VILNIUS UNIVERSITY
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Bachelor Thesis

MONETARY POLICY EFFECTS ON REAL ESTATE PRICES IN LITHUANIA

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Vilnius, 2024

MONETARY POLICY EFFECTS ON REAL ESTATE PRICES

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Bachelor Thesis

Quantitative Economics programme

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Supervisor - PhD Žymantas Budrys

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Summary

38 pages, 10 pictures, 1 table, 14 references.

The primary objective of this thesis is to investigate the impact of unbiased monetary policy shocks on house prices in Lithuania from 2006 to 2020. This study is relevant given the significant role housing markets play in economic stability. The thesis is structured into four main parts: literature review, methodology, results, and conclusions with recommendations.

The literature review provides a comprehensive overview of existing research on the relationship between monetary policy and house prices. It examines various theoretical approaches and empirical findings, including the transmission mechanisms of monetary policy and the significance of regional differences in these effects.

The methodology section outlines the use of local projections to estimate impulse response functions (IRFs), allowing detailed analysis of the dynamic causal effects of monetary policy shocks on house prices over time. This approach provides insights into both short-term and medium-term impacts. Additionally, the section presents and discusses the data used in the analysis, including the transformations done to the data.

The results indicate that contractionary monetary policy significantly reduces house prices in Lithuania, with a decrease of around 5% six months after the shock and a peak decline of nearly 17% at fifteen months. Additionally, there is notable cross-city heterogeneity, with Klaipėda experiencing more pronounced declines compared to Vilnius and Kaunas, highlighting the need for regional considerations in policymaking. Finally, the trade-off between controlling house prices and maintaining economic growth is discussed.

The conclusions and recommendations confirm that monetary policy has a significant impact on house prices in Lithuania and highlight the importance of incorporating regional heterogeneity into policy decisions. These findings provide valuable insights for policymakers aiming to manage housing market stability and mitigate economic disruptions.

PINIGŲ POLITIKOS POVEIKIS NEKILNOJAMO TURTO KAINOMS LIETUVOJE

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Bakalauro baigiamasis darbas

Kiekybinė ekonomika

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Vadovas - Dr. Žymantas Budrys

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Santrauka

38 puslapiai, 10 paveikslų, 1 lentelė, 14 literatūros šaltinių.

Šio darbo pagrindinis tikslas - ištirti nešališkų pinigų politikos šokų poveikį nekilnojamojo turto kainoms Lietuvoje 2006–2020 m. Šis tyrimas yra svarbus dėl reikšmingos būsto rinkų įtakos ekonominiam stabilumui. Disertacija suskirstyta į keturias pagrindines dalis: literatūros apžvalgą, metodologiją, rezultatus ir išvadas su rekomendacijomis.

Literatūros apžvalgoje pateikiama išsami esamų tyrimų apie pinigų politikos ir būsto kainų sąryšį apžvalga. Nagrinėjami įvairūs teoriniai požiūriai ir empirinės išvados, įskaitant pinigų politikos veikimo mechanizmus ir regioninių skirtumų svarbą.

Metodologijos skyriuje aprašomas vietinių projekcijų naudojimas impulsų atsako funkcijų (IRF) įvertinimui. Šis metodas leidžia analizuoti dinaminius priežastinius pinigų politikos šokų poveikius būsto kainoms per tam tikrą laiką. Metodas padeda suprasti trumpalaikius ir vidutinio laikotarpio poveikius. Be to, skyriuje pateikiami ir aptariami duomenys, naudojami analizėje, įskaitant duomenų transformacijas.

Rezultatai rodo, kad kontrakcinė pinigų politika ženkliai sumažina būsto kainas Lietuvoje. Kainos sumažėja apie 5% per šešis mėnesius po sukrėtimo, nuosmukis padidėja iki beveik 17% per penkiolika mėnesių. Taip pat pastebimas reikšmingas miestų heterogeniškumas: Klaipėdoje matomas ryškesnis kainų sumažėjimas nei Vilniuje bei Kaune, tai parodo regioninių aspektų svarbą pinigų politikos formavime. Galiausiai aptariamas sąryšys tarp būstų kainų kontrolės ir ekonominio augimo.

Išvados ir rekomendacijos patvirtina, kad pinigų politika turi reikšmingą poveikį būsto kainoms Lietuvoje, pabrėžiama regioninio heterogeniškumo svarba priimant pinigų politikos sprendimus. Šios išvados suteikia vertingų įžvalgų pinigų politikos formuotojams, siekiant palaikyti būsto rinkos stabilumą ir mažinti ekonominių sutrikimų poveikį.

CONTENTS

INTRODUCTION

Understanding the impact of monetary policy on house prices is crucial for both policymakers and the broader economy. This importance is highlighted by historical events such as the Great Financial Crisis, where housing market dynamics played a significant role. During this crisis, the collapse of the housing bubble led to a severe economic downturn, emphasising the need for better insights into the relationship between monetary policy and the housing market. More recently, the period following 2020 has seen interest rates surge to levels not observed in years, driven by efforts to combat inflation that spiked after extensive quantitative easing during the COVID-19 pandemic. Initially, central banks lowered interest rates to support economic activity and mitigate the impact of the pandemic, leading to an environment of low borrowing costs and increased liquidity. However, as inflationary pressures mounted, a contractionary monetary policy was adopted, raising interest rates significantly. This shift impacts housing affordability through higher mortgage rates, particularly in regions like Lithuania where fixed-rate mortgages are rare. This study focuses on Lithuania, where the prevalence of adjustable-rate mortgages increases sensitivity to interest rate changes, making it an important context for examining the effects of monetary policy.

This study aims to quantify the impact of monetary policy on house prices in Lithuania. Similar analyses have been conducted for the U.S. and Euro area countries, highlighting regional differences in the transmission of monetary policy effects (Albuquerque et al., 2024; Andaloussi et al., 2024; Gorea et al., 2022). For instance, in regions with predominantly fixed-rate mortgages, the immediate impact of interest rate changes is mitigated, unlike in regions where adjustable-rate mortgages are more common (Garriga et al., 2017). By examining these effects in Lithuania, my thesis contributes to the broader understanding of how monetary policy influences housing markets in different economic contexts. Additionally, I explore cross-city heterogeneity within Lithuania, analysing how monetary policy impacts house prices in different cities, adding a regional dimension to the analysis which is widely discussed in the existing scietific literature (Altavilla et al., 2019; Garriga et al., 2019).

The primary objective of this study is to quantify how monetary policy affects house prices in Lithuania. To achieve this, I employ monetary policy shocks developed by Jarociński and Karadi (2020). These shocks are constructed to be free from the biases typically associated with standard interest rate measures, providing a more accurate representation of policy changes. Jarociński and Karadi (2020) achieve this by isolating the unexpected components of monetary policy announcements. They do so by disentangling monetary policy shocks from central bank information shocks

using high-frequency co-movements of interest rates and stock prices, thereby excluding information effects that might otherwise contaminate traditional interest rate measures. These shocks serve as an instrument for the Euribor rate, addressing potential endogeneity issues and helping to isolate the causal impact of monetary policy changes on house prices.

In terms of methodology, I utilise local projections to estimate impulse response functions (IRFs), a technique popularised by Jordà (2005). IRFs allow us to trace the dynamic effects of monetary policy shocks on house prices over time, providing a clear picture of the short-term and medium-term impacts. This method is particularly useful for understanding causal relationships in economic data, as it accommodates various model specifications and assumptions, ensuring robust and flexible estimates. The local projection method is advantageous because it does not impose a strict structure on the data, allowing for more flexible and reliable estimates of dynamic responses to shocks.

However, there are several limitations to my analysis. Firstly, data limitations restrict the analysis to the period starting from 2006, as house price index data for Lithuania is unavailable for earlier years. Additionally, the analysis excludes the COVID-19 period to avoid distortions caused by the pandemic's unprecedented economic impact, limiting the analysis period from 2006 to 2020. Another challenge is the varying horizons of the local projections, while most IRFs estimate effects over 36 months, some projections are limited to 32 months due to interpretability issues. Furthermore, the wide confidence intervals of the projections indicate reduced significance, making it challenging to precisely estimate the magnitude of the effects of monetary policy shocks. Consequently, while the projections show statistically significant decreases in house prices, the exact magnitudes remain uncertain.

This thesis is structured as follows: a literature review provides an overview of existing research on monetary policy and its impact on real estate prices, covering studies conducted in various regions, including the U.S. and Euro area. Following this, the methodology section details the data and methods used in the analysis. The results section presents and discusses the empirical findings, comparing different models, including the baseline OLS model and the improved IV model to ensure robustness. Finally, the thesis concludes with a discussion of the implications of the results and recommendations for policymakers, emphasising the importance of understanding regional differences in the transmission of monetary policy effects and making future research suggestions.

1 LITERATURE REVIEW

The impact of monetary policy on real estate prices is an important issue in economic research because of its impact on economic stability. In this section, I present and analyse existing research on this subject. This section explores various theoretical approaches and empirical results to understand how monetary policy affects not only real estate markets but also macroeconomic variables and the overall financial well-being of an economy.

The analysis includes examining the immediate and long-term effects of monetary policy shocks on real estate prices. It discusses the channels through which these effects are transmitted, such as interest rate changes and housing supply constraints. Additionally, this review highlights regional variations and their role in the transmission of monetary policy.

By reviewing the findings from various researchers, this section highlights both agreements and differences in their conclusions. The main goal of this section is to provide a clear and structured overview of the literature, discuss the strengths and caveats of different perspectives, and offer a reasoned view on the topic based on the evidence presented in the existing research.

1.1 Rapid Response to Monetary Policy Surprises

In the analysis by Gorea et al. (2022), the researchers examine the high-frequency causal relationship between interest rates and house prices in the United States, using a dataset that comprises residential property listings between 2001 and 2019. They find that an unexpected increase in the average 30-year mortgage rates by 0.25 percentage points results in a 1% reduction in housing list prices within two weeks of a monetary policy announcement. This immediate effect largely continues to be felt in sale prices and maintains its influence for at least one year, showing both the immediate and medium-term impact of monetary policy on real estate valuations.

The findings provide valuable insights into the relationship between monetary policy and the real estate market, challenging the notion that the impact of interest rate changes on house prices is gradual and takes years to materialise. Instead, this paper finds a more immediate and considerable effect. Moreover, the paper suggests that list prices, more so than sale prices, can offer an accurate criterion for estimating house price reactions to monetary policy shifts, providing policymakers with a more immediate measure of the impact of their decisions.

1.2 Different Types of Monetary Policy Shocks

In their analysis, Jarociński and Karadi (2020) explore the two components of monetary policy surprises: policy actions and central bank information shocks. The paper's approach is innovative as it demonstrates distinct impacts on the financial markets of these two elements. The authors use a high-frequency structural vector autoregression (SVAR) to analyse the simultaneous movements of interest rates and stock prices around policy announcements. This methodology reveals that while a typical monetary policy tightening predictably depresses stock prices due to higher discount rates and dimmer economic prospects, an accompanying central bank information shock can paradoxically elevate stock prices if the central bank's assessment of the economy is positive.

Jarociński and Karadi (2020) find that monetary policy non-neutrality, a long-debated issue in macroeconomics, can be significantly biased if these information shocks are overlooked. The paper illustrates how traditional views on the effects of monetary policy on asset prices need to account for the roles of information shocks. These shocks, which have independent macroeconomic significance, suggest that the central bank's communication does more than just clarify policy stances — they affect market expectations and economic forecasts. Furthermore, in my thesis, I will incorporate monetary policy shocks obtained from the paper by Jarociński and Karadi (2020). These shocks are intended to capture the pure monetary policy component, I will use them to provide an unbiased measure of how unexpected changes in monetary policy affect the real estate prices.

1.3 Monetary Policy Impact on Macroeconomic Outcomes

Romer and Romer (2023) look into the historical impacts of monetary policy using a narrative analysis method. Using this approach, they examine qualitative sources, such as government records and news articles, to establish causal relationships between monetary policy and macroeconomic outcomes like unemployment, output, and inflation. Their approach deepens our understanding of the dynamic responses of markets, like housing, to changes in policy, revealing the relationship between policy decisions and economic development. The study explores the long-lasting effects of contractionary monetary policy, showing that these shocks can significantly increase unemployment and decrease output.

Building on the insights from Romer and Romer (2023) regarding the enduring impacts of monetary policy on macroeconomic indicators like unemployment and output, Williams (2015) elaborates on the direct effects of monetary policy on housing markets. He finds that monetary

policy actions have sizable and significant effects on house prices in advanced economies. The author notes that increasing interest rates results in a noticeable decrease in real house prices, however, this comes with a cost of reductions in real GDP and inflation.

Ramey (2016) explores the effects of monetary policy shocks, on macroeconomic outcomes. Her insights provide a deeper understanding of how monetary policy shocks influence key economic variables such as unemployment and output over time, offering valuable perspectives for policymakers on the potential long-term impacts of their decisions. The author's main findings include:

- **Impact on Unemployment and Output**. Contractionary monetary policy shocks lead to increased unemployment and reduced output, aligning with the findings of Romer and Romer (2023).

- **Timing and Persistence**. The timing and persistence of shocks are critical in understanding their full impact on the economy. The author points out that to asses the full economic impact of shocks, it is necessary to analyse their longer-term effects.

1.4 Housing as a Channel for Monetary Policy Transmission

Andaloussi et al. (2024) investigate how monetary policy affects housing markets and find that housing plays a crucial role in transmitting monetary policy shocks to the economy. In particular, house prices can amplify the effects of monetary policy on output due to their influence on consumption through wealth effects and their role in collateral constraints.

- **Wealth Effects**. When house prices increase due to expansionary monetary policy, homeowners feel wealthier, which may lead them to increase their consumption. On the other hand, a decline in house prices can result in reduced consumption due to the perceived decrease in wealth.

- **Collateral Constraints**. House prices also affect borrowing capacity. Higher house prices increase the value of collateral, enabling homeowners to borrow more against their property. This can stimulate investment and consumption, especially for financially constrained households. When monetary policy tightens, resulting in a decline in house prices, borrowing capacity decreases, which can reduce overall economic activity.

Andaloussi et al. (2024) use theoretical and empirical tools to show how house price fluctuations can alter monetary policy's effects. The authors use structural vector autoregression (SVAR)

analysis to identify the direct effects of monetary policy shocks on housing prices and their impact on output and consumption. Their main findings include:

- **Impact of Monetary Policy Shocks**. Expansionary monetary policy leads to higher house prices and increased consumption, while contractionary policy decreases both.
- **Asymmetric Effects**. The response of house prices and economic activity to monetary policy shocks may not be symmetrical. Contractionary shocks often lead to higher declines in house prices compared to the increases seen with expansionary shocks.
- **Regional Variations**: Different regions experience varying effects of monetary policy shocks due to differences in housing supply constraints, regulatory environments, and local economic conditions.

1.5 Euro Area Monetary Policy and Its Impact

Altavilla et al. (2019) examine euro-area monetary policy shocks and their impact on economic activity. They utilise a variety of models, including high-frequency identification methods, to isolate the effects of monetary policy surprises. Their findings include:

- **Impact of Easing Monetary Policy**. An unexpected easing of monetary policy significantly reduces mortgage rates, leading to an increase in house prices.
- **Unconventional Policies**. Unconventional monetary policies such as quantitative easing (QE) have a strong influence on real estate markets, stimulating housing demand through lower mortgage rates.
- **Heterogeneity Across Countries**. The impact of monetary policy shocks varies across euro-area countries, reflecting differences in mortgage markets, housing supply elasticity, and financial systems. Their research emphasises the importance of considering heterogeneity across euro-area countries when designing and implementing monetary policy.

1.6 Heterogeneity in the Transmission of Monetary Policy

Monetary policy shocks have varying impacts among different regions (Altavilla et al., 2019; Andaloussi et al., 2024). Understanding regional disparities in the impacts of monetary policy on real estate markets is crucial for designing effective economic interventions. Battistini et al. (2023) use a structural panel VAR approach to explore how both conventional and unconventional monetary policies influence economic activity and house prices across various Euro area

regions. Their findings highlight significant variations in monetary policy effects - regions with lower labour income and higher homeownership rates show more noticeable responses.

This heterogeneity aligns with findings from Gorea et al. (2022), who analyse the immediate impacts of monetary policy on real estate markets. They find that house prices primarily react to modifications in the anticipated future rates rather than unexpected variations in the federal funds rate. The price adjustments are particularly noticeable in areas with lower household incomes or house values, suggesting an increased sensitivity among financially constrained buyers and sellers to interest rate changes. Moreover, these price responses are not uniform but are heterogeneous across different regions, noting the need to consider regional economic conditions and housing market features when estimating the outcomes of monetary policy actions.

Similarly, Albuquerque et al. (2024) contribute to this discussion by emphasising the housing supply channel in monetary policy transmission, particularly under unconventional measures. The study also stresses the importance of considering regional housing market characteristics when assessing the outcomes of monetary policy interventions.

Additionally, the work by Garriga et al. (2019) should be mentioned here as they explore the macroeconomic impacts of monetary policy on housing markets with a focus on the cyclicality of housing demand and supply factors across different regions. Their research supports the idea that regional economic conditions highly influence the effectiveness of monetary policy in real estate sectors. These insights suggest a need for policymakers to consider regional economic disparities and housing market dynamics. This focus on regional disparities is essential for policymakers aiming to achieve balanced economic growth and stability across all areas of the Eurozone.

1.7 Monetary Policy and Mortgage Dynamics

Changes in interest rates significantly affect borrowing conditions, influencing demand and prices in the housing market (Garriga et al., 2017). This interaction highlights the need to consider the condition of mortgage markets when assessing the influence of monetary policy on housing as this is one of the main channels through which monetary policy affects housing demand and prices.

Complementing this perspective, Bhutta and Ringo (2021) investigate how a reduction in mortgage insurance premiums, affects home buying. Their study shows that a 50 basis point decrease in the Federal Housing Administration's (FHA) mortgage insurance premiums results in a 14% increase in home purchases among FHA-reliant individuals. The easing of debt-to-income (DTI) constraints (because of lower premiums) allows more potential buyers to qualify for home

financing.

Moreover, unconventional policy measures like quantitative easing affect mortgage financing conditions, therefore, influencing housing demand and prices (Altavilla et al., 2019). As previously stated, one of the authors' key results is that an unanticipated relaxation of monetary policy dramatically lowers mortgage rates, resulting in a rise in housing values.

1.8 Monetary Policy and Financial Stability

A paper by Jordà et al. (2015) analyses the long-term effects of monetary conditions on housing markets and their impact on financial crises. Their analysis, spanning 140 years and 14 advanced economies, demonstrates that loose monetary conditions lead to surges in real estate lending and house prices. Using instrumental variables, their research highlights how periods of easy monetary policy are strongly correlated with the formation of housing bubbles, which significantly increase the risk of financial crises.

The findings suggest a need for macroprudential tools to mitigate the risks associated with prolonged periods of low interest rates, which can result in bubbles in real estate markets. Central banks are challenged to consider the broader implications of their policy settings on financial stability, weighing the benefits of stimulating economic activities against the potential risks of causing financial vulnerabilities. Findings of Williams (2015) complement this study by quantifying the economic trade-offs involved.

While higher interest rates generally lead to lower house prices, which can help stabilise housing markets, these actions come with notable economic costs. Specifically, a 1 percentage point increase in interest rates is associated with a reduction in real house prices by over 6% and a nearly 2% decline in real GDP per capita over two years (Williams, 2015). This substantial economic impact emphasises the trade-offs that policymakers face when using monetary policy to address fluctuations in housing markets.

2 RESEARCH METHODS AND DATA

In this section, I outline the methodologies used to evaluate the causal effects of monetary policy on real estate prices in Lithuania. The primary aim of this research is to analyse the implications of monetary policy decisions on the national housing market. Specifically, I utilise local projections to estimate impulse response functions (IRFs), which calculate the dynamic responses of housing prices to monetary policy shocks (Jordà, 2005). This section details the use of both Ordinary Least Squares (OLS) and Two-Stage Least Squares (2SLS) methods for estimating IRFs. Additionally, the section covers the basic visual representations I used to begin analysing the data. Finally, it discusses the necessary transformations to achieve stationarity in data and the statistical tests employed to validate the robustness of the stationarity.

2.1 Impulse Response Functions

I employed linear impulse response functions (IRFs) to analyse causal effects and make inferences about how monetary policy affects real estate prices. Firstly, I tried applying the Ordinary Least Squares (OLS) method to estimate these functions. OLS is a standard approach in regression analysis that minimises the sum of the squared differences between the observed and predicted values, ensuring the best linear unbiased estimates. I used local projections, a method popularised by Jordà (2005), to estimate and plot these IRFs. The method involves conducting a series of regressions on an outcome variable over multiple horizons h. The model can be written as follows:

$$\ln P_{t+h} = \beta^h \text{MP\_Shock}_t + \sum_{i=1}^{12} \gamma_i^h \ln P_{t-i} + \sum_{j=1}^{12} \delta_j^h \text{Controls}_{t-j} + \epsilon_t^h, \tag{1}$$

where $\ln P_t$ represents the natural logarithm of the housing price index in Lithuania at time t, *MP_Shock*$_t$ is the monetary policy shock variable from (Jarociński & Karadi, 2020), $\ln P_{t-i}$ are the natural logarithms of the lagged housing price index values. The control variable *Controls*$_{t-j}$ includes the first difference of unemployment and the natural logarithm and the first difference of industrial production, with industrial production serving as a proxy for GDP.

- β^h coefficient measures the effect of monetary policy shocks,
- γ_i^h are the coefficients for the lagged housing price index values, capturing the influence of past housing prices,

- δ_j^h are the coefficients for the control variables, accounting for other economic factors that may affect housing prices.

- ϵ_t^h is the error term.

The model includes 12 lags for monthly variables, both the housing price index and the controls, which is common in the literature to capture the dynamic effects over time (Andaloussi et al., 2024; Jarociński and Karadi, 2020; Romer and Romer, 2023). This choice is consistent with other studies that use different lag lengths based on the data frequency, which still amounts to one year, such as 4 lags for quarterly data (Romer & Romer, 2023) or 52 lags using weekly data (Gorea et al., 2022).

By estimating the IRFs, we can observe how a shock to monetary policy impacts housing prices over time. Using exogenous variables such as industrial production and unemployment as controls helps isolate the effect of monetary policy shocks on housing prices, accounting for other economic factors that may influence the results.

2.2 Impulse Responses Functions with an Instrument

Here I present another method I employed in my analysis to estimate impulse response functions (IRFs) using an instrumental variable (IV). The IV approach, specifically Two-Stage Least Squares (2SLS), is used to address potential endogeneity issues that may arise in the OLS estimates.

In this approach, I use monetary policy shocks as an instrument for the Euribor 12-month rate. This allows to isolate the exogenous variation in the Euribor rate that is driven by monetary policy shocks, providing a clearer view of its impact on housing prices.

The 2SLS method involves two stages. In the first stage, the Euribor 12-month rate is regressed on the monetary policy shocks to obtain the predicted values. In the second stage, these predicted values are used in place of the Euribor 12-month rate to estimate the final model. The model for estimating IRFs using 2SLS can be written as follows:

$$\ln P_{t+h} = \beta^h \widehat{\text{Euribor}}_t + \sum_{i=1}^{12} \gamma_i^h \ln P_{t-i} + \sum_{j=1}^{12} \delta_j^h \text{Controls}_{t-j} + \epsilon_t^h, \tag{2}$$

where $\widehat{Euribor}_t$ is the predicted value of the Euribor 12-month rate obtained from the first stage regression using the monetary policy shocks as an instrument,

The IV approach, particularly the use of 2SLS, allows for the estimation of causal effects by mitigating biases arising from endogeneity. By using predicted values of the Euribor 12-month

rate in the second stage, this method obtains more reliable estimates of the impact of monetary policy on housing prices.

The use of instrumental variables is well-documented in the literature for addressing endogeneity in time series analysis (Gorea et al., 2022; Jarociński and Karadi, 2020). This approach is particularly relevant in the context of monetary policy shocks, where exogenous instruments can help isolate the causal impact on real estate prices.

2.3 Data Collection

The data I used in this analysis were collected from various sources. All data are in monthly frequency, spanning different periods depending on the variable. The primary variables include the housing price index for Lithuania and several cities within Lithuania, which is our main variable of interest [1]. This index represents house prices in Lithuania for repetitive transactions and was obtained from the Bank of Lithuania website. Due to the limited availability of Lithuanian data, the index only covers the period from January 2006 to March 2024[2], however, this should be sufficient for the analysis. Monetary policy shocks were obtained from the study by Jarociński and Karadi (2020). Additionally, I included the Euribor 12-month rate mainly for instrumental variable analysis, where monetary policy shocks were used as an instrument for the Euribor rate, and this data was obtained from the European Central Bank Data Portal. While the Euribor rate alone might seem sufficient for analysing the impact of monetary policy on real estate prices, it may be endogenous, leading to biased results. Therefore, monetary policy shocks are utilised to achieve unbiased results, even if they appear less smooth.

Moreover, industrial production data for Lithuania which I used as a proxy for GDP due to the quarterly frequency of GDP data, is seasonally adjusted to remove the effects of seasonal variations. This data was taken from the Federal Reserve Economic Data (FRED). Similarly, seasonally adjusted unemployment data for Lithuania was included to control for labour market conditions, accounting for the influence of employment levels on housing prices. The unemployment data was obtained from the Official Statistics Portal of Lithuania.

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[1] House Price Index For Repetitive Transactions Documentation

[2] In my analysis, I will focus only on the period from 2006 to 2020 to avoid anomalies caused by the global pandemic

2.4 Data Visualisation

My analysis begins with an overview of basic visual representations of the data. Plotting the data is a straightforward yet effective method to initially engage with the dataset, providing an immediate sense of trends, patterns, and potential anomalies. This step is essential in any empirical research as it guides further data processing decisions and helps to understand the data dynamics. Additionally, such visual inspections can be instrumental in identifying seasonal variations or outliers, which if unaddressed, could distort later analyses and lead to biased conclusions. In this section, I present the visualisations of the data and briefly discuss the behaviour and nature of the dataset I constructed.

2.4.1 Housing Price Index for Lithuania

Figure A1 shows the house price index for recurring transactions in Lithuania over time. It is clear that the index exhibits exponential growth, therefore, for further analysis, I performed log transformations for this variable. I did the same for house price indexes for different cities in Lithuania (Figure A2), which I have separate indexes for. Later on in my analysis, I work specifically with natural logarithms of these variables.

Additionally, Figure A2 highlights the variations in the house price index among the three biggest cities in Lithuania. During the pre-crisis period of 2006-2008, the index for Vilnius did not reach the same heights as those for Kaunas or Klaipėda. Following the Great Financial Crisis, the indexes stabilised at similar levels. However, in the post-2020 period, house prices surged dramatically in all cities. This increase was less pronounced in Klaipėda, while it was more significant in Vilnius and most notably in Kaunas, where the price index rose to substantially higher levels.

2.4.2 Monetary Policy Shocks and Euribor

In this section, I present and discuss the monetary policy shocks alongside the Euribor 12-month rate. In further analysis, I will monitor how these variables impact house prices in Lithuania and macroeconomic variables.

Figure A3 shows the time series plot of the monetary policy shocks. These shocks are obtained from the methodology developed by Jarociński and Karadi (2020), which decomposes the monetary policy surprises into components related to changes in interest rates and the information revealed by central banks. This decomposition isolates the unexpected changes in monetary policy, providing a clearer picture of the exogenous monetary policy shocks that can affect the housing market.

The plot indicates several significant spikes, corresponding to periods of monetary policy interventions such as The Global Financial Crisis or the post-COVID period. These shocks exhibit both positive and negative values, indicating contractionary and expansionary monetary policy actions, respectively.

The 12-month Euribor rate is illustrated in Figure A4. The Euribor rate is an interest rate benchmark for the Eurozone that reflects the average interest rate at which Eurozone banks are willing to lend unsecured funds to other banks over a 12-month period. It is an essential indicator of the banking sector's overall monetary conditions and liquidity. I use the Euribor 12-month rate in my analysis because it is a widely recognised and reliable measure of medium-term interest rates in the Eurozone and it provides a consistent measure for monetary policy conditions.

Figure A4 shows that the Euribor rate has experienced significant fluctuations, particularly during and after The Global Financial Crisis and the recent periods of monetary easing. The sharp decline and subsequent low levels reflect the prolonged period of low interest rates maintained by the European Central Bank (ECB) to stimulate economic activity. In recent years, there have been rate hikes to combat the surge in inflation, indicating a shift towards a tighter monetary policy stance by the ECB to control inflationary pressures.

2.4.3 Industrial Production and Unemployment in Lithuania

In this part, I illustrate and analyse the transformations applied in Lithuania's industrial output and unemployment data, which serve as exogenous controls in my analysis to account for broader economic circumstances.

Figure A5 shows the industrial production index for Lithuania. This index captures the output of the industrial sector and serves as a proxy for economic activity. The plot demonstrates significant fluctuations, particularly around periods of economic crises and recovery phases, providing insights into the cyclical nature of industrial production. This untransformed data gives an initial view of how industrial production has varied over time, allowing for a better understanding of the economic context before any transformations are applied for stationarity.

Figure A6 illustrates the unemployment rate in Lithuania. This rate represents the percentage of the labour force that is unemployed and actively seeking employment. The figure reveals the trends and changes in the labour market over time, highlighting periods of economic downturns and recoveries. Observing the raw unemployment rate helps to understand the overall labour market conditions, which is essential before conducting any transformations to ensure stationarity.

2.5 Data Transformations and Stationarity

In my analysis, I encountered variables that exhibited exponential growth, such as industrial production and housing price indexes. Other variables such as unemployment, exhibited "noisy" behaviour. To prepare these variables for further analysis, I applied necessary transformations, including logarithmic and first differences, to stabilise their variance and trend characteristics. The transformations applied to each variable are summarised in Table 1.

Table 1
Transformations of Variables

Variable	Transformations	Data Source
House Price Index	log	Bank of Lithuania
Monetary Policy Shocks	None	(Jarociński & Karadi, 2020)
Euribor 12-Month Rate	None	ECB Data Portal
Industrial Production	log, Δ	FRED
Unemployment Rate	Δ	Official Statistics Portal of Lithuania

Notes: log denotes taking the natural logarithm of the variable, and Δ denotes calculating the first difference of the variable. Transformations are written in the order they were made.

Despite these transformations, it is crucial to verify the stationarity of the data to ensure the validity of future econometric analyses. To this end, I conducted the Augmented Dickey-Fuller (ADF) test, which is designed to test for a unit root in time series data, thus helping determine whether the series is stationary.

The Augmented Dickey-Fuller test is structured to reject the null hypothesis that a series has a unit root, implying non-stationarity. It expands the standard Dickey-Fuller test to include higher-order lagged differences, thus accommodating serial correlation in the error terms. Regarding industrial production and unemployment data, which showed no trend after transformations, I chose to conduct an ADF test without the constant since both series seem to fluctuate around zero and no trend term since the data do not exhibit trends. The test equation is:

$$\Delta x_t = \rho x_{t-1} + \sum_{i=1}^{k} \phi_i \Delta x_{t-i} + \epsilon_t, \tag{3}$$

where:

- Δx_t is the first difference of the series at time t,
- ρ is the coefficient on the lagged level of the series, which is the primary focus in testing for a unit root,
- ϕ_i are the coefficients of the i-th lagged difference of the series, included to capture any autocorrelation,

- ϵ_t is the error term,
- k represents the number of lags included in the regression, calculated to optimise model accuracy without introducing undue complexity.

The Augmented Dickey-Fuller test used in the analysis employs an automatic lag selection criterion, which is based on the truncated cube root of the sample size minus one, to optimise the number of lags used in the regression. Specifically, the number of lags k is calculated as follows:

$$k = \text{trunc}((\text{length}(x) - 1)^{1/3}), \tag{4}$$

where *lenght*(x) is the length of the series. This formula ensures that the lag structure is appropriate for the size of the data sample, balancing the need for a sufficient number of lags against the risk of overfitting.

While the industrial production data in Lithuania, post-transformation, demonstrated significant levels of stationarity, the post-transformation unemployment yielded insignificant results. The null hypothesis of a unit root was rejected at a 1% significance level for industrial production (p-value <0.01), while for unemployment, I could not reject the null hypothesis that the series is stationary. Consequently, using the ADF test I managed to confirm the stationarity of only one of the exogenous variables - industrial production. However, despite ambiguous results for unemployment, I decided not to conduct further transformations to the variable since the visual inspection of the first-differenced unemployment rate Figure A7 suggests that the series fluctuates around zero, indicating that it is close to stationarity. Further transformations could impede the interpretability and consistency of my findings.

3 DATA ANALYSIS AND RESULTS

In this section, I will present and analyse the findings on the effects of monetary policy on real estate prices in Lithuania. I begin by presenting the primary model used in my study to estimate the impact of an interest rate shock on house prices, discussing its results and potential drawbacks. The analysis continues with the baseline results using OLS, followed by an improved version of the model using an instrumental variable (2SLS) approach. Additionally, the analysis explores regional differences in the impact of monetary policy by comparing results across different cities in Lithuania. Various robustness checks are conducted to ensure the validity of the findings, including examinations of seasonal effects and a different Euribor rate. Moreover, an analysis of the impact of interest rate shocks on macroeconomic variables is included. Finally, I address the limitations of my study.

3.1 Interest Rate Effects on House Prices in Lithuania

In this section, I present and discuss the results obtained with a model that **does not use** the monetary policy shocks from Jarociński and Karadi (2020). Instead, I solely rely on the 12-month Euribor rate as the shock variable with industrial production and unemployment as controls. Therefore, I slightly adjust Equation 1 as follows:

$$\ln P_{t+h} = \beta^h \text{Euribor}_t + \sum_{i=1}^{12} \gamma_i^h \ln P_{t-i} + \sum_{j=1}^{12} \delta_j^h \text{Controls}_{t-j} + \epsilon_t^h, \tag{5}$$

where Euribor_t is the 12-month Euribor rate used instead of monetary policy shocks derived from the study by Jarociński and Karadi (2020).

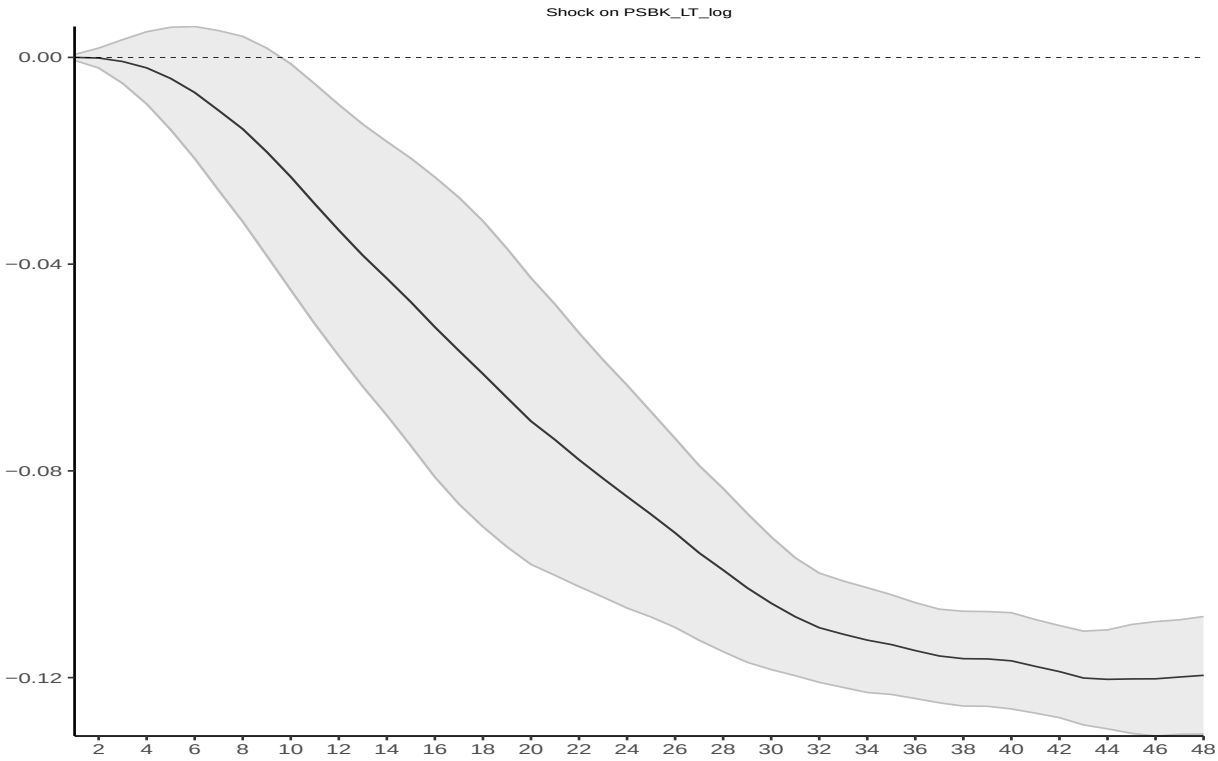
Figure 1 shows how the Euribor rate shock—a contractionary monetary policy shock affects house prices in Lithuania over the horizon of 48 months. The short-term impact of the shock seems to be rather small, and as the confidence bands are rather wide, the statistically significant changes in the house price index can be observed mostly in the medium term. Around the 14th month, house prices decrease by approximately 4%. This decrease amounts to 8% in 22 months after the shock and peaks at 12% at the end of the observed horizon at the 44th month.

The local projection shows that house prices react significantly negatively to a contractionary monetary policy shock. However, such findings should be interpreted with caution due to possible endogeneity in the model. It is likely that the interest rate used as a shock in this model is correlated with house prices, making the model possibly biased and consequently less reliable.

For this reason, in future analyses, the models I estimate will incorporate the "clean" monetary shock to avoid bias in the findings (Jarociński & Karadi, 2020).

Figure 1

Euribor Rate Shock Effect on House Prices in Lithuania



Notes: The local projection presents how a shock in the 12-month Euribor rate affects the house prices in Lithuania. The model here uses only the Euribor rate as the shock variable. The local projection is estimated using OLS. The grey area denotes the 95% confidence interval.

3.2 Baseline Results

The local projection estimated using OLS assesses the impact of monetary policy shocks on real estate prices in Lithuania. Here I will analyse the effect of the shocks derived from a study by Jarociński and Karadi (2020) on the dependent variable - log-transformed house price index.

Figure 2 illustrates the estimated percentage change in the house price index following a monetary policy shock over a horizon of 36 months. Immediately after the shock, house prices show a noticeable decline. Within the first 6 months, house prices decrease by approximately 10%. The most significant impact is observed around the 16th month when house prices decrease by over 40%. Over the medium term, the impact gradually diminishes, and by the 36th month, house prices begin to recover, although they remain below the pre-shock level during the presented horizon.

However, it is important to note that the 95% confidence intervals (CI) are quite wide, and many of the estimated effects are not statistically different from zero. Even at the peak decrease,

the drop in prices is possibly not bigger than 10%. This uncertainty suggests that the results should be interpreted with caution. The large confidence bands indicate that while the model suggests a substantial impact, the evidence is not robust enough to make definitive conclusions.

Figure 2
Effect of a Monetary Policy Shock on House Prices (OLS)

Notes: The grey area denotes the 95% confidence interval.

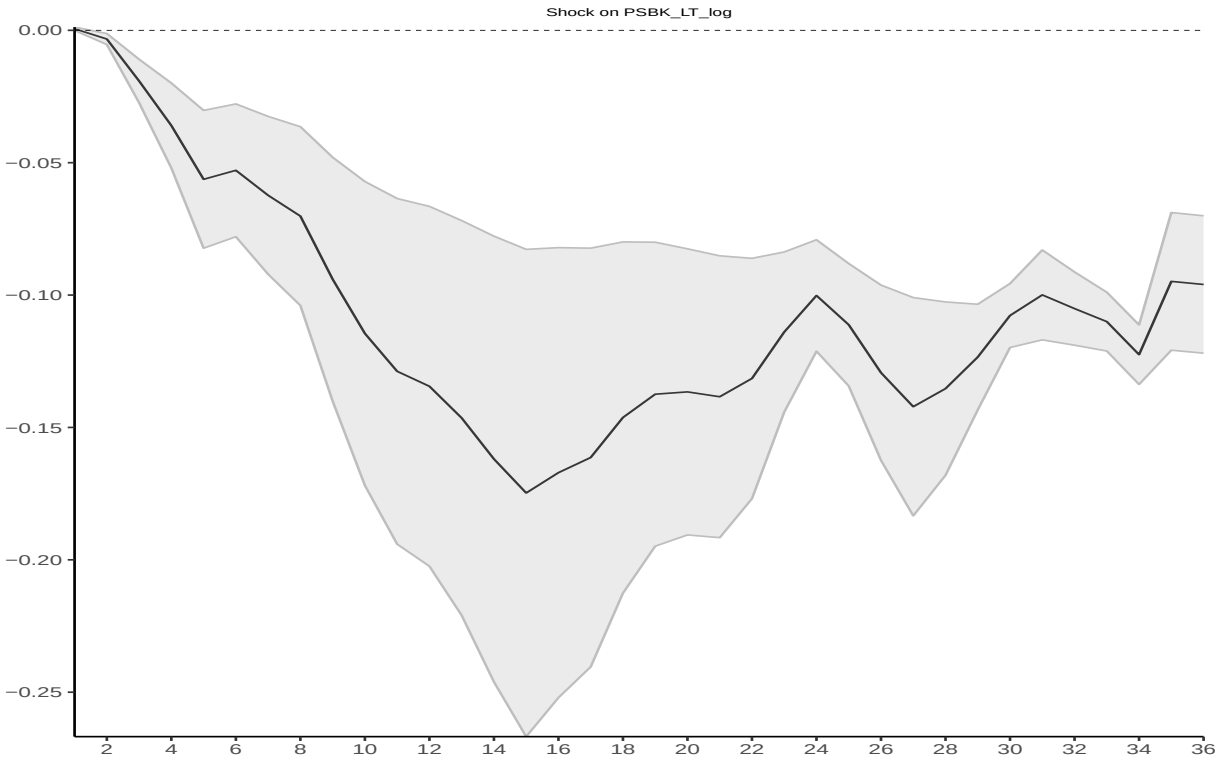
3.3 Instrumental Variable Approach

To address the issue of low significance, I decided to use a different model. Here I present the instrumental variable approach which is widely recognised in the scientific literature (Gorea et al., 2022; Ramey, 2016). Specifically in this model instead of monetary policy shocks, I use the 12-month Euribor rate as the shock variable and the monetary policy shocks as the instrumental variable. In this analysis, a two-stage least squares (2SLS) approach is employed.

The results of the local projection (Figure 3) reveal a decrease in house prices following a contractionary monetary policy shock. Specifically, the findings indicate that house prices declined by over 5% in the first six months after the shock. The impact peaks at around 17% in the medium-term (15 months), with the confidence bands indicating that the decrease could be as low as 7.5%. Later on, house prices seem to gradually stabilise, showing an approximate 10% decrease at the end of the observed horizon.

These results suggest that changes in monetary policy have significant implications for the housing market, with a contractionary policy leading to observable decreases in house prices. Compared to the OLS case in Figure 2, the findings seem to be more robust using the IV approach as they become more statistically significant according to the model.

Figure 3
Effect of a Monetary Policy Shock on House Prices (2SLS)



Notes: The grey area denotes the 95% confidence interval.

3.4 Cross-city Analysis

A great deal of the research finds that monetary policy is heterogeneous (Andaloussi et al., 2024; Gorea et al., 2022). This heterogeneity may occur in several ways, for example, Albuquerque et al. (2024) find that monetary policy in the U.S. has varying impacts in different states. Similarly, Altavilla et al. (2019) and Garriga et al. (2017) provide evidence of regional differences in the transmission of monetary policy.

In this section, I present and analyse cross-city differences in the response of house prices to monetary policy shocks in Lithuania. Using local projections, I estimate the effects of monetary policy shocks on house prices for three different cities: Vilnius, Kaunas, and Klaipėda. The analysis aims to determine whether the impact of monetary policy on house prices varies significantly across these cities, thereby highlighting any regional heterogeneity within Lithuania.

The results for Vilnius (Figure 4) appear to be similar to those for the whole country (Figure 3), with slightly lower magnitudes for the decline in house prices due to a monetary policy shock. Both figures show a peak drop at 15 months after the shock, however, in Vilnius, the peak value reaches 15%, compared to 17% for the whole country. In the short term, the magnitudes seem slightly lower and the projection is less smooth in Vilnius. Finally, at the end of the observed horizon, house prices in Vilnius do not fully stabilise and continue to fluctuate more than in the analysis for Lithuania.

Figure 4

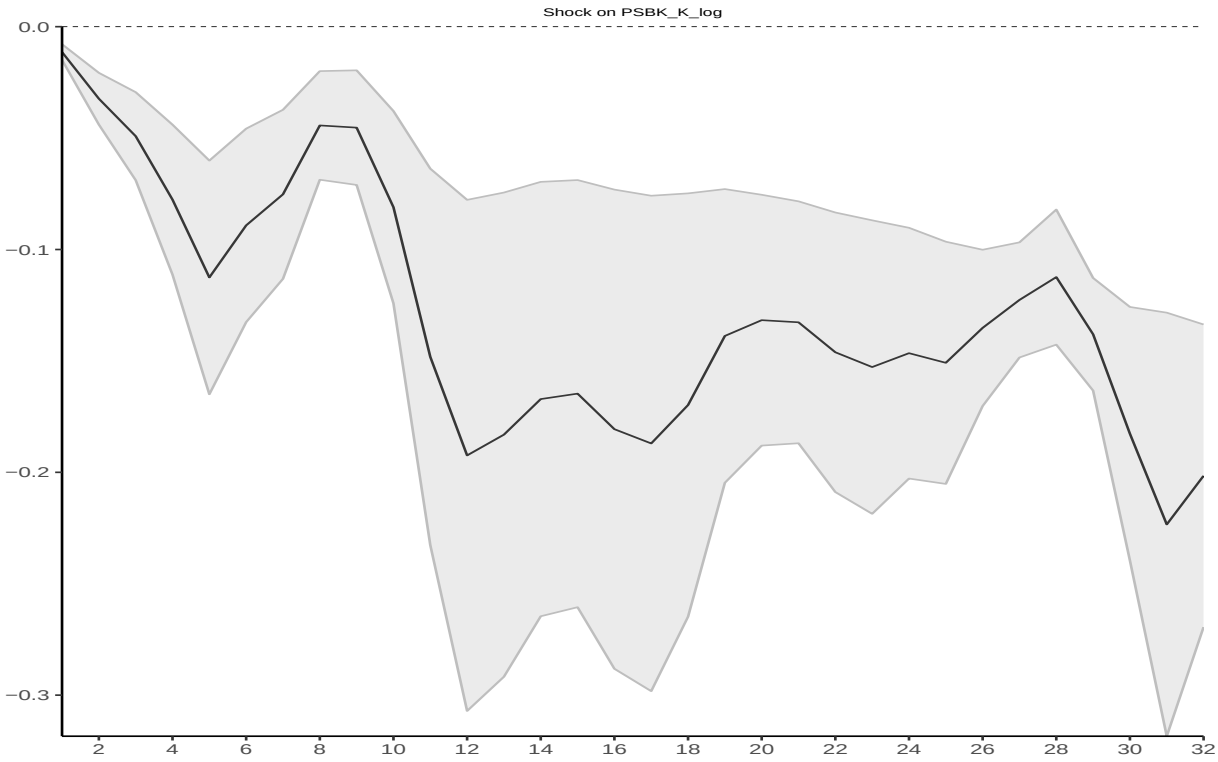
Effect of a Monetary Policy Shock on House Prices in Vilnius (2SLS)

Notes: The grey area denotes the 95% confidence interval.

In Kaunas (Figure 5), the impact of monetary policy shocks on house prices appears to be more pronounced than in Lithuania as a whole (Figure 3). The house price index exhibits a sharper and more sustained decline, peaking at around 20% in the 12th month after the shock, which is sooner than in Vilnius (Figure 4) and Lithuania. This suggests that overall, monetary policy has a stronger effect on house prices in Kaunas, except for the lower impact observed around the 8th month after the shock. In the short term, the effect of the shock spikes at over 10% decrease in the house price index, indicating a higher short-term impact in this city. Unlike in the previously analysed projections, house prices in Kaunas do not seem to stabilise by the end of the observed horizon. Overall, the results indicate a higher sensitivity to monetary policy changes in Kaunas.

Figure 5

Effect of a Monetary Policy Shock on House Prices in Kaunas (2SLS)

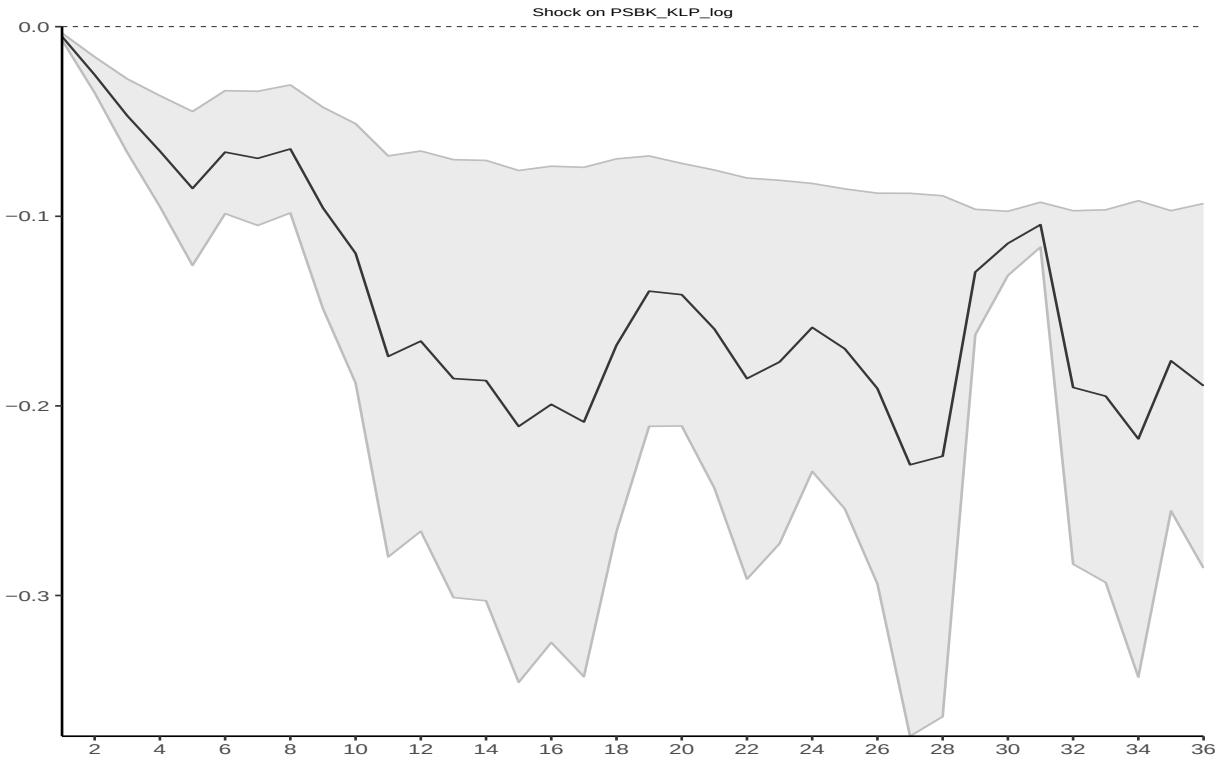


Notes: The horizon for Kaunas is slightly lowered from 36 to 32 months for better interpretability of the local projection. The grey area denotes the 95% confidence interval.

In Klaipėda (Figure 6), the impact of monetary policy shocks on house prices is the most pronounced among the three cities. While in Kaunas (Figure 5) the short-term effect appears to be slightly larger, Klaipėda exhibits the highest medium-term decline in house prices, peaking at over 20% several times in the medium term of the observed horizon. This significant decline indicates a higher sensitivity to monetary policy changes in Klaipėda compared to Vilnius (Figure 4) and Kaunas. The broader confidence intervals in Klaipėda suggest greater uncertainty in the housing market's response to monetary policy shocks in this region. Overall, the findings for Klaipėda demonstrate that the city's housing market likely reacts more strongly to monetary policy shocks, with a significant and extended decline in house prices.

Figure 6

Effect of a Monetary Policy Shock on House Prices in Klaipėda (2SLS)



Notes: The grey area denotes the 95% confidence interval.

In summary, the comparison across cities reveals that while all three cities (Vilnius, Kaunas, and Klaipėda) experience declines in house prices following a contractionary monetary policy shock, the magnitude and duration of these impacts vary. Kaunas and Klaipėda exhibit more substantial and sustained declines compared to Vilnius. These findings highlight the heterogeneity in the impact of monetary policy across different regions within Lithuania. This emphasises the need for policymakers to consider regional dynamics when assessing the overall impact of monetary policy on the housing market.

3.5 Instrumental Variable Approach with Seasonal Dummies

I was concerned that my housing price index data might not be seasonally adjusted. If this was the case, it could affect causal inference or introduce other issues due to seasonal fluctuations. To improve the robustness of my analysis, I needed to ensure there was no seasonality in my data.

To address this, I estimated the same model as in section 2.1, but included seasonal dummies to account for any seasonal effects. First, I generated the seasonal dummies, then I incorpo-

rated the seasonal dummies directly into the model. The adjusted model can be written as follows:

$$\ln P_{t+h} = \beta^h \text{MP\_Shock}_t + \sum_{i=1}^{12} \gamma_i^h \ln P_{t-i} + \sum_{j=1}^{12} \delta_j^h \text{Controls}_{t-j} + \sum_{m=1}^{11} \phi_m \text{Dummy}_m + \epsilon_t^h, \quad (6)$$

where *Dummy*$_m$ represents the seasonal dummy variables, where m indexes the specific months (1 to 11). The seasonal dummies are included to capture the fixed seasonal effects that might otherwise bias the results. For monthly data, m ranges from 1 to 11, representing each month except for December (which is excluded to avoid multicollinearity). By incorporating these dummies, the model accounts for regular seasonal patterns, ensuring that these patterns do not confound the estimated effects of monetary policy shocks on housing prices.

Figure 7 presents the local projection using the updated model, which includes monthly dummies to control for potential seasonality. The objective is to ensure that the model with monthly dummies matches the results of the 2SLS model presented in Figure 3. By comparing the local projections, it is evident that both figures show very similar patterns and overall results. This similarity allows me to conclude that the dependent variable in my analysis, the house price index for Lithuania, does not exhibit seasonal patterns. Thus, my analysis is not biased by potential seasonality. This approach enhances the robustness of the analysis by ensuring that seasonal fluctuations do not influence the model, providing a clearer understanding of the monetary policy's impact on real estate prices in Lithuania.

Figure 7

Effect of a Monetary Policy Shock on House Prices (2SLS with dummies)

Notes: This local projection presents an adjusted 2SLS model using monetary policy shocks from Jarociński and Karadi (2020) as an instrument for 12-month Euribor rate. The model also includes seasonal dummies for the house prices index to account for possible seasonality in the variable of interest. The grey area denotes the 95% confidence interval.

3.6 Instrumental Variable Approach with 3-month Euribor rate

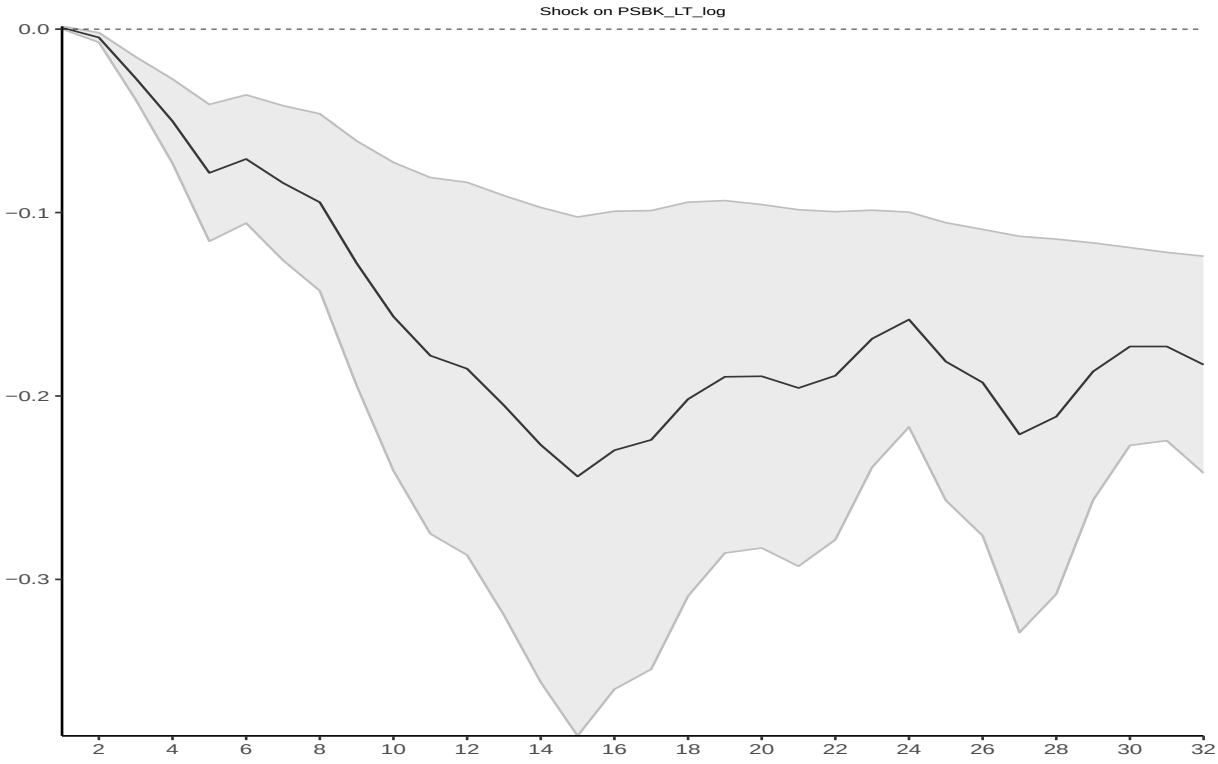
In this section, I compare the IV 2SLS model used in my analysis (Section 2.2) with a slightly adjusted version of it to test the robustness of my results. The main model uses the 12-month Euribor rate as the shock variable and monetary policy shocks derived from Jarociński and Karadi (2020) as the instrumental variable to estimate the effect of monetary policy on house prices in Lithuania (Figure 3). Here, I introduce an alternative model that is essentially the same, except it uses the 3-month Euribor rate as the shock variable to replace the 12-month Euribor rate.

The local projection for the updated model is presented in Figure 8 and compared to the local projection of the initial model (Figure 3). Trend-wise, both graphs look nearly identical, however, there is an important difference when comparing the two. The projection that uses the 3-month rate exhibits much higher magnitudes of the decrease in house prices at all points in the observed horizon. For example, in Figure 8, the peak value reaches nearly 25% at the 15th month of the observed horizon, indicating a 25% decrease in house prices due to a monetary policy shock, which is rather unrealistic. This suggests that the 3-month Euribor rate might not be as suitable for capturing the monetary policy impact on house prices as the 12-month rate.

The significantly larger declines in house prices observed with the 3-month Euribor rate likely reflect its higher sensitivity to short-term fluctuations and market volatility. The 12-month rate, being more stable, provides a more accurate representation of the long-term effects of monetary policy on the housing market. Therefore, the 12-month Euribor rate remains the preferred shock variable for this analysis due to its more realistic and stable results.

Figure 8

Effect of a Monetary Policy Shock on House Prices Using 3-month Euribor (2SLS)



Notes: This figure shows how a monetary policy shock affects house prices in Lithuania, using the 3-month Euribor rate as the shock variable instead of the 12-month rate used in previous projections. The horizon is reduced to 32 months for better interpretability.The grey area denotes the 95% confidence interval.

3.7 Interest Rate Effects on Macroeconomic Variables

In this section, I explore how monetary policy shocks, specifically changes in the 12-month Euribor rate, affect macroeconomic variables such as industrial production and unemployment in Lithuania. I employ local projections to estimate impulse response functions using the OLS approach. The model for industrial production can be written as follows:

$$\ln \text{IP}_{t+h} = \beta^h \text{Euribor}_t + \sum_{i=1}^{12} \gamma_i^h \ln \text{IP}_{t-i} + \sum_{j=1}^{12} \delta_j^h \Delta \text{Unemp}_{t-j} + \epsilon_t^h, \tag{7}$$

where $\ln IP_{t+h}$ is the natural logarithm of industrial production in Lithuania, $Euribor_t$ is the 12-month Euribor rate and $\Delta Unemp_{t-j}$ is the first difference of the unemployment rate in Lithuania. The model for unemployment can be written as follows:

$$\text{Unemp}_{t+h} = \beta^h \text{Euribor}_t + \sum_{i=1}^{12} \gamma_i^h \text{Unemp}_{t-i} + \sum_{j=1}^{12} \delta_j^h \Delta \ln \text{IP}_{t-j} + \epsilon_t^h, \tag{8}$$

where $Unemp_{t+h}$ is the unemployment rate in Lithuania and $\Delta \ln IP_{t-j}$ represents the first difference of the natural logarithm of industrial production.

Figure 9 shows how industrial production responds to a shock in the 12-month Euribor rate over the horizon of 48 months. Intuitively, a contractionary monetary policy shock causes industrial production to decrease. We can see that in the 6th month after the shock, industrial production drops by 2%, and in the medium term, around 2 years after the shock, the decrease in industrial production peaks at nearly 6%. After that, industrial production begins to stabilise, reaching its initial value in the 48th month after the interest rate shock. It is evident that contractionary monetary policy negatively affects industrial production, which aligns with economic theory.

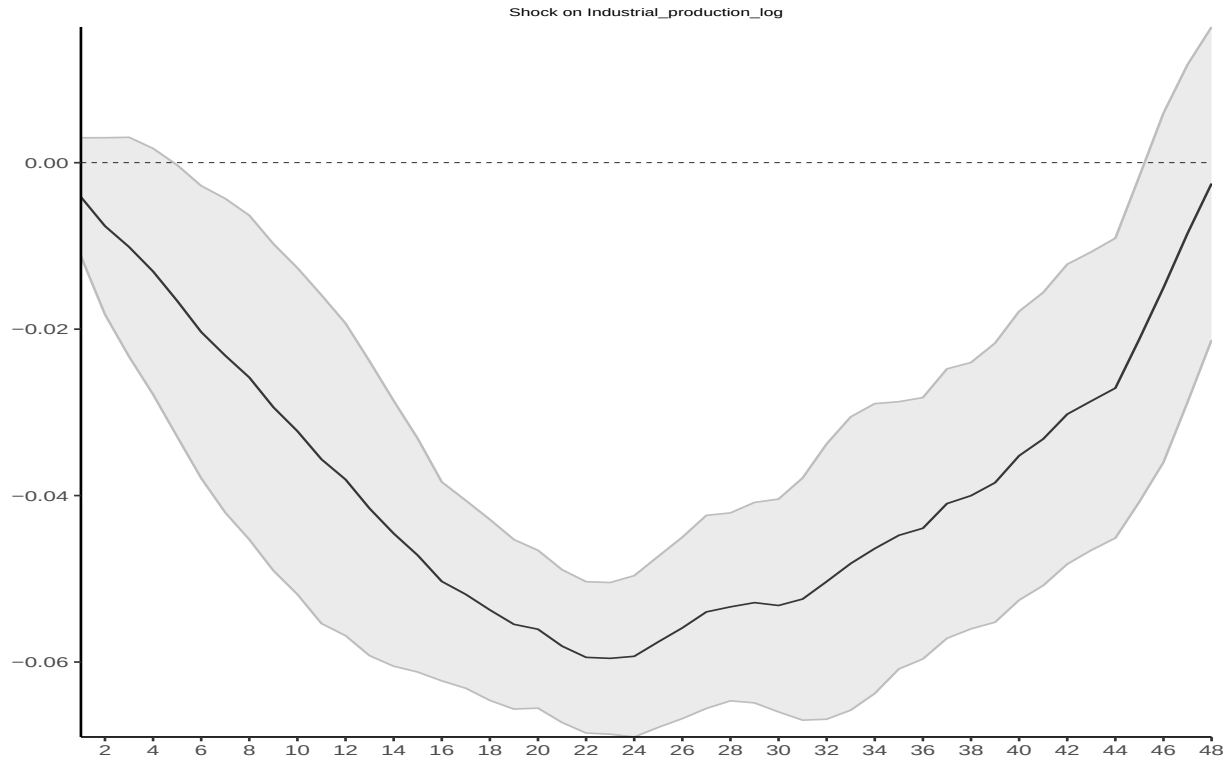
Figure 10 presents how the unemployment rate reacts to the contractionary interest rate shock over the same horizon of 48 months. We can see that the shock causes unemployment to increase. Since in this case, I use the unemployment rate without any transformations, the results should be interpreted slightly differently. According to the local projection, the increase in unemployment is a bit slow to materialise, however, at around the 14th month, the unemployment rate increases by 1 percentage point. The increase peaks approximately 3 years after the shock, reaching nearly 2.5 percentage points, and starts to stabilise after that.

This analysis helps us understand how monetary policy shocks affect not only house prices but also macroeconomic variables such as industrial production and unemployment. This underscores the trade-offs policymakers face in using monetary policy to address rising house prices

while maintaining economic stability (Williams, 2015).

Figure 9

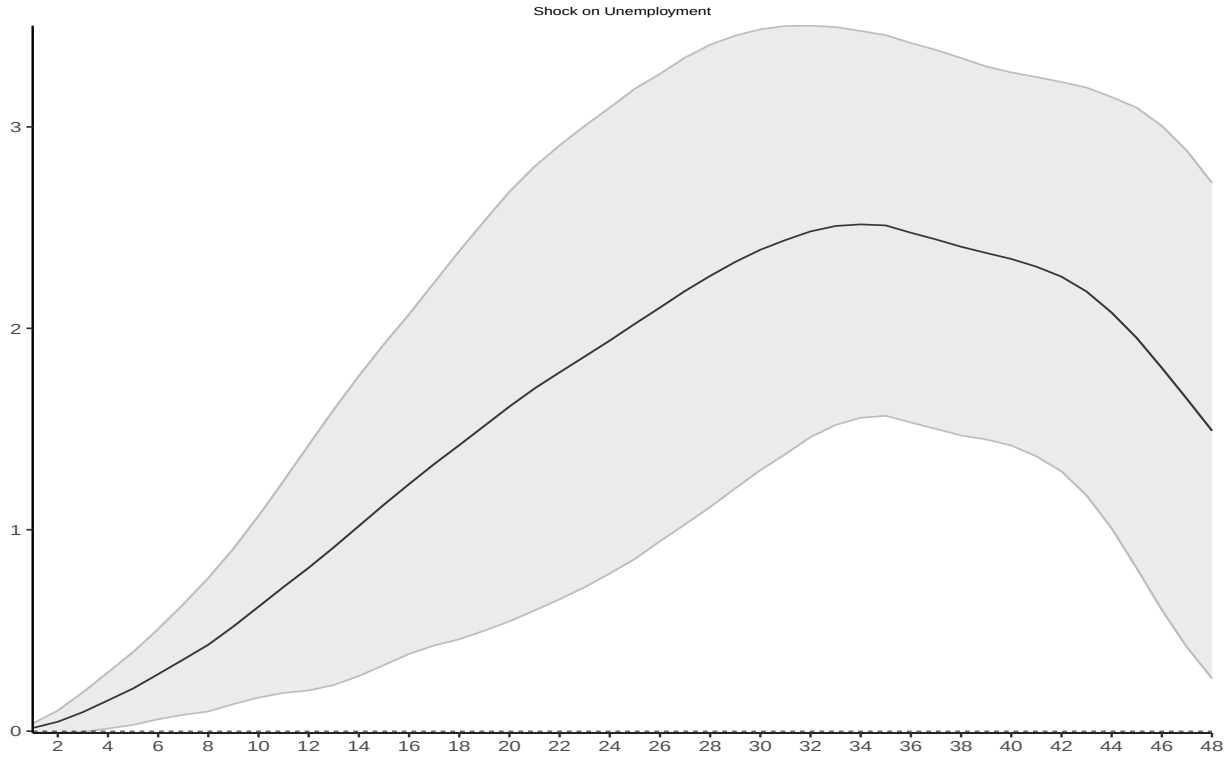
Euribor Rate Shock Effect on Industrial Production in Lithuania



Notes: The grey area denotes the 95% confidence interval.

Figure 10

Euribor Rate Shock Effect on Unemployment Rate in Lithuania



Notes: The local projection presents how a shock in the 12-month Euribor rate affects the unemployment rate in Lithuania. The y-axis shows the change in percentage points rather than percentage changes in the variable of interest. The grey area denotes the 95% confidence interval.

3.8 Limitations

In this section, I discuss the limitations encountered in my analysis. These limitations stem from data availability, the exclusion of certain periods, methodological constraints, and uncertainties in the results.

One of the primary limitations is the lack of available data for the house price index before 2006. This constraint restricts the scope of my analysis to the period from 2006 onwards. As a result, any long-term trends or structural changes in the housing market that may have occurred before this period are not captured in my study.

Moreover, the Covid-19 pandemic significantly impacted global economies, including the housing market. However, my analysis disregards the Covid period to avoid the anomalies and irregularities introduced by the pandemic. Consequently, the time span of my analysis is from 2006 to 2020. This exclusion might result in a loss of important economic shifts such us the recent surge in the interest rates and their effects on house prices.

Another issue faced was the horizon of the local projections. Most Impulse Response Functions (IRFs) estimate local projections using a 36-month horizon. However, in some instances, I had to reduce the horizon to 32 months. This adjustment was necessary to maintain interpretability, as the graphs exhibited sudden changes in magnitudes beyond 32 months, complicating the analysis by making the projections impossible to read.

The confidence bands of my local projections are quite wide, indicating reduced precision in the estimates. Although the projections show statistically significant decreases in house prices, the large 95% confidence intervals make it challenging to accurately determine the magnitude of these decreases. This uncertainty complicates the interpretation of the real effects of monetary policy on house prices in Lithuania.

The estimated magnitude of the impact of monetary policy on house prices appears larger than expected. Typically, one would anticipate slightly smaller changes in house prices. The observed significant changes might be influenced by the wide confidence bands, masking the real effects. This discrepancy raises questions about the accuracy of the estimated impacts.

While the analysis provides valuable insights into the effects of monetary policy on house prices in Lithuania, it is essential to acknowledge these limitations. Addressing these issues in future research could help enhance the robustness and accuracy of the findings, providing a clearer understanding of the dynamics of monetary policy and house price fluctuations.

CONCLUSIONS AND RECOMMENDATIONS

The analysis reveals that monetary policy significantly affects house prices in Lithuania. The results indicate that a contractionary monetary policy shock leads to a substantial decline in house prices. Specifically, in the short term, around the 6th month after the shock, house prices decrease by approximately 5%. The medium-term impact is even more pronounced, with the peak effect occurring around the 15th month, where house prices drop by nearly 17%. These findings show the sensitivity of the Lithuanian housing market to monetary policy changes, highlighting the critical role of monetary policy shocks in influencing housing prices.

The study also uncovers significant cross-city heterogeneity in the impact of monetary policy on house prices within Lithuania. The effects of monetary policy shocks vary notably between different cities. For instance, the housing market in Klaipėda experiences the most substantial impact that persists over time, with house prices declining by over 20% in the medium term. In contrast, Vilnius and Kaunas exhibit relatively smaller declines, with house prices decreasing by around 15% and 19%, respectively. This variation suggests that local economic conditions, housing market dynamics, and other regional differences contribute to the differing responses to monetary policy.

Policymakers must consider the effects of monetary policy on house prices when designing and implementing policy measures. While monetary policy can be an effective tool to combat rapid growth in house prices and prevent housing bubbles, it comes with trade-offs. Contractionary monetary policy, aimed at cooling down the housing market, can also lead to reduced economic output and increased unemployment. Therefore, a balanced approach is essential to mitigate adverse economic impacts while achieving housing market stability. Such measures could include macroprudential policies like tightening lending standards, increasing capital requirements for banks, or adjusting existing loan-to-value (LTV) and debt-to-income (DTI) ratio limits. By employing a combination of monetary policy and macroprudential regulations, policymakers can better control house price inflation while maintaining overall economic stability.

The observed cross-city heterogeneity implies that regional differences should be accounted for when estimating the effects of monetary policy. Policymakers should recognise that the impact of monetary policy will vary across different regions. In cities like Klaipėda, where the effects are more pronounced, additional measures may be required to manage the housing market effectively. Conversely, in regions with less sensitivity to monetary policy like Vilnius, different strategies may be more appropriate. Adjusting policy measures to regional conditions can enhance

the effectiveness of monetary interventions.

Future research could extend the analysis to include periods before 2006 or the post-2020 period. Incorporating a broader timeframe could provide a more comprehensive understanding of the long-term effects of monetary policy on house prices. Additionally, analysing the post-2020 period, which includes the COVID-19 pandemic and subsequent economic measures, could offer valuable insights into how unique economic events such as quantitative easing influence the housing market.

Future studies could explore different methodologies or approaches to improve the precision of causal impact estimates. One area of focus could be finding ways to narrow down the confidence intervals of impulse response functions (IRFs), thereby providing more precise estimates of the effects of monetary policy shocks. Employing advanced econometric techniques or incorporating additional data sources may help achieve this goal, leading to more robust and reliable findings.

REFERENCES

Albuquerque, B., Iseringhausen, M., & Opitz, F. (2024, February). *The housing supply channel of monetary policy* (tech. rep.). European Stability Mechanism Working Paper No. 59. https://ssrn.com/abstract=4716803%20or%20http://dx.doi.org/10.2139/ssrn.4716803

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics*, *108*, 162–179. https://doi.org/https://doi.org/10.1016/j.jmoneco.2019.08.016

Andaloussi, M. B., Biljanovska, N., Stefani, A. D., Mano, R., et al. (2024, April). Feeling the pinch? tracing the effects of monetary policy through housing markets [Chapter 2]. https://www.imf.org

Battistini, N., Falagiarda, M., Roma, M., & Hackmann, A. (2023). Assessing the role of the housing market in the transmission of conventional and unconventional monetary policy across euro area regions [SSRN Working Paper No. 4280134]. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4280134

Bhutta, N., & Ringo, D. (2021). The effect of interest rates on home buying: Evidence from a shock to mortgage insurance premiums. *Journal of Monetary Economics*, *118*, 195–211. https://doi.org/https://doi.org/10.1016/j.jmoneco.2020.10.001

Garriga, C., Kydland, F. E., & Šustek, R. (2017). Mortgages and Monetary Policy. *The Review of Financial Studies*, *30*(10), 3337–3375. https://doi.org/10.1093/rfs/hhx043

Garriga, C., Manuelli, R., & Peralta-Alva, A. (2019). A macroeconomic model of price swings in the housing market. *American Economic Review*, *109*(6), 2036–72. https://doi.org/10.1257/aer.20140193

Gorea, D., Kryvtsov, O., & Kudlyak, M. (2022). House price responses to monetary policy surprises: Evidence from the u.s. listings data. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4188292

Jarociński, M., & Karadi, P. (2020). Deconstructing monetary policy surprises—the role of information shocks. *American Economic Journal: Macroeconomics*, *12*(2), 1–43. https://doi.org/10.1257/mac.20180090

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, *95*(1), 161–182. https://doi.org/10.1257/0002828053828518

Jordà, Ò., Schularick, M., & Taylor, A. M. (2015). Betting the house [37th Annual NBER International Seminar on Macroeconomics]. *Journal of International Economics*, *96*, S2–S18. https://doi.org/https://doi.org/10.1016/j.jinteco.2014.12.011

Ramey, V. (2016). Chapter 2 - macroeconomic shocks and their propagation. In J. B. Taylor & H. Uhlig (Eds.). Elsevier. https://doi.org/https://doi.org/10.1016/bs.hesmac.2016.03.003

Romer, C. D., & Romer, D. H. (2023). Presidential address: Does monetary policy matter? the narrative approach after 35 years. *American Economic Review*, *113*(6), 1395–1423.

Williams, J. C. (2015). Measuring monetary policy's effect on house prices. *FRBSF Economic Letter*, *28*, 1–6.

ANNEXES

Figure A1
House Price Index for Recurring Transactions in Lithuania

Figure A2

House Price Index for Recurring Transactions in Different Cities

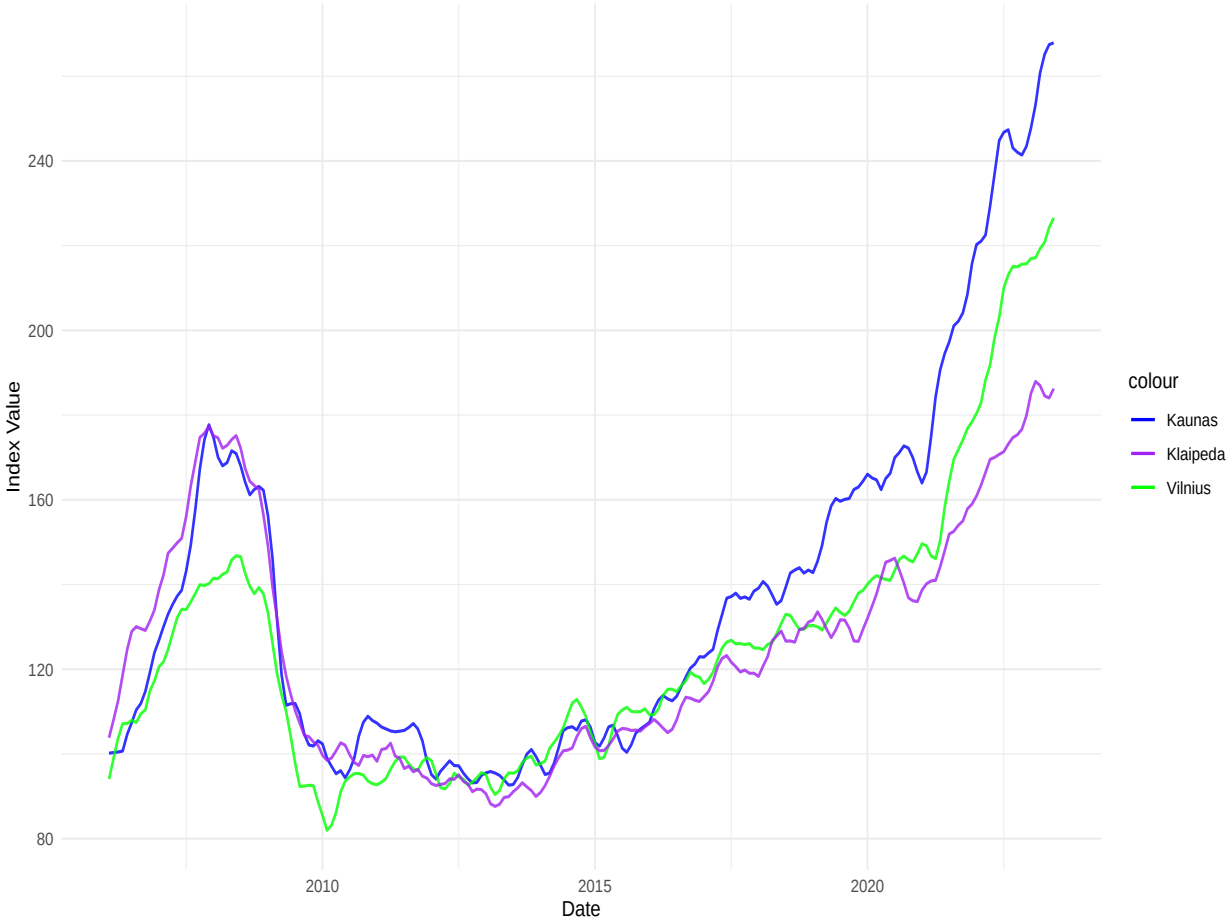


Figure A3
Monetary Policy Shocks

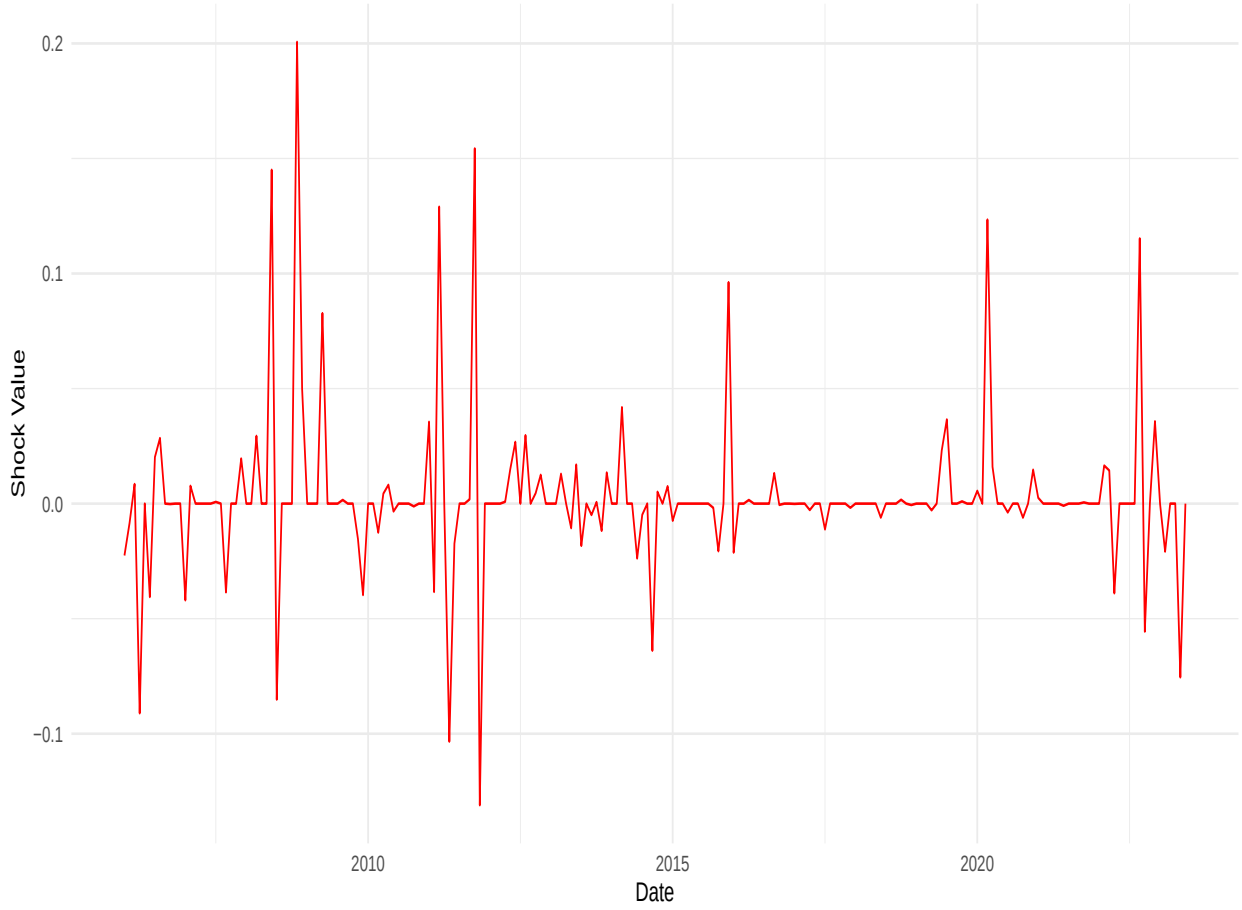


Figure A4
12-month Euribor Rate

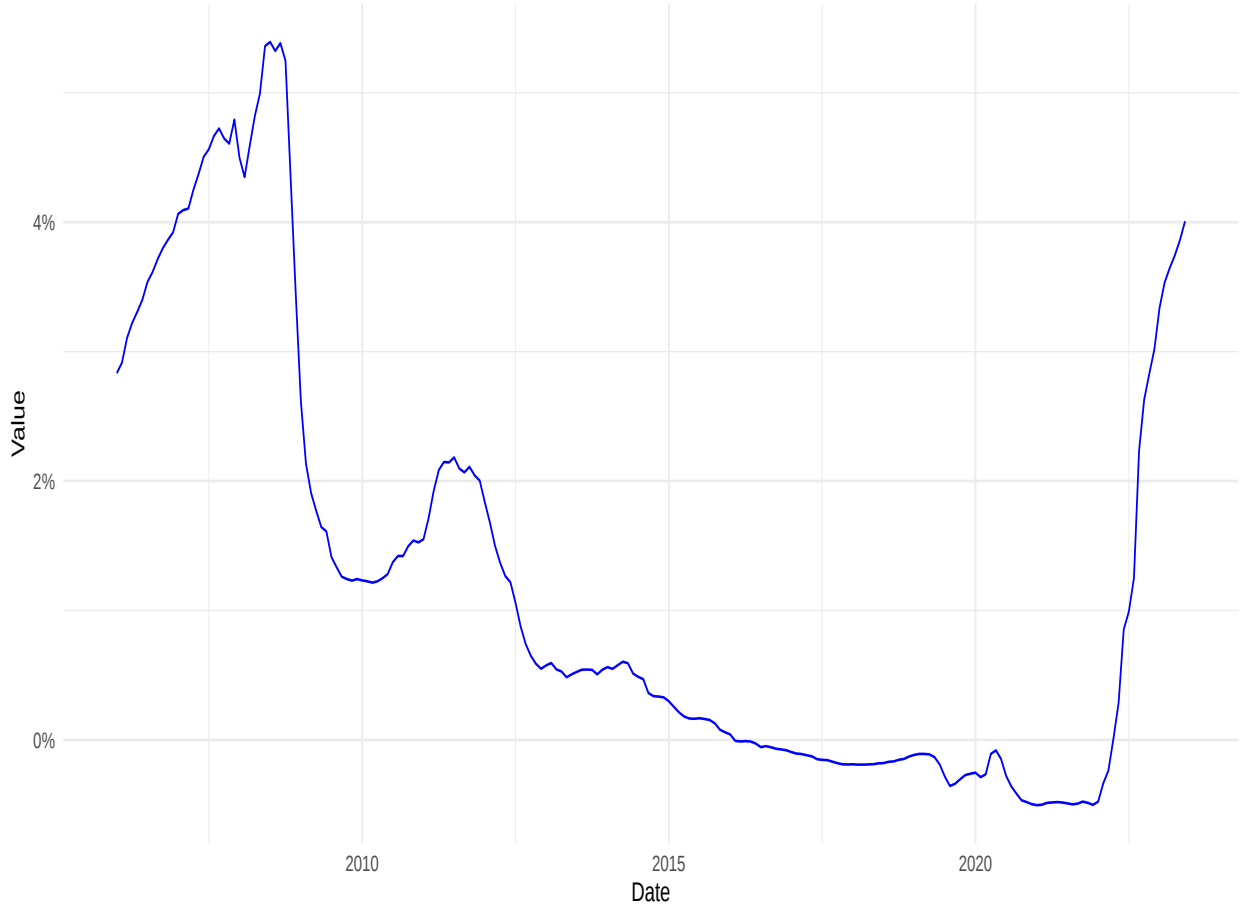


Figure A5

Industrial Production in Lithuania

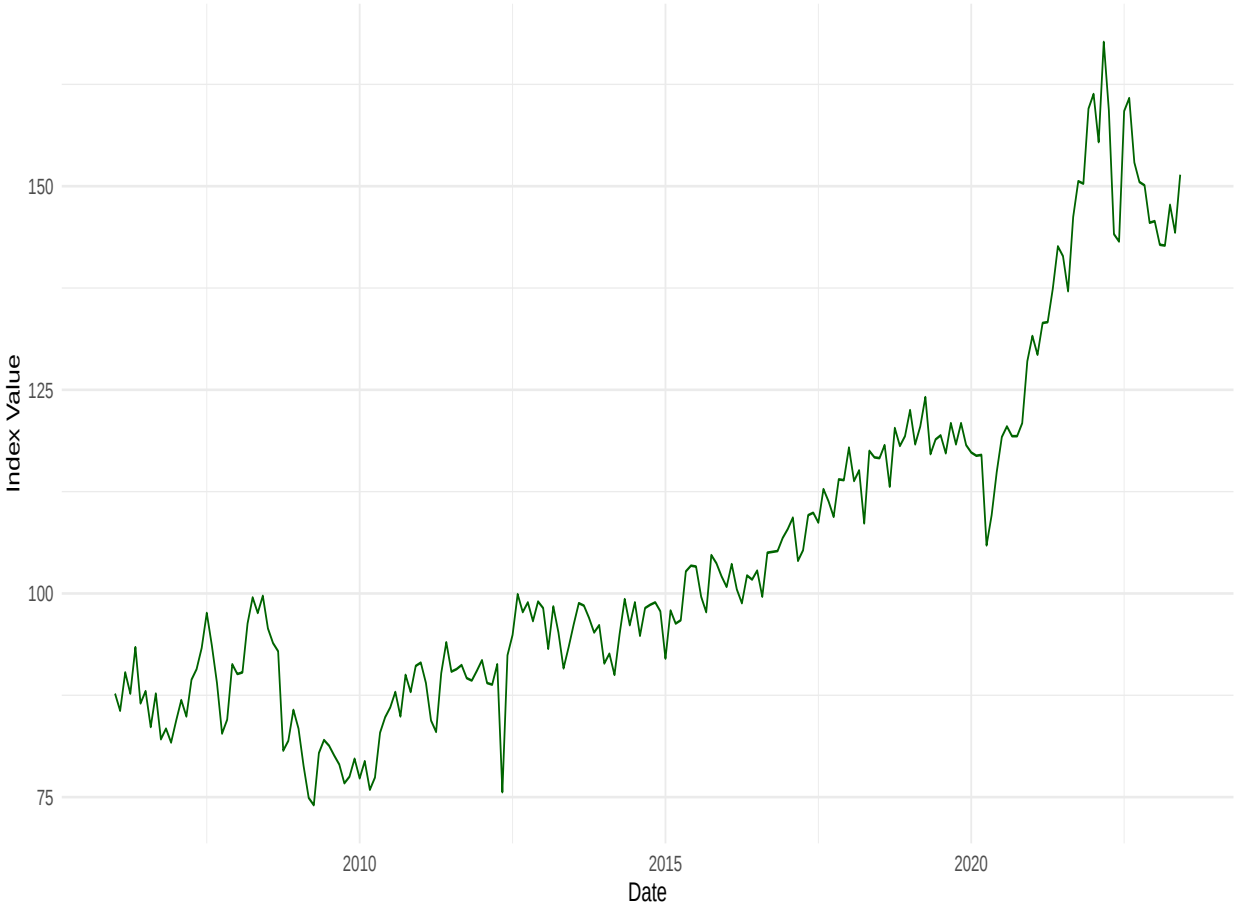


Figure A6

Unemployment Rate in Lithuania

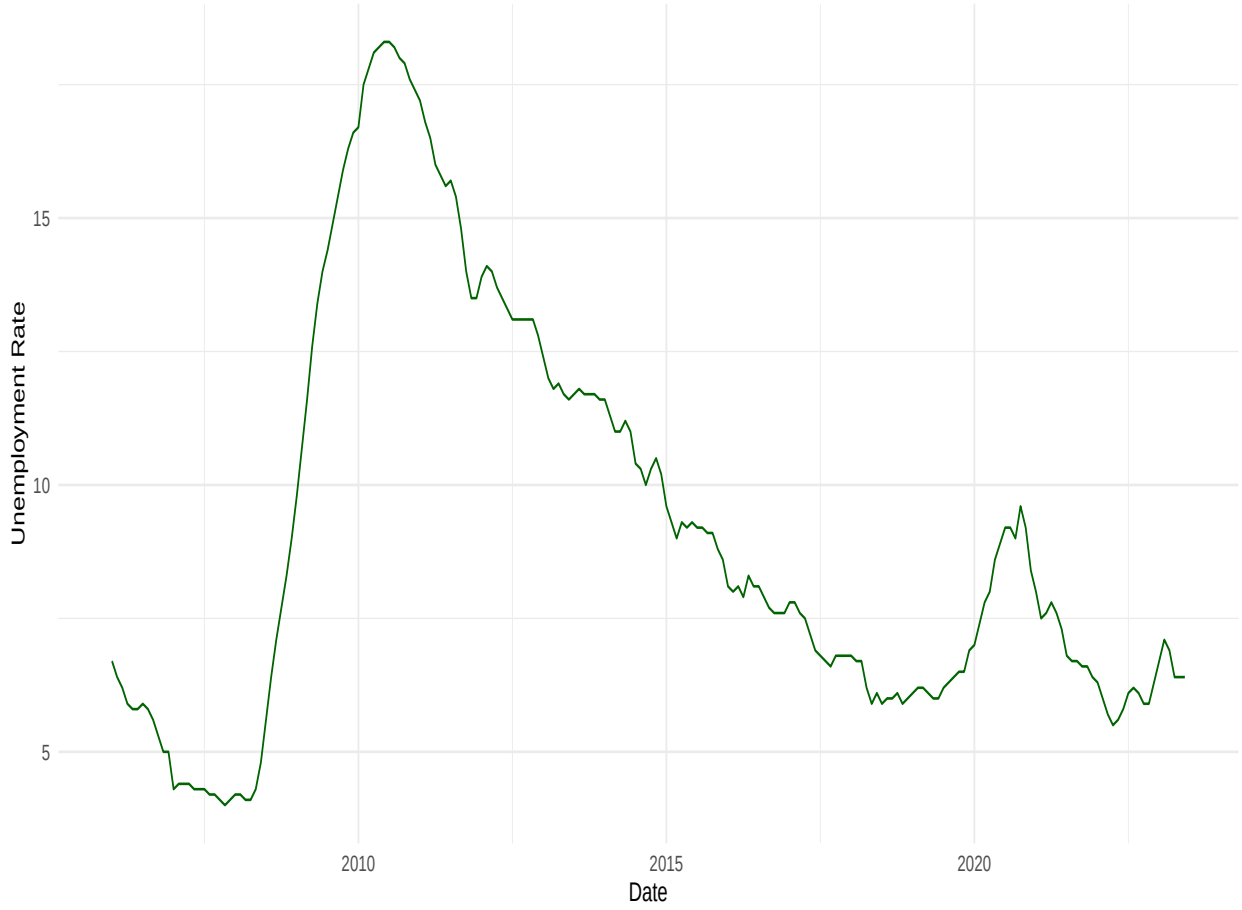


Figure A7

First Difference of Unemployment Rate in Lithuania