seasonally adjusted real housing prices of the national and regional markets. Figure 1b displays the seasonally adjusted number of houses sold each quarter.

4 Results and Analysis

Since most other studies on the Swedish housing market have been on the national level we start in section 4.1 to present results for compare our model results to other studies. In the subsequent section 4.2, we present and discuss the results for the regions. With different model set-ups presented in section 4.3.

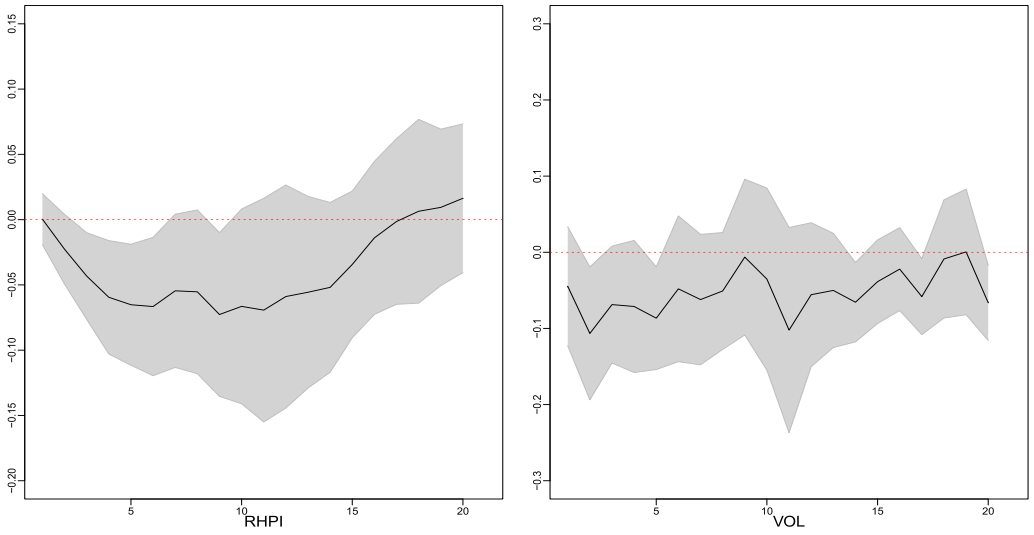
4.1 National level results

Figure 3 panel a) and b) shows the result from the local projections for the monetary policy and mortgage spread shock respectively on the national real house prices (RHPI) and number of sold houses (VOL). In line with the literature, a monetary policy tightening leads to a slowdown in the housing market, decreasing both prices and the number of houses sold. The gradual decline in property prices following a monetary policy shock indicates a delayed pass-through of monetary policy, with the peak response occurring after about 8 quarters (2 years). We find that a shock in mortgage spread has no significant short-term impact on the house price index, but the response is steadily declining and turn significant after about ten quarters. Walentin (2014) found greater immediate impacts of mortgage spread shocks on Swedish house prices. However, our analysis differs from Walentin (2014) due to our use of a different data source and maturity of the mortgage interest rate, and a somewhat different sample period.

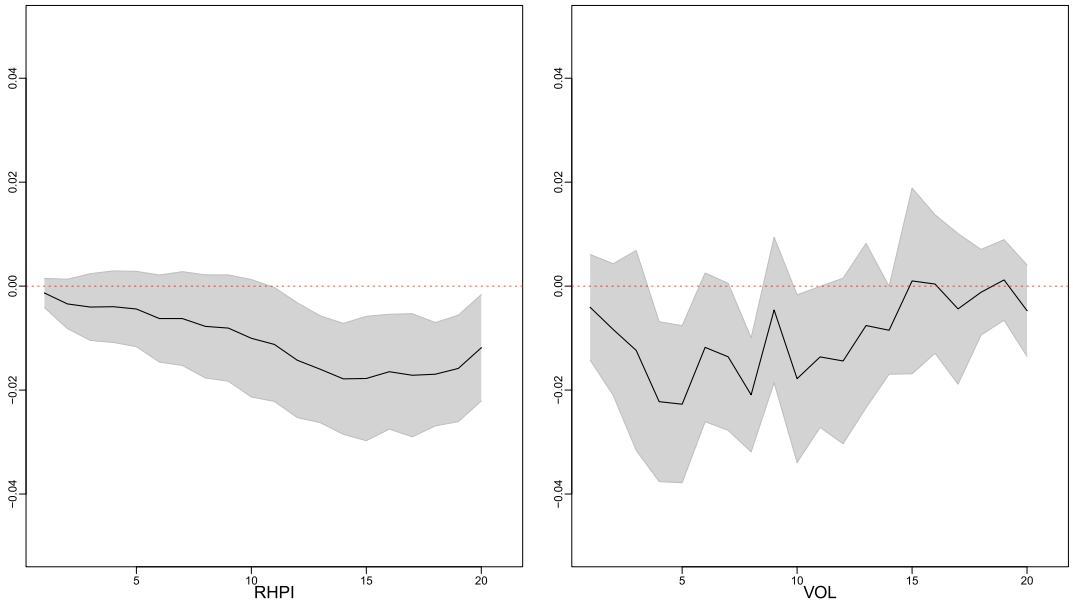
For sales volume we find that both the monetary policy shock and mortgage spread shock have a negative impact, but with a somewhat later response to the latter shock. Similar to both Hort (2000) and Oikarainen (2012), we find that the number of houses sold responds quicker than prices, peaking already in the first quarters after the monetary shock and after about four quarters for the mortgage spread shock. The explanations provided by Hort (2000) and Oikarainen (2012), which is in line with our results, is that sellers adjust their reservation prices and/or price expectations more slowly than buyers. Also the continuously rising housing prices and an increasing household indebtedness may have reinforced this effect. With high leverage, even a small percentage decline in housing prices, for example as a result of rising interest rates, can lead to lock-in effects. Sellers might demand a high price in order to be able to pay off their mortgage, which leads to buyers and sellers being unable to meet, resulting in fewer sales.

Figure 3. National responses to monetary policy and mortgage spread shocks

a) Monetary policy shock



b) Mortgage spread shock



Notes: The figure displays the national real house price (NAT) and number of houses sold (VOL) to monetary policy shocks *(a)* and mortgage spread shocks *(b)* obtained from LPs. The confidence interval in grey is the 95% interval calculated based on the Newey and West (1987) method.

It is also interesting to analyze the timing of the response in relation to findings in the existing literature. Oikarainen (2012) finds that transaction volumes in Finland respond more quickly to a user cost shock than those in Sweden do to an interest rate shock, as found by Hort (2000). In Oikarainen (2012), transaction volume reacts strongly within the same period as the shock

occurs, which the author partly attributes to the model allowing sales to react contemporaneously. However, even though our LPs in Figure 3 also allow for contemporaneous reactions, our results are more in line with those of Hort (2000).

5.2 Regional level

The results in Figure 4 *(a)* displays how the monetary policy shock affects the regional housing prices. In general, most regions seem to be significantly affected at or after the 5th quarter. STH has the sharpest decline to a monetary policy shock with a significant decline from 3 to 6 quarters after the shock. The response of STH diminishes with increasing horizons and reverts to its original level after about 15 quarters (4 years). Similar responses are observed also for the other regions, although the response appears to be more long-lasting in EMS, SMI and SSE.

In addition to STH, we also observe notable declines in housing prices for both SSE and WSE. These three regions have in common that they include Sweden's largest cities, Stockholm, Gothenburg, and Malmö. The fact that these three regions react strongly to a monetary policy shock is also in line with Yang et al. (2010), who observe the noticeable impacts of monetary policy primarily on metropolitan areas. These three regions are also those with highest household debt ratios (see, e.g., van Santen and Ölcer, 2017) and where housing prices have risen the most. Unlike Yang et al. (2010), we find that monetary policy also seems to have a significant impact on housing markets in regions outside metropolitan areas. For example, we observe large declines in both EMS and SMI as well as in the northern regions MN and UN. Our study differs in several ways from Yang (2010), which could possibly explain the discrepancy between our results. First, we differ in terms of methodology, with our study focusing on short-term rather than long-term dynamics. Secondly, we use a much more recent sample period, which is an important aspect to consider given that housing prices have risen rapidly throughout the country over the past two decades, possibly making all regions more sensitive to interest rate changes than before.

Figure 4 *(b)* shows the effects of a mortgage spread shock on housing prices. In line with Walentin (2014), we notice that a shock to the mortgage spread in general reduces the prices in all regions, although the effect is insignificant in some cases. In comparison to the monetary policy shock, the reaction to the mortgage spread shock appears to be slower and more gradual. The effect is largest for the metropolitan regions together with ENS and SME. Contrary to the

previous results, MN and UN are rather unaffected by the mortgage spread shock, and their responses are insignificant over all horizons. Hence, we observe larger regional heterogeneity in response to the mortgage spreads shock than to monetary policy.

So what can explain our results? A couple of possible explanations for regional dispersion in response to monetary policy shocks have been provided in the literature. Following the literature on supply constraints (see, e.g., Glaeser et al., 2005; Glaeser et al., 2008; Glaeser and Gyourko, 2018) both Fischer et al. (2021) and Aastveit and Anundsen (2022) argues that differences related to housing supply elasticities can explain dispersion across US regions. Our results from the monetary policy shock are somewhat, but not entirely, in line with such an explanation. According to this belief, we would expect prices in STH, SSE, and WSE to react the most, as these regions can be assumed to be the most supply-constrained[19]. However, this explanation is challenged by the fact that we also observe a strong reaction in the presumably more elastic regions MN and UN. On the other hand, the responses to the mortgage spread shock appear to be more in line with this explanation. Another theory provided by Margaris (2024), is that the level of housing affordability rather than housing supply elasticities could explain dispersion in regional housing prices to monetary policy shocks. The author argues that monetary policy expansions might not be enough to stimulate demand if housing prices are too unaffordable. However, this theory does not align well with our results. While Margaris (2024) finds the weakest response in the most unaffordable region (London), we find a strong response in regions that with the most expensive housing prices (STH, WSE, SSE). This does not, however, disprove the explanation provided in Margaris (2024), bit could rather suggest that

[19] Note that there are no published estimates of supply elasticities for the Swedish NUTS2 regions, but Stenvall (2024) has provided some preliminary estimates. These indicates that regions encompassing the largest cities have lower elasticities than, for example, the northern regions. According to Oikarainen et al. (2015), city size is negatively associated with the price elasticity of supply, which thus supports the view that the metropolitan NUTS2 regions should have lower elasticities. Other constraints, such as geography and land-use regulations, that have been highlighted in the literature as obstacles to construction are, however, difficult to analyze when it comes to such large areas as NUTS2. Sweden is a special case in the sense that many cities that are not limited by coast are instead limited by lakes. Geographical constraints are therefore not unique to coastal and/or major cities in the country. Regarding land use, it is also difficult to find suitable measures at the NUTS2 level. For example, the northern NUTS2 regions include large areas of protected natural land, but these are not predominantly located near the most densely populated cities (where demand for new housing would presumably be highest). Using proxy variables, such as the area of protected natural land, to estimate land use and/or elasticities is, in our view, not particularly appropriate for the NUTS2 regions in Sweden.

housing in Sweden is still affordable enough for interest rate changes to affect household demand.

Another potential explanation that fits quite well with our results is presented by Mabille (2023). According to this study, the level of house prices across regions plays a crucial role, with expensive cities tending to have a larger share of young households for which credit constraints are binding. As a result, Mabille (2023) argues that a tightening of national credit standards will have a greater impact on house prices in expensive regions than in cheaper ones. Just as the theory predicts, it is indeed in the more expensive cities that we observe the largest effects from both monetary policy shocks and the mortgage spread shock. The arguments presented in Mabille (2023) also offer a potential explanation for why the northern regions respond less to the mortgage spread shock compared to the monetary policy shock. From Figure 1, we observe that the mortgage spread shock series displays larger movements in the earlier part of the sample compared to the monetary policy shock series, for example around the dot-com crisis. At that time, house prices in the northern regions were still relatively low — and thus less binding.

In Figure 5, we present the regional responses for the sales dataset. From Figure 5 panel a), we notice a sharp and immediate decline in the number of houses sold mainly for STH and SSE to the monetary policy shock. However, the impact seems to be more gradual and persistent for other regions. For instance, the maximum impact for MN is reached after more than 15 quarters. Thus, the quick maximum impact found in the national results of Figure 3 seems to be driven mainly by the reaction of a few metropolitan regions. Moreover, we also note that the confidence intervals generally are broad, and some regions (e.g., NMS, UN, and SMI) only show statistically significant results at some single horizons.

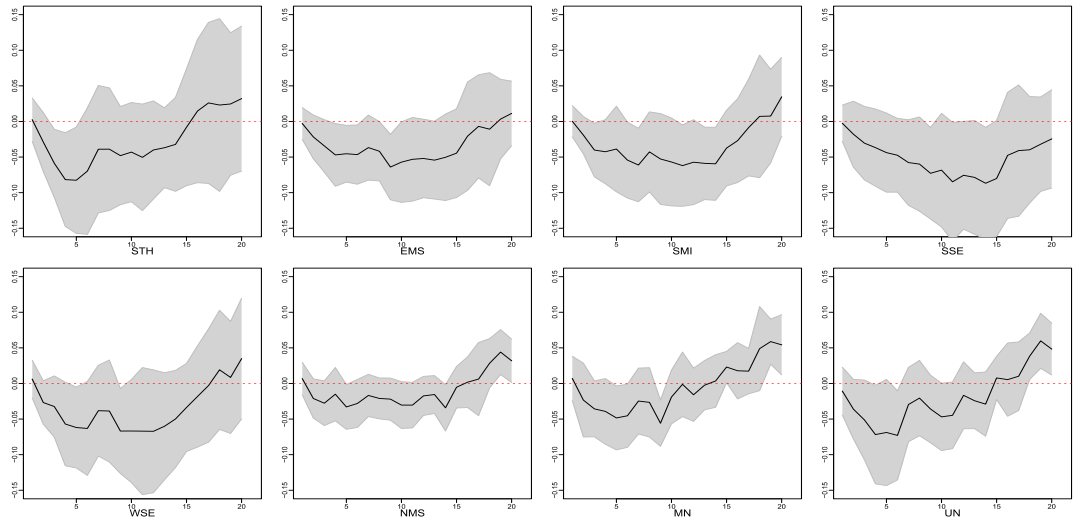
As regards the mortgage spread shocks in Figure 5 panel b), we find that the reaction is quite uniform across regions. The results show an initial decline in volumes in the first few quarters, followed by a gradual return to baseline. It is very difficult to explain in detail what this reaction might be due to, as the mortgage spread itself can be affected by many different factors[20]. We can only speculate about potential explanations behind the reaction. One potential explanation could be a general difficulty in obtaining a mortgage. Since the mortgage spread partly reflects

[20] For example, Walentin (2014) lists seven different factors that influence "mortgage spread innovations" in an American context, of which at least a majority can probably also be applied to Swedish conditions.

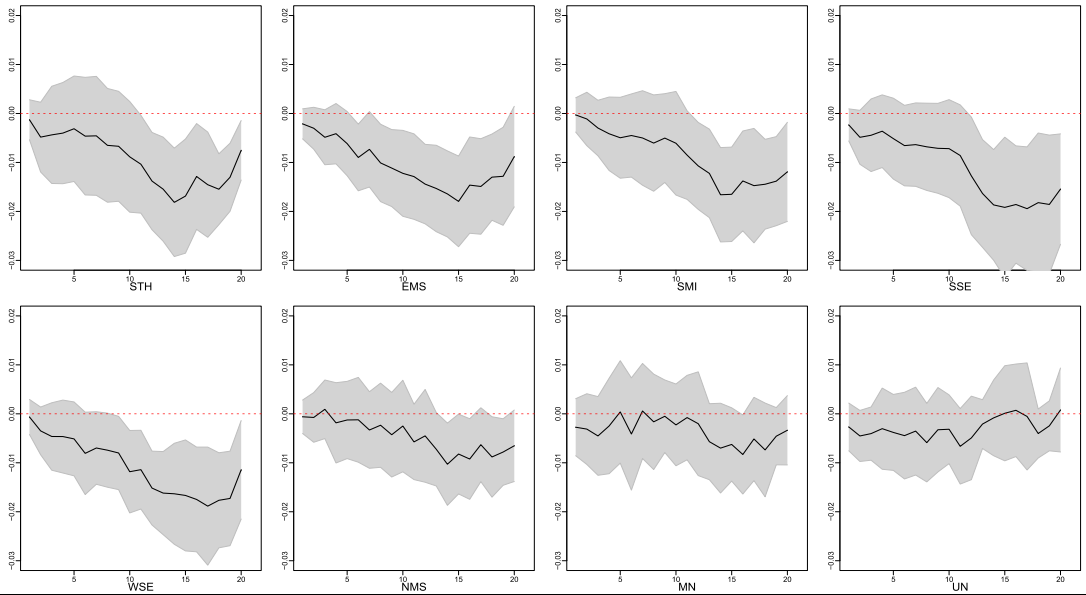
the risk premium in the mortgage market, a shock in the spread may be associated with temporary general credit tightening by banks towards households in all regions. Another potential explanation could be the general uncertainty (such as uncertainty about the labor market) that tends to prevail during times of stress in financial markets. This could possibly make households more hesitant to make major financial decisions and then postpone their potential home purchases.

Figure 4. Regional price responses to monetary policy and mortgage spread shocks

(a) Monetary policy shock



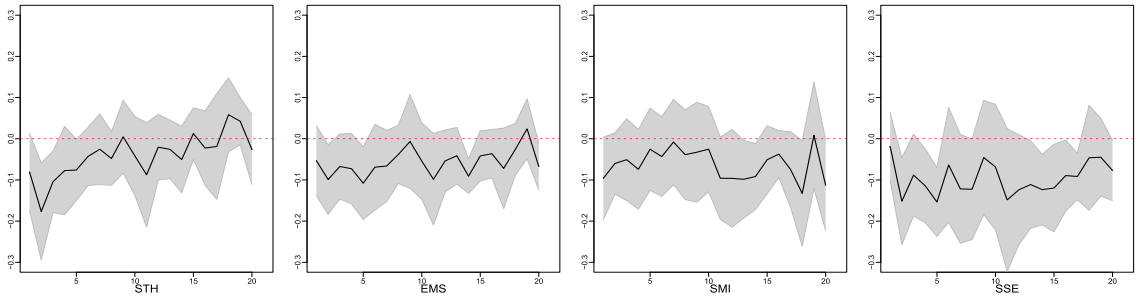
(b) Mortgage spread shock

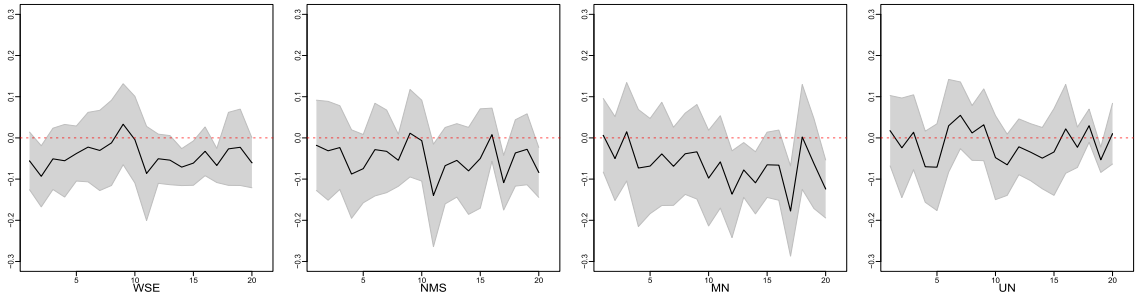


Notes: The figure displays the regional real house price responses to monetary policy shocks *(a)* and mortgage spread shocks *(b)* obtained from LPs. The confidence interval in grey is the 95% interval calculated based on the Newey and West (1987) method.

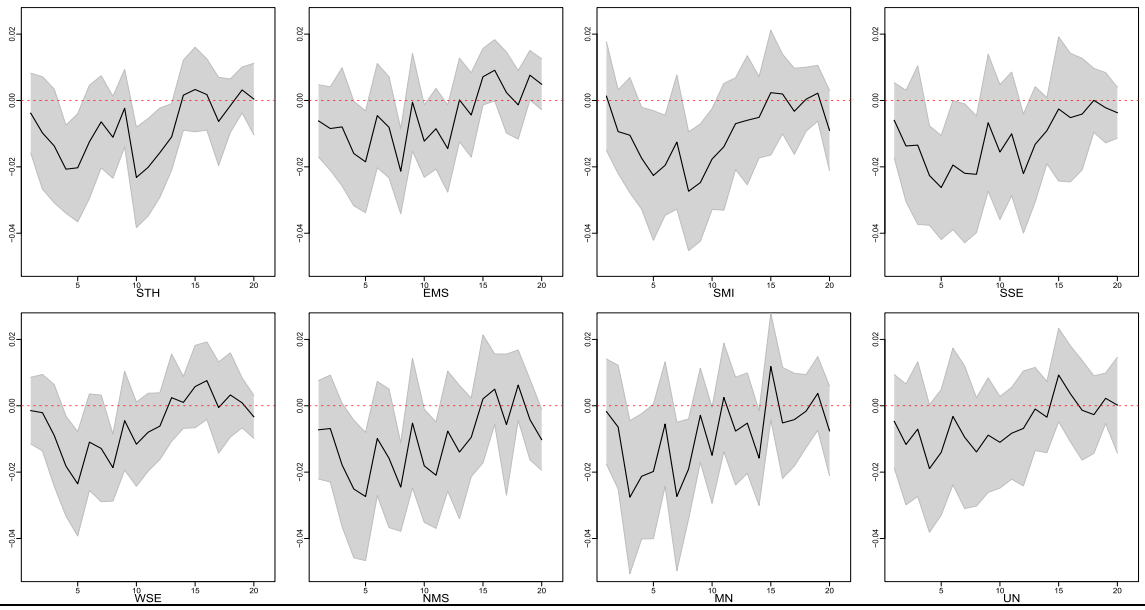
Figure 5. Regional responses of housing sales volumes to monetary policy and mortgage spread shocks

(a) Monetary policy shock





(b) Mortgage spread shock



Notes: The figure displays the regional number of houses sold (VOL) to monetary policy shocks *(a)* and mortgage spread shocks *(b)* obtained from LPs. The confidence interval in grey is the 95% interval calculated based on the Newey and West (1987) method.

5.3 Robustness checks

To assess the robustness of the results, we provide a battery of robustness checks. We also conduct more robustness-tests and additional analysis that we include solely in the appendix. In this section, we focus on the results for house prices, as these are likely to be more sensitive to the model specification considering that they are non-stationary without any further corrections. In the first robustness check, we follow Pizzuto (2020) by including a spatial lag as a control variable in our LP-estimations. The spatial lag has been constructed based on a weight matrix that assigns zero weight to regions that do not have geographical boundaries, and equal weight to neighboring regions price indices. To avoid any form of simultaneity between the shock and these spatial price indices, we include the spatial lag (like the other control variables) lagged one additional period (i.e., $t-1$) as compared to the shock (t). In the second robustness check, we use a long-difference approach (see e.g., Jordà and Taylor, 2025). This method calculates the change from a baseline period to the k:th period, thereby capturing the cumulative change between the periods. In our case, we use this approach to explain the cumulative change in the log real house price indices. Consequently, it offers complementary perspectives on the findings in the previous section. In a third robustness check, we deviate from the pre-identified shocks by estimating small-scale VAR-models. In the monetary policy VAR models, we use three national-level variables (GDP, CPIF and the policy rate) and a regional house price series[21]. In the mortgage spread VAR models, we use the same national-levels variables but also include the mortgage spread, ordered before the policy rate in system. Hence, the impulse variable is the policy rate in a) and the mortgage spread in b). Reginal housing markets are assumed not to affect the national-level variables, and the models are therefore estimated with block exogeneity restrictions. Housing prices are treated as fast moving and therefore placed last in the VAR system. We use two lags in the VAR-system and identified using Cholesky decomposition. Using Generalized Least Squares (GLS), we estimate the VAR models with two lags and identify the shocks using a Cholesky decomposition.

The results from these estimations are displayed in Figure 6. To save space, we only report the IRFs without confidence bands, but complementary results are available in the appendix, Figures A1 to A4. In all specifications, the response to policy rate shocks in Figure 6a displays clear heterogeneity across regions. Starting with the spatial specification in (i), the relative responses do not change much compared to the baseline results in Figure 4. However, we notice

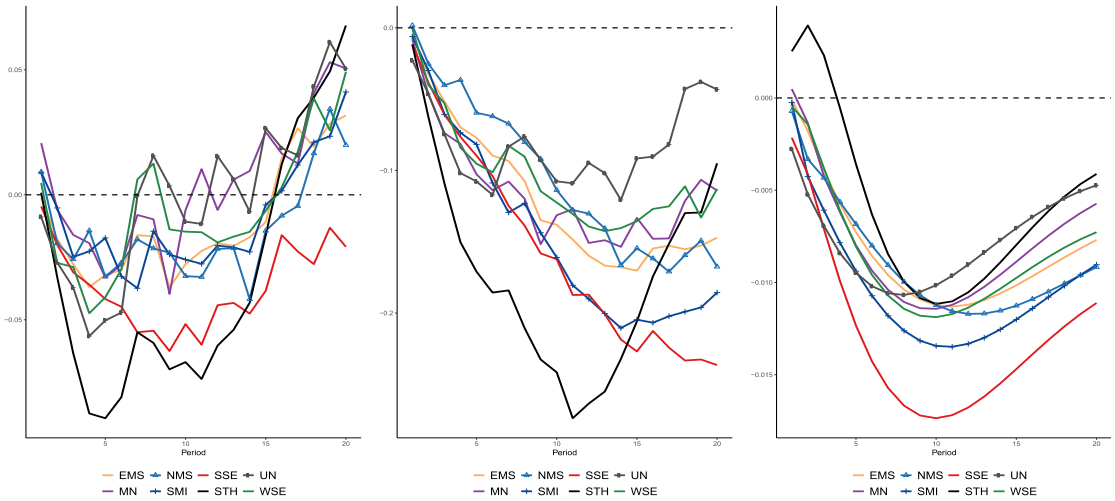
some noteworthy difference. We find a somewhat smaller response of the SSE region than before, although it still exhibits a large negative response, second only to Stockholm. Another difference is the response of WSE, that now displays a less persistent pattern. Looking at the long-difference specification in (2), STH and SSE again show greater sensitivity than the other regions. Other regions also respond, but the effect is particularly pronounced in STH, EMS, SMI and SSE where the housing markets are larger. The effect on UN, which was quite large in the previous baseline estimates and earlier robustness check, however, now shows a lower sensitivity than before and responds more in line with what we expect from the theory of supply elasticities. However, unlike the other two metropolitan areas, we find a weak response for WSE. The effect of a monetary policy shock identified using a simple Cholesky decomposition, as shown in (3), also delivers results in line with our previous findings. Although STH reacts somewhat less, we instead find a larger effect on WSE than in (2). We can thus conclude that metropolitan areas seem to react more strongly to monetary policy shock, although the effect is not economically insignificant for other smaller regions.

As regards to the mortgage-spread shock in Figure 6b, the results align with the baseline in some respects, but some regions exhibit distinct responses. In particular, we see that the reaction for SSE has been dampened compared to the baseline model in two of three robustness checks. The MN region also stands out with a stronger reaction than before. In both i) and iii), however, it is still metropolitan regions that tend to react most strongly to a mortgage spread shock. However, this tendency is, in contrast to what we found for the monetary policy shock, somewhat weakened in this robustness check.

Figure 6. Regional price responses to monetary policy and mortgage spread shocks with alternative model specification

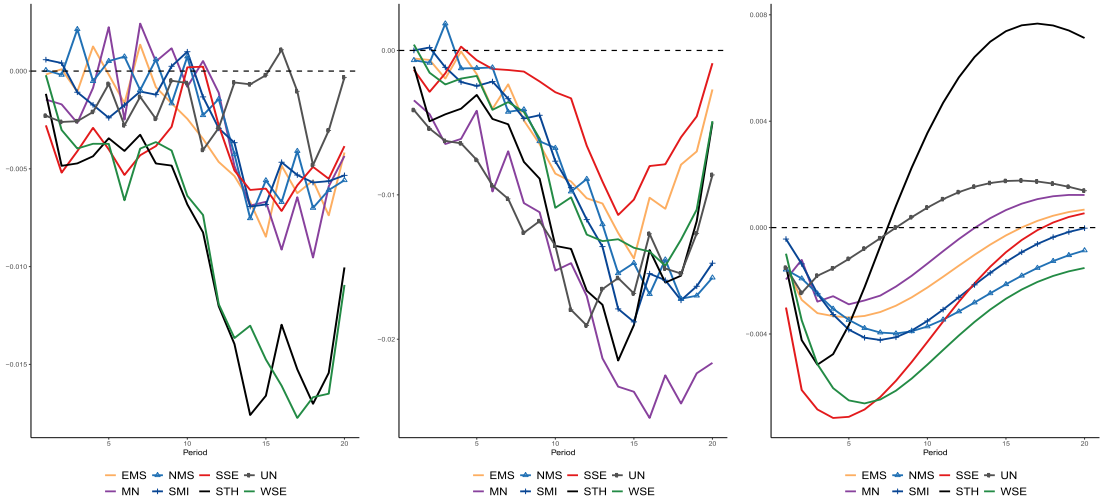
a) Monetary policy shock

i) Spatial lag *ii) Long-difference* *iii) VAR*



b) Mortgage spread shock

i) Spatial lag *ii) Long-difference* *iii) VAR*



Notes: The figure displays the response of regional house prices to monetary policy shocks *(a)* and mortgage spread shocks *(b)* obtained from LPs. In i), we estimate the baseline specification in Eq. 1, but include spatial lags as controls. In ii), we use a long-difference specification (see e.g., Jordà and Taylor, 2025). iii) is based on small-scale VAR models with block exogeneity restrictions, with the impulse variable is the policy rate in a) and the mortgage spread in b).

5 Conclusion

This study analyzes the impact of monetary policy and mortgages spreads on the Swedish housing markets, both at the national and the regional level. This paper builds on the results from Walentin (2014) that studied mortgage spread on aggregate macro variables, with this

study extending the analyses for regions and uses a high-frequency policy rate shock series, and by studying regional markets using local projections. Hence, this study contributes with new knowledge about the regional dynamics of the housing market in Sweden.

The monetary policy shock has a negative impact on housing prices and housing transactions, and unlike Yang et al. (2010) we find that the policy rate shock impacts all Swedish regions. The effects are more pronounced immediate effect in the Stockholm region and more muted and delayed response in the smaller regions, which can be explained by a higher loan-to-value ratio, combined with high net migration and strong income growth - factors that have been identified as price drivers in previous studies. The mortgage spread shocks show delayed effect from the impulse response results, however, other model specification show similar directional results and overall trend but have lower magnitudes. Thus, for some regions the mortgage spread shocks sometimes becomes insignificant using different model specifications. However, both mortgage-spread shocks have an immediate effect that lower transaction volumes.

This gives a signal for policymakers that evaluating the policy rate impact to not only focus on the short term impact of the Stockholm region but also take into account the more persistent effects in other regions. Furthermore, mortgage rate shocks is more important to consider in tighter housing market regions with higher prices and indebtedness, such as the metropolitan regions.

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