



Pass-through of monetary policy to bank interest rates in the economic and monetary union

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Abstract

This dissertation analyzes the policy interest rate pass-through to bank lending and deposit interest rates in different interest hiking cycles within 11 EMU countries. Understanding the drivers behind heterogeneity within the pass-through process is crucial for improving the monetary policy transmission mechanism. Using an ARDL ECM approach, this dissertation examines both short- and long-term pass-through to bank interest rates and the influence of country-specific characteristics on the pass-through in the periods 2000-2001, 2005-2008 and 2022-2024. Results show, that in the periods 2000-2001 and 2005-2008, the policy interest rate pass-through was more homogenous. In 2022-2024, however, the pass-through was significantly lower for all bank rates. Despite this, the speed of pass-through remained consistently fast across all periods and bank rates. Furthermore, higher industrial production for large loans to NFCs and higher inflation for small loans to NFCs are associated with higher pass-through in the 2022 period. For household deposits in the same period, higher inflation and stock price index have a positive effect on the pass-through, whereas industrial production has a negative effect. For NFC deposits, the stock price index negatively impacts short-term pass-through but positively effects it in the long term. Higher country risk premiums negatively impact pass-through in the most recent hiking cycle.

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Resumo

A presente dissertação analisa a transmissão das taxas de juro diretoras às taxas de juro dos empréstimos e depósitos bancários durante diferentes ciclos de subida das taxas de juro em 11 países da UEM. Compreender as causas da heterogeneidade circunscritas ao processo de transmissão das taxas é crucial para melhorar o mecanismo de transmissão da política monetária. Utilizando um modelo ARDL ECM, examina-se a transmissão a curto e longo prazo das taxas de juro e como características específicas de cada país influenciam a transmissão nos períodos de 2000 a 2001, 2005 a 2008 e 2022 a 2024. De 2000 a 2001 e entre 2005 e 2008, a transmissão das taxas de juro diretoras foi mais homogênea em ambos os períodos. Contudo, de 2022 a 2024 a transmissão foi significativamente mais reduzida para todas as taxas de juro. Não obstante, o ritmo da transmissão foi consistentemente rápido ao longo dos vários períodos e para todas as taxas. Adicionalmente, uma maior produção industrial para os grandes empréstimos às SNF e uma inflação superior para os pequenos empréstimos às SNF estão associadas a uma maior transmissão no período de 2022. Para os depósitos das famílias no mesmo período, inflação e índice de preços das ações superiores impactam positivamente a transmissão, enquanto a produção industrial impacta negativamente. Para os depósitos das SNF, a transmissão a curto prazo é impactada negativamente pelo índice de preços das ações, mas positivamente a longo prazo. No ciclo recente, elevados prémios de risco-país impactaram negativamente a transmissão.

Título: Pass-through of monetary policy to bank interest rates in the economic and monetary union

Palavras-chave: Transmissão de taxa diretora; Empréstimos e depósitos bancários, UEM; Ciclo de aumento

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III. List of Abbreviations

| | |
|-------|-------------------------------------|
| ECB | European Central Bank |
| ZLB | Zero Lower Bound |
| EMU | Economic and Monetary Union |
| NFC | Non-Financial Corporation |
| EU | European Union |
| EONIA | Euro Overnight Index Average |
| €STR | Euro Short-Term Rate |
| HICP | Harmonized index of Consumer Prices |
| ARDL | Autoregressive Distributed Lag |
| ECM | Error Correction Model |
| HHI | Herfindahl-Hirschman-Index |

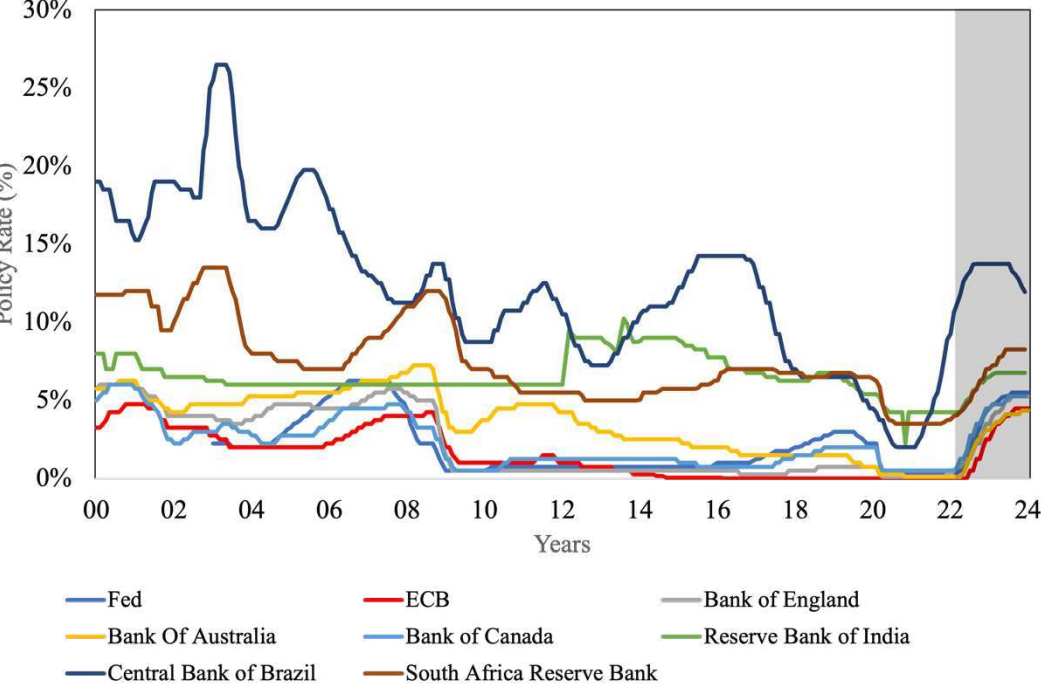
1. Introduction

Since its establishment in 1999, the Economic and Monetary Union (EMU) has navigated through various crises, with the latest being the Covid-19 pandemic and the still ongoing Russia-Ukraine conflict. Rising commodity prices, post-covid aftereffects, global supply chain constraints and geopolitical tensions resulted in rising inflation, which the European Central Bank (ECB) needed to address in 2022 (Lagarde & de Guindos, 2022). After years of low interest rates at the zero lower bound (ZLB), it started what is to this day the fastest tightening cycle with an increase of the key interest rate by 450 basis points in just over one year (ECB, 2024a). With adjustments in its policy rates, the ECB makes use of one of its most common monetary policy instruments, trying to bring back inflation to the 2% target to maintain price stability. This change in the policy rates had a direct effect on the money market rate, which in turn changes the interest rates, at which banks lend and deposit money to firms and households (ECB, 2011). This process, known as the interest rate pass-through, is a vital part of the monetary policy transmission mechanisms. It represents a complex hurdle in understanding how policy adjustments ultimately impact the economy (Gregor et al., 2020).

Analyzing the policy rate decisions by the ECB, we can identify three key periods where interest rates were hiked significantly: from 1999 to 2001, then from 2005 to 2008 and the most recent from 2022 - 2023 (ECB, 2024c). Each of these cycles is characterized by similar triggers and a unique progression. From 1999 to 2001 and 2005 to 2008 interest rate hiking cycles were primarily responses to economic factors in the European Union (EU), such as rising energy and consumer prices, to keep the inflation rate around the 2% target (ECB, 1999). The reason for the rapid increase in the key interest rate in 2022 can be attributed to similar factors as in previous policy interest rate hiking cycles. Rising energy costs, food prices and supply chain constraints forced ECB to act to ensure price stability and decrease inflation.

However, in contrast, the recent key interest hiking cycle follows a global pattern, confirmed by a significant departure from earlier cycles. This is highlighted by *Figure 1*, which demonstrates the recent monetary policy hiking cycle in Europe not only being the most rapid we have ever seen, but also aligning with simultaneous movement by countries worldwide in an unprecedented manner.

Figure 1: Comparison between central banks key interest rates across the world



Source: ECB, FED, Trading Economics, and author’s calculation

Note: Shaded area indicates most recent hiking cycle that is in sync across various countries (start date: July 2022 with the first key interest rate hike by the ECB)

Furthermore, through examining the policy interest rate pass-through in the three different key interest rate hiking periods it can be concluded that prior to the financial crisis in 2008 lending and deposit rates exhibit a more homogenous pass-through behavior (Hristov et al., 2014). This shift underscores the importance of understanding the policy interest rate pass-through in different key interest rate hiking cycles to identify the determinants of heterogenous pass-through. Such an understanding is crucial, as the relevance of policy interest rate pass-through stems from the fact that the speed and magnitude of changes in key and money market interest rates relative to lending and deposit rates have a significant impact on the strength of monetary policy transmission and, ultimately, on price stability (Aristei & Gallo, 2014). The heterogeneity in the pass-through of the EMU’s policy interest rate to bank lending and deposit rates is a widely known and well documented phenomenon that illustrates the complexity of monetary transmission mechanisms across various European countries. In light of this, research in recent years has identified several bank- and country-specific characteristics that influence the size and speed of interest rate pass-through in the EMU. These including, but not limited to bank size, liquidity or country-specific characteristics such as market concentration of banks (Holton & Rodriguez d’Acari, 2018).

Against this backdrop, it is important to analyze and compare how the policy interest rate pass-through to bank lending and deposit rates is impacted in different times of crisis and economic adjustments, more precisely in periods of policy interest hiking cycles. Such a comparative analysis can provide invaluable insights into the evolving challenges and resilience of the monetary policy transmission mechanism and thus help to understand the magnitude and its determinants of the heterogeneous pass-through of policy rates in the EMU.

This thesis strives to provide empirical evidence on the country-specific macroeconomic, financial market and banking sector determinants on size and speed of short- and long-term policy interest rate pass-through while comparing different policy interest hiking cycles in the EMU.

Considering these factors, this thesis explores the following research question: *How do country-specific characteristics within the Economic and Monetary Union affect the policy interest rate pass-through to banks lending and deposit interest rates in different policy rate hiking cycles?*

The structure of this thesis is organized as followed. Chapter 2 will provide a literature review subdivided into three parts. First there will be an overview of how the monetary policy transmission mechanisms work, as well as the principles of policy interest rate pass-through. This is followed by a review of the pass-through of policy rates to bank lending and deposit rates and their determinants. Finally, the common methodologies employed in these studies are analyzed and discussed. Chapter 3 discusses the data that was used in detail. Chapter 4 describes the analysis of the data described previously and the methodology to carry out the analysis. Chapter 5 discusses the results of the two estimated models. Finally, Chapter 6 provides a comprehensive overview of the dissertation and possible future research on the topic.

2. Literature Review

2.1 Monetary Policy and Pass-through Mechanism

To gain an understanding of how monetary policy decisions are transmitted to the economy it is essential to elaborate on the functioning of **monetary policy**. The overall goal of the central bank is to maintain price stability, by aiming to keep the inflation rate close, but below the 2% threshold (ECB, 2011). In the context of the euro area, to achieve this, the ECB can make use of several monetary policy instruments. Conventional monetary policy primarily operates through the setting of interest rates. Through this mechanism, central banks influence economic activity and inflation (ECB, 2011).

When these instruments are implemented, several complex mechanisms transmit through different channels to ultimately influence the economy and the prices (ECB, 2011). The transmission mechanisms of monetary policy start by the ECB setting the official interest rates. Through this, the ECB directly impacts the money market rate which in turn influences the overall bank loans and the interest rates set by banks for short-term deposits and loans. These interest rates directly influence the supply of credit to households and firms (ECB, 2011). Changes in the money market rate influence savings, spending and investments of households as well as firms. This influence on investment decisions has indirect effect on the employment and goods market. Furthermore, asset prices may change because of the effects of monetary policy activities on market expectations and financing circumstances in the economy. Ultimately, the transmission of the ECB policy interest rate through the different channels ends up influencing price developments. However, it is impossible for the ECB to precisely control the transmission mechanisms, as this is also influenced by exogenous shocks, such as a change in commodity prices or the global economy (ECB, 2011).

Given these challenges, it is important to understand the size and speed of the policy interest rate pass-through to banks loan and deposit rates, as it is closely tied to the effectiveness of monetary policy in achieving macroeconomic goals such as stabilizing prices and output (Beyer et al., 2024).

2.2 Policy Interest Rate Pass-through in the EMU & Europe

To better illustrate the pass-through of policy interest rates to bank lending and deposit rates, a marginal cost pricing model can be used, as given by de Bondt (2005):

$$br = \alpha + \beta mr$$

In this equation, the bank rate (br) is dependent on a constant mark up (α), the long-term pass-through of policy interest rate (β) and the market rate (mr). The long-term pass-through is defined between 1 and 0, whereby 1 would denote a perfect market and a bank risk that is neutral (Gigineishvili, 2011). Analyzing the long-term pass through is an essential component of the research on policy interest rate pass-through, as it subject to a range of influencing factors that are discussed in more depth in the following (de Bondt, 2005).

Against this backdrop, the extensive coverage of policy interest rate pass-through to bank lending and deposit interest rates in recent literature becomes particularly relevant. The focus and methodologies reveal diversity across studies.

A substantial amount of the cross-country examination studies focus solely on regional or economic unions such as the **EMU** and **Europe**. (Andries & Billon, 2016; Belke et al., 2013; Bernhofer & van Treeck, 2013; Holton & Rodriguez d’Acri, 2015; Hristov et al., 2014; Leroy & Lucotte, 2015a). Within the studies different approaches are used to identify the driving factors that influence the policy interest rate pass-through. It is worth noting that some studies focus solely on the heterogeneity, speed or short- and long run equilibrium of the pass-through rate and not the underlying causes, but these are in the minority (Petrevski & Bogoev, 2012). Building up on this particular focus, Belke et al. (2013), who examined 12 countries within the EMU in the period between 2003 and 2011, discovered that the loan pass-through rate to non-financial corporations (NFC) is much more homogenous and almost complete, contrary to household loans.

Most of the literature tries to explain the underlying cause of why the interest rate pass-through to **bank loan rates** is incomplete. Holton & Rodriguez d’Acri (2018) carry out an extensive study as they both examine macroeconomic variables such as inflation and industrial production, but at the same time also bank level data such as size, liquidity, and external liabilities of banks. The authors (Holton & Rodriguez d’Acri, 2018) analyzed small and large loan interest rate pass-through and concluded that an increase in size of the bank weakens the pass-through rate of money market rates for small loans. However, they found that a higher

capital ratio is linked with a significantly lower immediate reaction to a change in money market rates.

Recent studies, that focused on the relationship between bank capital requirements and monetary policy in the euro area, revealed that alterations in bank capital requirements can impact the transmission of monetary policy to corporate lending rates (Imbierowicz et al., 2020). Furthermore, the banking market structure, including competition levels among other things, can affect the efficiency of the interest pass-through rate to loans (Carbó et al., 2009).

All together the literature verifies that there is a heterogeneity in the policy interest rate pass-through on a country and banking level on loan interest rates within and outside of Europe. Gregor et al. (2020) confirmed this through a Meta-Analysis that contained over 50 analyzed empirical studies and more than a thousand estimates that the average policy interest rate pass-through to bank lending rates is incomplete with an average of 82%.

While most of the literature focuses solely on the interest pass through on bank lending rates, the effect on **bank deposit rates** has not yet been sufficiently studied and its importance should not be overlooked. Past research has revealed that the adjustment of retail lending interest rates tends to be more uniform and complete compared to retail deposit interest rates, indicating heterogeneity in interest rate stickiness and adjustment asymmetry (Kovanen, 2011). Looking at the euro area Mojon (2000) concluded that there is insufficient short-term pass-through for deposit rates, particularly for saving deposits, and that deregulation has had a major impact on the interest rate pass-through for deposits but not loans.

Especially in the early years after the euro was introduced, it was observed that the stickiest bank interest rates with a long-term pass through of only almost 40% were overnight deposits and deposit redeemable at notice of up to three months (de Bondt, 2005). However, it should be noted that the overall speed of the interest rate pass-through increased since the launch of the euro in 1999. One likely explanation for the increase in speed is the trend towards an acceleration of competition within the retail banking market (de Bondt, 2005). Regarding recent literature, Kho (2024) tries to shed light on the asymmetric response of deposit pass-through rates in the European area, as the study provided empirical evidence on 13 European countries in the period between 2003 and 2023. Kho (2024) showed that in a higher concentrated banking sector the pass-through rate speed on overnight and time deposits to households and NFCs is slower when monetary policy interest rates increase and therefore faster when monetary policy interest rates decline (Kho, 2024).

With the introduction of the **negative interest rate** policy by the ECB in 2014, the deposit facility rate was cut below zero percent for the first time in history of the European Union (Altavilla et al., 2022a, 2022b). With European banks passing these negative interest rates through to corporations and customers, albeit with significant variations in the different European countries, the common belief was challenged that banks would not be able to cut deposit interest rates below zero percent. This is because, firms and households could just hold on to cash, which would yield zero percent interest (Blot & Labondance, 2022). Altavilla et al. (2022a) discovered that in times the deposit interest rates are above the ZLB, financially constrained banks are more likely to pass-through policy interest rates. Contrary, if deposit interest rates fall below the ZLB, financially stable banks are more capable of passing through the negative deposit interest rates to their customers (Altavilla et al., 2022a).

Past studies have already shown that there is a fundamental heterogeneity in the pass-through rate in Europe (Gregor et al., 2020). As the policy rate remains one of the most important instruments in the ECB's monetary policy, especially in times of crisis, it is important to understand how the pass-through of the policy interest rate varies in different **interest hiking cycles** (Beyer et al., 2024). A variety of current literature that deals with the comparison of the pass-through rate within different hiking cycles identifies that the pass-through in the post-COVID hiking cycle is weaker overall than in the previous ones. In particular, the pass-through rate to household term deposits as well as to business and household overnight deposits (Byrne & Foster, 2023). Beyer et al. (2024) identified several factors that contributed to the incomplete pass-through of policy interest rates to deposit rates during the period following the post-COVID hiking cycle. These include a higher financial sector concentration, a larger volume of deposits relative to loans and greater liquidity. However, it should be mentioned that Beyer et al. (2024) could not find significant evidence that the pass-through of loan rates to NFCs and NFC time deposits are smaller and slower in the post-COVID interest hiking cycle.

2.3 Methodological Approaches in Studying Interest Rate Pass-Through

Taking a closer look at the methodology of various studies, a clear trend emerges. Predominantly, studies utilize an autoregressive distributed lag (ARDL) and error correction model (ECM) approach (Holton & Rodriguez d'Acri, 2018; Leroy & Lucotte, 2015b). The combination of these approaches offers a variety of advantages that are particularly important when analyzing policy interest rate pass-through to bank lending and deposit interest rates. These include analyzing simultaneously immediate effects of policy changes and the long-term adjustments towards equilibrium (Holton & Rodriguez d'Acri, 2018). Furthermore, these models are flexible in dealing with variables with different orders of integration. Especially the ECM provides valuable information by measuring the speed of adjustment to the long-term equilibrium, after deviating due to a shock (Leroy & Lucotte, 2015b).

However, some studies also utilize a vector approach in form of a VAR model. Through this the traditional ARDL model is extended by including a multivariate approach, as is it possible to compare the policy interest rate pass-through by looking at different instruments simultaneously (de Bondt, 2005).

3. Data

To analyze the policy interest rate pass-through to bank lending and deposit rates, the dataset used in this thesis is in panel form for 11 different countries within the EMU. These countries include the founding countries of the EMU: *Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain*. Luxembourg was excluded due to lack of data availability, while *Greece*, which joined the EMU in 2001 and had great data availability, was included (Leroy & Lucotte, 2015b). The panel dataset has a monthly frequency in the period from January 2000 to January 2024 and has been collected from various sources, including Eurostat, World Bank, OECD and, the ECB database. The past three policy interest hiking cycles of the EMU are analyzed: 1999¹ to 2001, 2005 to 2008 and 2022 to 2023². An extensive summary of the data and the variable description can be found in *Table A-11* in the Appendix.

3.1. Dependent Variables

Data on bank loan and deposit interest rates has been selected for each of the 11 countries from the ECB database and were distinctly categorized between households and NFCs. The distinction was made so that it is possible to examine whether there are significant differences in the policy interest pass-through rate in individual sectors (Aristei & Gallo, 2014). A total of three separate loan interest rates and two separate deposit interest rates were used, a visual comparison of the average European loan rates and deposit rates can be seen in *Figure 2 & 3*.

The three bank loan interest rates are *a) loan interest rates to households, b) loan interest rates to NFCs big loans* and *c) loan interest rate to NFCs small loans*. All of the bank loan and deposit rates refer to so-called “new business” which refers to loans that were newly agreed between the bank and the borrower. This makes it possible to capture the contemporaneous lending conditions, which are influenced by the latest monetary policy measures. Furthermore, all loans have a certain interest rate fixation period during which the lending rates will remain the same. However, after this period these lending rates are adjustable until the maturity of the loan.

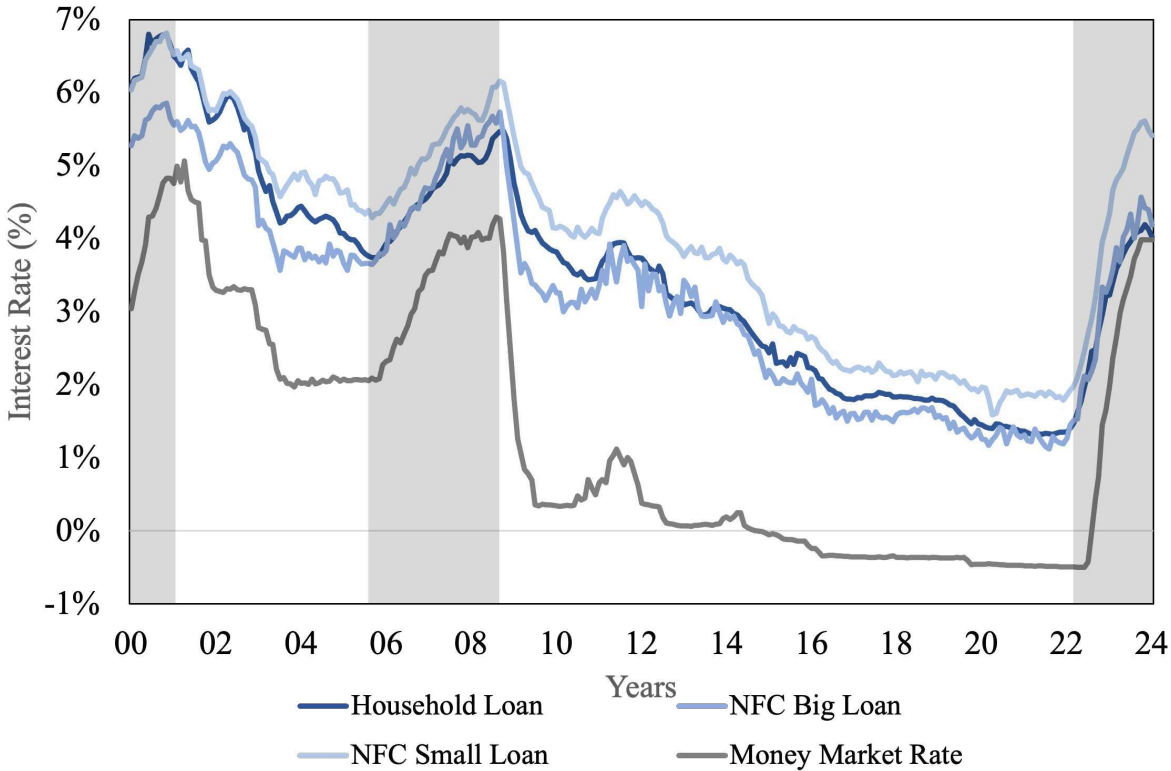
¹ Due to data availability this observation period starts in January 2000.

² Even though the hiking cycles ended in September 2023, the observation period is extended till January 2024 to enrich the analysis with more data points.

Household lending rates used in this thesis are the weighted average of four different bank lending rates with varying maturities: up to one year, over one and up to five years, over five and up to ten years and up to ten years. All of them are bank lending rates to households specifically for house purchases. The large number of these loans and the availability of extensive data led to the selection of this focus, which offers a clearer and more comprehensive view.

As mentioned above, bank lending rates to NFCs are divided into two categories: *small loans to NFCs up to EUR 1M* and *big loans to NFCs over EUR 1M*. This distinction is made to capture not only bank lending rates to small and medium-sized enterprises, but also to large enterprises (Holton & Rodriguez d’Acri, 2018). NFC lending rates used in this thesis comprise of the weighted average of three different bank lending rates with varying maturities: over one year, over one and up to five years and over five years.

Figure 2: Average EMU bank loan interest rates

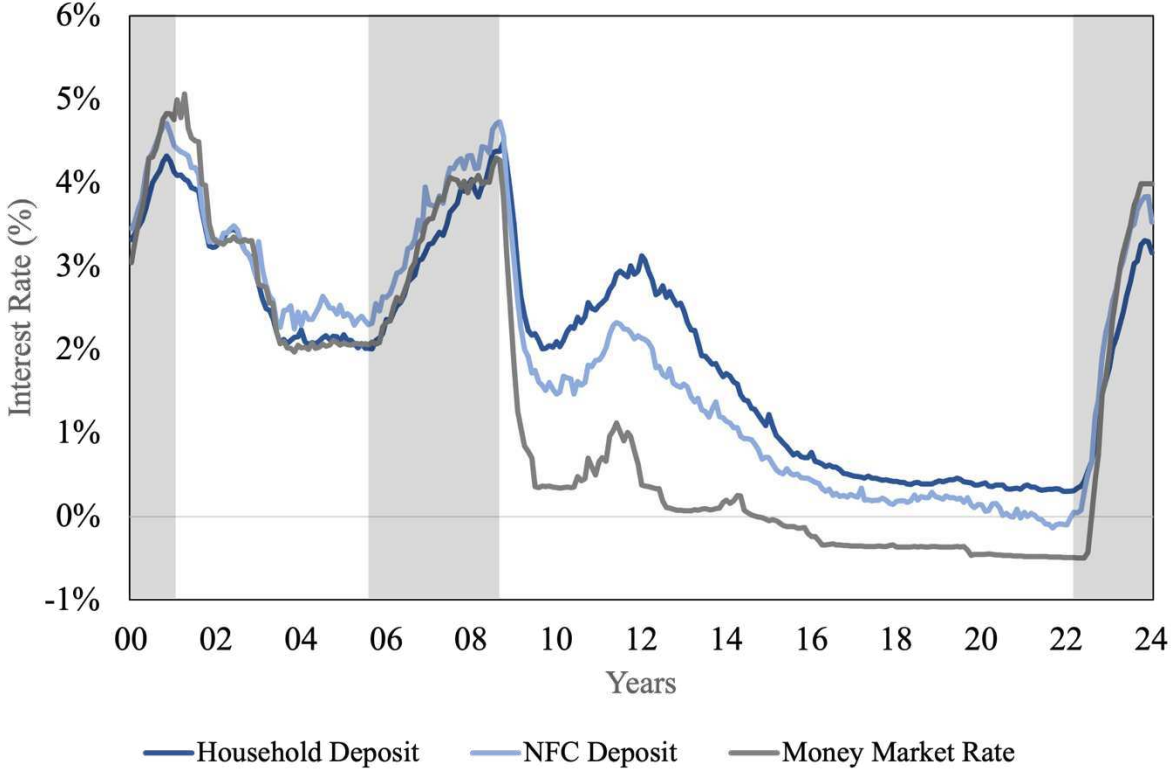


Source: ECB and author’s calculation
 Note: Shaded areas indicate the observation periods

The bank deposit rates can be divided into *d) deposit interest rates to households* and *e) deposit interest rates to NFCs*. Here no distinction is necessary between small and medium-sized and large enterprises. Furthermore, deposit interest rates with an agreed maturity were included. The reason for this is that, even though overnight deposits have a larger volume they tend to be stickier due to their greater liquidity. Therefore, it is more relevant when analyzing pass-through to look at deposits with an agreed maturity, as firms and households price elasticity may be higher (Beyer et al., 2024; Byrne & Foster, 2023).

Bank deposit interest rates to households and NFCs are calculated as the weighted average of four different deposit interest rates with varying maturities: up to one year, over one and up to two years, up to two years and over two years. Different from those used for bank lending rates, the maturities used for bank deposit rates to households and NFCs were modified to fit the data that was available.

Figure 3: Average EMU bank deposit interest rates

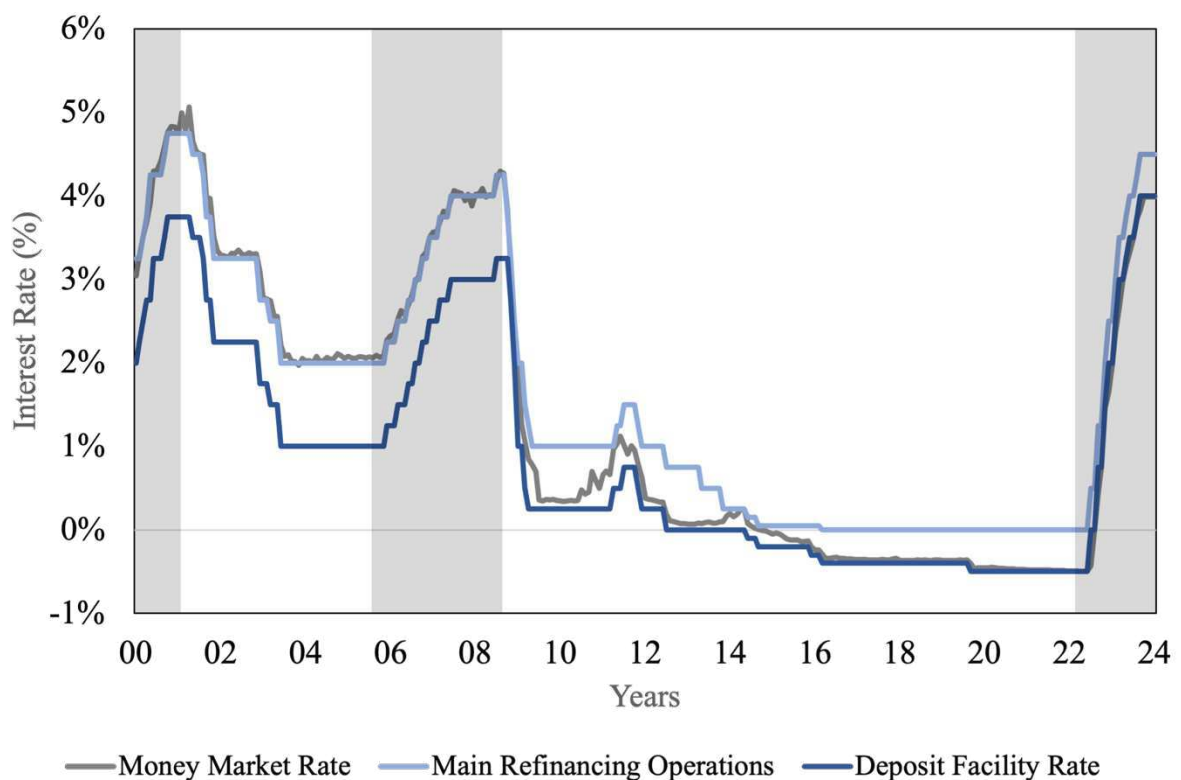


Source: ECB and author's calculation
 Note: Shaded areas indicate the observation periods

3.2. Independent Variables

To capture the policy interest rate pass-through to bank lending and deposit interest rates a money market rate is used that is close to the key interest rate set by the ECB. Since the global financial crisis in 2008, the deposit facility rate has increasingly served as a more relevant policy benchmark than the main refinancing operation, particularly due to its role in setting the lower limit of market interest rates and managing excess liquidity in the euro areas banking system (Greene, 2002; Hristov et al., 2014). The European overnight index average (EONIA) and euro short-term rate (€STR) represent the implicit operational target and are therefore directly linked to the key interest rate, which is why they were chosen over the 3-month EURIBOR to represent the money market rate (*Figure 4*) (Linzert & Schmidt, 2008). Furthermore, infrequent changes in the key interest rate necessitate the combination of EONIA and €STR as a proxy (de Bondt, 2005).

Figure 4: Comparison Money Market Rate (EONIA & €STR), Main Refinancing Operations and Deposit Facility Rate

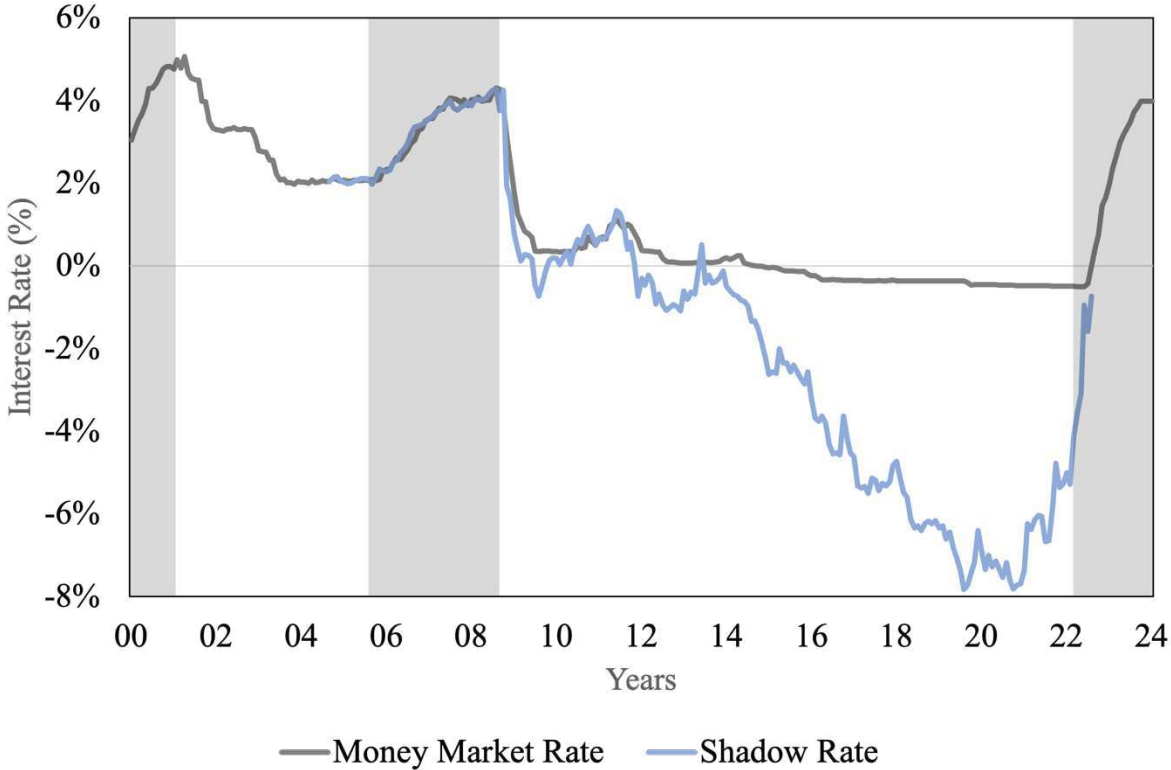


Source: ECB and author's calculation

Note: Shaded areas indicate the observation periods

As of October 2019, the EONIA is no longer used by the ECB as the overnight interest rate benchmark and was replaced by the €STR (ECB, 2022). To ensure consistency in this thesis, the interest rate of the €STR minus 8.5 basis points was used as the money market rate from October 2019, as this is the official calculation method (ECB, 2022). Additionally, this thesis uses an estimate of the shadow rate to test the results regarding the pass-through of monetary policy to bank lending and interest rates. The shadow rate offers insight into the behavior of interest rates during crises when traditional policy tools are limited, mirroring the real economy’s response to such scenarios (De Rezende & Ristiniemi, 2023). The concept was first introduced by Black (1995) and describes the short-term interest rate without the option to hold currency (Wu & Xia, 2017). The shadow rate, as calculated by Wu & Xia (2017) is used to cover the period from September 2004 to August 2022 (Figure 5). For the period before and after this time frame, the shadow rate is complemented by the money market rate (EONIA & €STR).

Figure 5: Comparison Money Market Rate and Shadow Rate



Source: ECB, Wu & Xia and author’s calculation

Note: Shaded areas indicate the observation periods

3.3. Control Variables

By adding country-specific control variables, which are also independent variables, it is possible to isolate the relationship between bank lending and deposit interest rates and the money market rate, while considering country-specific characteristics that may influence the pass-through of the policy interest rate. In addition, all control variables are categorized into one of three different groups consisting of macroeconomic indicators, financial market indicators and bank sector indicators.

Among macroeconomic indicators, industrial production, inflation, and GDP at market prices stand out as measures of the economy and potential determinants of policy interest rate pass-through. Industrial production can be seen as a strong indicator of the health of an economy and for some it is also seen as a proxy for the demand of loans. Additionally, with an increase in industrial production banks could be incentivized to shift their portfolios towards riskier investments (Holton & Rodriguez d’Acri, 2018; Leroy & Lucotte, 2015b). Industrial production was initially given with the base year of 2015 (2015 = 100) but was converted into growth rate to ensure consistency with the other variables. It includes industries such as mining and quarrying, manufacturing, electricity, gas, steam, and air conditioning supply (Eurostat, 2024). Leroy & Lucotte (2015b) argue that typically an increase in industrial production can be associated with a growing or flourishing economy. However, this might be associated with a moderated pass-through of policy interest rates due to lower perceived credit risks. Therefore, no clear expectation regarding the influence of industrial production on the pass-through can be made. Similarly, the inflation rate computed as the rate of change in the harmonized index of consumer prices, can be seen as an indicator of economic performance and a key indicator of changes in the ECB’s monetary policy. (Leroy & Lucotte, 2015b). Furthermore, high inflation leads to a more frequent adjustment in prices and money market rates, which causes banks to adjust their loan and deposit interest rates more frequently (de Bondt, 2002; Leroy & Lucotte, 2015b). It is thus expected in this study that an increase in the inflation rate is associated with a higher policy interest rate pass-through. Furthermore, GDP at market prices is included in this study for robustness check of the model, as it represents the total value of all goods and services produced within a country’s borders over a specific time period and serves as an adequate measure of economic activity, which is what industrial production is intended to proxy. The data was obtained from the ECB statistical data warehouse, originally at a quarterly frequency, but was converted to monthly frequency through linear interpolation to ensure consistency throughout the dataset. Since GDP at market prices also reflects the health

of an economy, it is expected in this study that an increase in GDP at market prices is also associated with an increase in policy interest rate pass-through.

Financial market indicators included are stock price indices and country risk premium. These variables are crucial to understand the influence on Europe's banking sector, which is very strongly linked to the financial markets (Leroy & Lucotte, 2015b). Stock price indices are calculated by the monthly average of daily closing stock prices from common shares of companies traded on domestic or international stock exchanges (OECD, 2024). It was originally given with a base year of 2015 (2015=100) but was also converted into a growth rate to ensure consistency in the dataset. It signals market sentiment and economic trends, influencing monetary policy decisions by the ECB and therefore also the policy interest rate pass-through (Hubert & Maule, 2021). Therefore, it is expected in this study that strong stock price indices are associated with an increase in policy interest rate pass-through (Leroy & Lucotte, 2015b). Moreover, country risk premium is calculated as the spread between the countries' ten-year bond rate and a risk-free bond, represented here by the ten-year government bond by Germany. Accordingly, the country risk premium of Germany is 0. It is a measure of how much riskier it is for an investor to hold the specific long-term country bond rather than a safe short-term benchmark (Leroy & Lucotte, 2015b). Therefore, it is expected in this study that a higher country risk premium is associated with a decrease in policy interest rate pass-through.

Finally, banking sector indicators are represented by leverage ratio and banking market concentration. The leverage ratio is calculated by dividing the Tier 1 capital of monetary financial institutions (excluding central banks of the European system) by their total leverage ratio exposure. This exposure includes all assets and off-balance-sheet entities, regardless of risk level (ECB, 2023b). It offers a clear evaluation of whether a bank has enough capital to cover all its possible liabilities and serves as a vital sign of both financial stability and regulatory compliance (ECB, 2023b). A clear prediction of the association on policy interest cannot be given as it depends on broader economic conditions and market dynamics. Ultimately, banking market concentration is represented by the Herfindahl-Hirschmann Index (HHI). Banking market concentration is used in this thesis only for robustness checks, as it is reported at an annual frequency and interpolation was used to convert it to a monthly frequency. The HHI is calculated as the ratio of total assets of banks within a country (ECB, 2023a). A high banking market concentration indicates a less competitive market, which can lead to the banks exploiting their market power and therefore is associated with passing less of the policy interest rate through (Gödl-Hanisch, 2022).

4. Methodology

To capture the effect of policy interest rate pass-through to bank lending and deposit interest rates this thesis models the relationship between the policy rate (independent variable) and the different lending and deposit rates (dependent variables) with parallel control for country-specific characteristics that may influence the pass-through. The vast majority of the literature has used an ARDL and/or ECM framework to capture the effect and magnitude of the policy interest rate pass-through to bank interest rates. The great advantage of these models is its ability to estimate short- and long-term dynamics simultaneously while also taking into account the heterogeneity across different groups (Cho et al., 2023). Furthermore, it is also possible to analyze the size of the pass-through.

To take advantages of all these benefits this thesis employs an ARDL error correction model. The ARDL error correction model is estimated through a panel regression analysis with country fixed effects. Panel regression is used as it incorporates an enhanced estimation efficiency and allows for detailed examination and direct control of variables influence across different entities, such as countries (Wooldridge, 2010).

To account for unobserved heterogeneity and prevent biased results, country fixed effects (μ_i) were included in the panel regression. This ensures that the policy interest rate pass-through can be observed accurately without confounding effects of stable national characteristics (Greene, 2002).

The ARDL error correction model to measure short- and long-term policy interest rate pass-through to bank lending and deposit interest rates, follows a similar approach as employed by Holton & Rodriguez d'Acri (2018) and is given as:

$$\Delta br_{it} = \mu_i + \sum_{j=1}^n \alpha_j \Delta br_{i,t-j} + \sum_{k=0}^n \beta_k \Delta pr_{t-k} + \delta br_{i,t-1} + \theta pr_{t-1} + \sum_{m=0}^n \gamma_m \Delta X_{i,t-m} + v_{it} \quad (1)$$

In this model the corresponding bank rate (Δbr_{it}) (lending and deposit rates to households and NFC's) depends on the past changes of the bank rate ($\Delta br_{i,t-j}$), as well as the past changes of the policy rate (Δpr_{t-k}) and the so-called error correction term, represented by

$\delta br_{i,t-1} + \theta pr_{t-1}$ ³. The coefficient β_0 denotes the short-term pass-through of policy interest rate that is transmitted to bank lending and deposit interest rates.

The term denoted as $\Delta \mathbf{X}_{i,t}$ represent the different control variables that include the various macroeconomic, financial market and bank sector country-specific indicators. As discussed above, these variables are included in the equation controlling for the numerous factors that can influence the transmission of policy interest rate pass-through to banks' lending and deposit interest rates. By accounting for these control variables, the model aims to isolate the effect of policy rate changes on bank rates more accurately, ensuring that the observed relationships are not confounded by changes in these country-specific characteristics.

As the ECM assumes a long-run equilibrium between the bank rates and the policy rate, to estimate the long run pass-through, both the long-run coefficient of the policy rate (θ) and the bank rate (δ) in this equilibrium relationship are examined (Cho et al., 2023). The long-term pass-through represents the proportional change in bank rates in response to a change in the policy rate when the bank rates have fully adjusted to any shocks or deviations from equilibrium. When the equation is in long-term equilibrium, the change in the bank rates ($\Delta br_{i,t}$) is zero, leading to the equilibrium condition given by $0 = \delta br_{i,t-1} + \theta pr_{t-1}$. To isolate the long-run pass-through from this condition, the equation can be rearranged to $br_{t-1} = -\frac{\theta}{\delta} pr_{t-1}$. Therefore, in the long run, the pass-through, which is the expected change in bank rates for a given change in policy rates, is represented by the ratio of the coefficients θ and δ .

To estimate the time it takes to return to equilibrium, this thesis uses the concept of the so-called "half-life" within the framework of the ECM. Half-life is a well-known when it comes to physics to calculate, for example, the half-life of radioactive atoms. A modified half-life formula is adapted here to determine duration needed for half of the initial disequilibrium to adjust back to its long-term equilibrium state after a shock (Choi et al., 2006). The standard ECM yields that a fraction of the disequilibrium, given by δ , is corrected each period. Assuming the initial total disequilibrium is given by ω_0 , then the remaining disequilibrium after one period can be described as $(1 + \delta)\omega_0$ ⁴. Applying this to the half-life formula as used by Choi et al. (2006) the half-life (**hl**) is estimated as followed:

³ This represents the converted error correction term. Holton & Rodriguez d'Acari (2018) show that the error correction term can be written as $\delta(br_{i,t-1} - pr_{t-1}) + \mu pr_{t-1}$, whereby $\theta = (\mu - \delta)$ (Pesaran & Shin, 1999).

⁴ δ is given here by the long run pass-through $-\frac{\theta}{\delta}$

$$hl = \frac{\ln(0.5)}{-\ln\left(1 + \frac{\theta}{\delta}\right)}$$

To capture the isolated influence of the different country-specific characteristics on the policy interest rate pass-through a similar approach as in Holton & Rodriguez d’Acri (2018) is used. The second equation including interaction terms is given by:

$$\begin{aligned} \Delta br_{it} = & \mu_0 + \sum_{j=1}^n \alpha_j \Delta br_{i,t-j} + \sum_{k=0}^n (\beta_k \Delta pr_{t-k} + \beta_k^* \Delta pr_{t-k} X_{t-1}) + \lambda X_{t-1} + \delta br_{i,t-1} \\ & + \delta^* \Delta br_{i,t-1} X_{t-1} + \theta pr_{t-1} + \theta^* pr_{t-1} X_{t-1} + \sum_{m=0}^n \gamma_m X_{i,t-m} + v_{it} \end{aligned} \quad (2)$$

All interaction terms are included with one period lagged terms to minimize potential endogeneity (Holton & Rodriguez d’Acri, 2018). Furthermore, all control variables interaction terms are estimated separately, to isolate their affect. Looking at the expression $\beta_k \Delta pr_{t-k} + \beta_k^* \Delta pr_{t-k} X_{t-1}$ the short term pass-through can be estimated by $\beta_0 + \beta_0^*$. The long run policy interest rate pass-through can be estimated by looking at the expression $\delta br_{i,t-1} + \delta^* \Delta br_{i,t-1} X_{t-1} + \theta pr_{t-1} + \theta^* pr_{t-1} X_{t-1}$, whereby $-\frac{\theta + \theta^*}{\delta + \delta^*}$ denotes the long-term pass-through formula.

Direct interpretation of the short- and long-term coefficients of the interaction terms can be misleading because the variables in this ARDL error correction model are continuous (Holton & Rodriguez d’Acri, 2018). Therefore, to ensure an accurate interpretation of the interaction coefficients in this analysis, dummy variables are implemented. For every control variable a corresponding dummy variable was created. The control variables were assigned a value of “1”, if their average was above the median of the control variables across all observed countries, otherwise a value of “0” was assigned. The interaction terms coefficients now provide insights into how control variables above and below the median influence the relationship between the policy rate and the corresponding bank lending rate.

Furthermore, the half-life formula can be modified to:

$$hl = \frac{\ln(0.5)}{-\ln\left(1 + \frac{\theta + \theta^*}{\delta + \delta^*}\right)}$$

5. Results

To validate the underlying assumptions of the ARDL error correction models, preliminary tests were conducted. First a correlation analysis was performed to identify and quantify the degree of linear relationship between the policy interest rate and bank lending and deposit rates. *Table A-12* in the Appendix shows that the policy interest rate and the bank interest rates are significantly correlated in all three observation periods (2000-2001, 2005-2008 & 2022-2024). However, it is clearly visible that a higher correlation is present in the second observation period, except for big loans to NFC.

Furthermore, the Harris-Tzavalis panel unit root test was performed to ensure that the integration of the variables is either $I(0)$ or $I(1)$, as ARDL models can handle variables that are stationary or integrated at first order, but not higher (*Table A-13*). All variables are of first difference ($I(1)$), except industrial production, stock price index, and leverage ratio⁵, which are at level ($I(0)$).

To ensure the robustness of the ARDL error correction models and to test for a stable long-term relationship between the policy interest rate and bank lending and deposit interest rates, the Westerlund cointegration test was conducted. The results, detailed in *Table A-14* in the Appendix, indicate the presence of cointegration⁶ between the policy interest rate and most of the bank lending and deposit rates across the observed periods. This result supports that even with short-term disequilibrium, there is a stable long-term relationship, supporting the use of the ARDL error correction model in this analysis (Leroy & Lucotte, 2015b).

Estimating equation (1) provides insights into the short- and long run effects across the 11 EMU countries regarding policy interest rate pass-through to bank lending and deposit interest rates. To put these results into perspective, the short- and long run pass-through as well as the half-life was also estimated for the whole euro area. A detailed overview can be seen in the Appendix in *Tables A-15 to A-18*.

In general, what is striking about the results is that in the period of 2000 to 2001 and from 2005 to 2008, not only the pass-through is more homogenous, but also the size of the pass-through is very close to each other. However, a significantly lower level of policy interest rate pass-

⁵ Leverage ratio is $I(0)$, except in the period of 2022 to 2024 it is $I(1)$.

⁶ Significant cointegration between the policy rate and bank rates was found in all periods, except for deposit interest rates to households in the second observation period and for loans to households in the first observation period.

through can be observed for all bank interest rates in the 2022 to 2024 observation period. Comparing these findings to the euro area, for almost all periods and bank rates the pass-through is weaker, which could be attributed to differences in countries in terms of policy interest rate pass-through. However, even though there are significant variations in the pass-through size, the speed at which the policy interest rate is passed through to bank lending and deposit interest rates is relatively fast for all observation periods and samples.

Regarding short run pass-through (β_0) to bank loan rates within the EMU sample, varying results are observable. As can be seen in *Figure 6*, looking at loans of over one million euros, the pass-through between 2000 and 2001 as well as 2005 to 2008 is 42% and 38% respectively. However, in the period of 2022 to 2024 the short run pass-through is significantly higher with 67%. One explanation for this result could be that an overshoot effect occurred, as the fastest interest rate hiking cycle on record took place during this period. Because of this rapid increase, and the fact that the policy interest rate was already at to the zero lower bound, banks may have passed-through more in the short-term to lending rates and less in the long-term as the economy and market began to stabilize. Similar can be observed when looking at small loans to NFC, as the period of 2022 to 2024 has the highest pass-through with 60%, against the more sluggish 35% and 19% pass-through from period 2000 to 2001 and 2005 to 2008. However, evaluating the long run pass-through ($-\frac{\theta}{\delta}$) in the period of 2022 to 2024 for big and small loans to NFC, the pass through is significantly lower with 48% and 47% respectively (*Table A-16*). These results contrast with previous findings, as Beyer et al. (2024) claim that the pass-through in the long run to NFC loans in post-pandemic policy interest rate hiking cycle was higher than in previous cycles. Furthermore, Beyer et al. (2024) found that the pass-through to interest rates on loans to NFCs in this recent tightening cycle were overall faster, which is in contradiction to this finding with the half-life being significantly longer for big and small loans to NFCs in the period of 2022 to 2024 (*Figure 7*). This becomes even more evident when looking at the euro area for the period of 2022 to 2024 with a long run pass through of 22% and a half-life of over 3.5 months⁷. One explanation for the divergence found in the results of this thesis and the ones from Beyer et al. (2024) could be that the study used 30 European countries including nations like Albania, Cyprus, Romania, Malta, Serbia, Slovakia, and the UK that were not used in this thesis. Beyer et al. (2024) also acknowledged limitations regarding data availability and

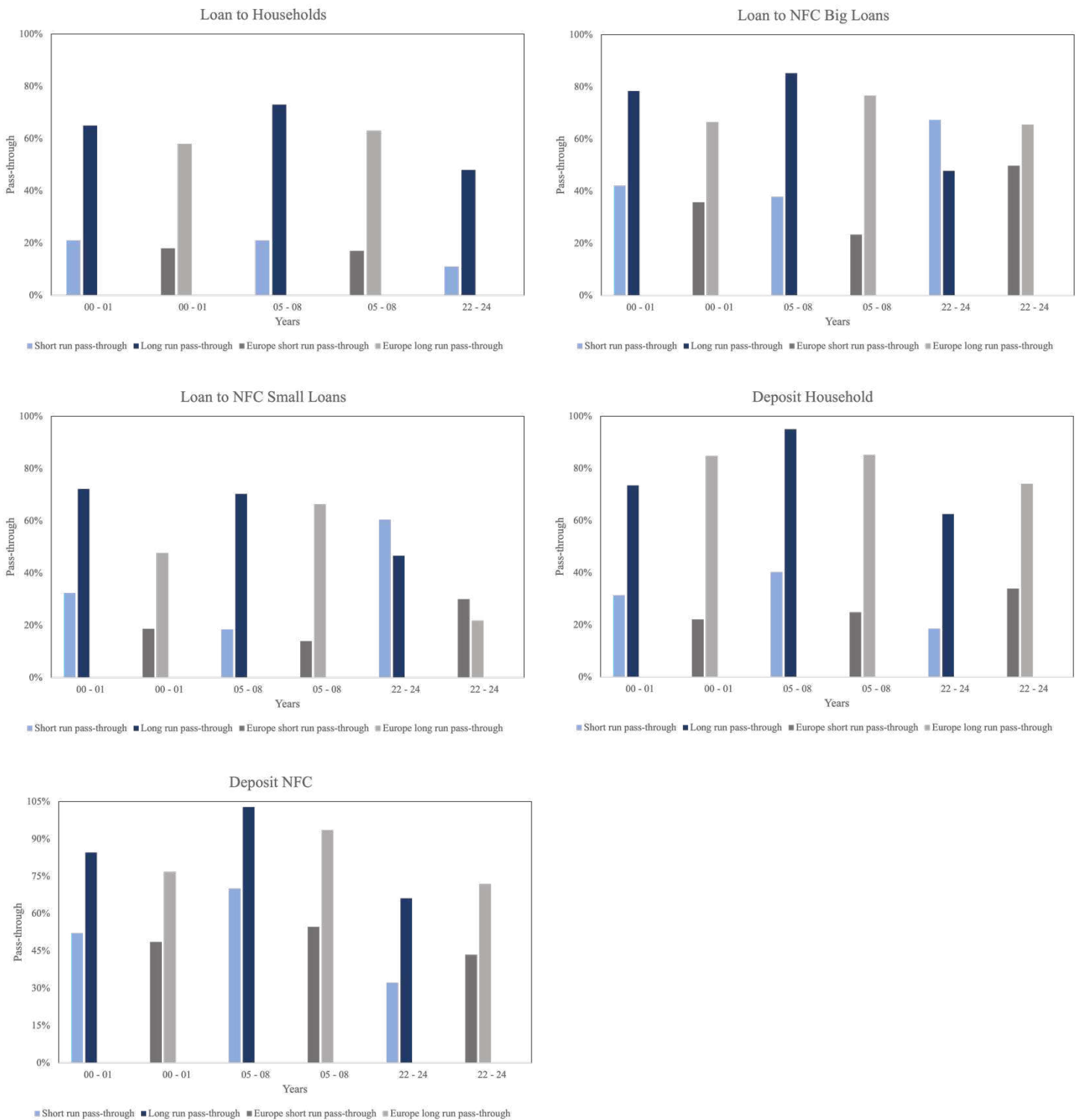
⁷ The long run coefficient as well as the half-life were not significant for this period.

the heterogeneity of the economic and regulatory environments across these countries, as such factors likely can influence the results.

Analyzing the pass-through to banks deposit interest rates, it is evident that the short run pass-through especially to household deposit rates is fairly strong in the period from 2000 to 2001 with 31% and from 2005 to 2008 the pass-through rises to around 40%. However, from 2022 to 2024 the pass-through declines sharply to 19%. The same picture emerges when looking at NFC deposits, as between 2000 to 2001 52% of policy rate changes are passed-through immediately and between 2005 to 2008 even 78% are. As with household deposits, only 32% of policy interest rates were passed through to NFC deposit interest rates between 2022 and 2024. These findings are in line with the study conducted by Kho (2024), as his results also indicate that the pass-through to deposit rates was more complete before the financial crisis in 2008.

When analyzing the long run pass through to household and NFC deposit rates a complete pass through can be observed in the period of 2005 to 2008 with 95% and 102% respectively. However, in the period from 2022 to 2024 only 62% of the policy rate was passed through to household deposits and 66% to NFC deposits. The incomplete pass-through to household and NFC deposit rates can be attributed to different factors influencing the pass-through. Negative interest deposit rates altered the behavior of consumers, firms, and banks. Due to the low rates depositors are less sensitive to rate changes, which reduces the need of the banks to pass-through the policy interest rates to deposits (Kho, 2024; Messer & Niepmann, 2023). Furthermore, in times of low interest rates, sometimes even negative, banks absorbed these rather than passing them through directly to the depositor. This tends to cause deposit rates to adjust more sluggish than before the financial crisis (Kho, 2024). Comparing these results with the euro area, it is observable that the short run pass-through to deposit interest rates to households and NFCs for the periods of 2000 to 2001 and 2005 to 2008 were lower, however from 2022 to 2024 the pass-through to deposit are higher than in the observed sample of the EMU. The same picture emerges when looking at the long run pass-through, as it is lower for the periods of 2000 to 2001 and from 2005 to 2008, and higher from 2022 to 2024.

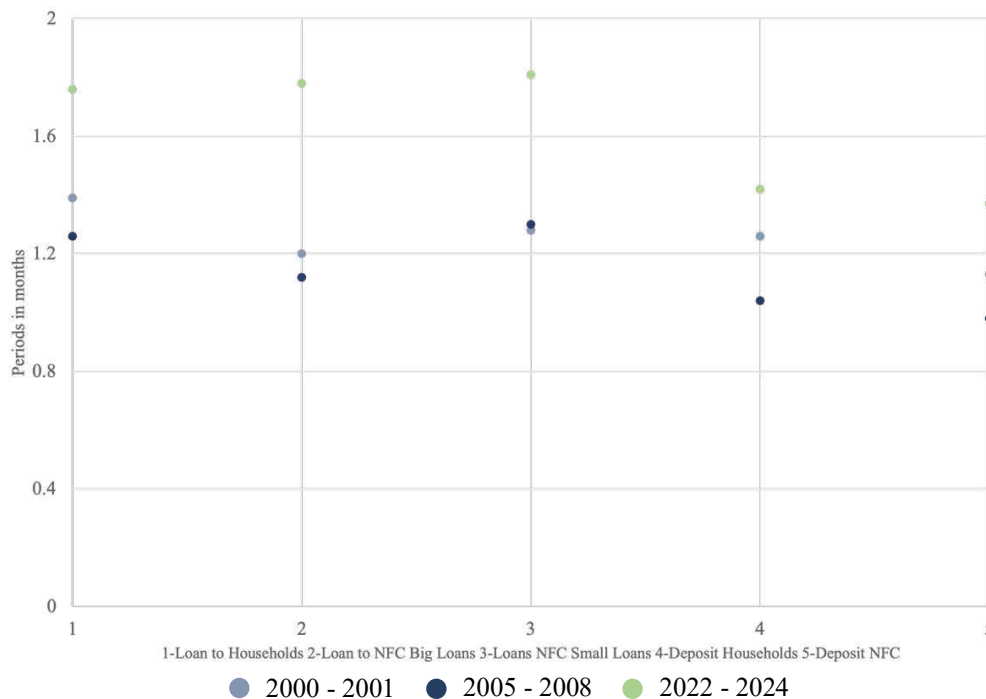
Figure 6: Comparison of the absolute short- and long run pass-through for 11 EMU and euro area countries during periods of hiking policy rates



Source: Author's calculation

Note: For loans to households in the 2022 to 2024 period for the euro area, the short- and long-term pass-through are not included as they are strongly negative

Figure 7: Half-life of bank loan and deposit interest rates for 11 EMU countries



Source: Author's calculation

Estimating equation (2) analyzes the influence of country-specific characteristics on the pass-through of policy interest rates to bank lending and deposit rates. This analysis allows to determine the exact direction and size of the influence of the control variables on the pass-through indicated by the coefficients with a *. To capture the effect not only for countries where the average of country-specific characteristics were above the 50th percentile, but also for the ones that were below, estimates were conducted for both cases, as presented in the following Tables. As discussed before, interacting the interest rate changes with dummy variables instead of continuous variables, allows for a better and easier interpretation of the results. A comprehensive overview is provided in the Appendix, spanning *Tables A-19 – A-23*.

First, no significant influence of the interaction with any of the control variables on the short and long run pass-through to interest rates on loans to households could be detected, as shown in *Tables 1 & 2*. This contrasts with to the existing literature, as Leroy & Lucotte (2015b) identified stock price index, inflation and industrial production as positive determinants of pass-through to household loans, whereas country risk premium had a negative influence. One explanation for the deviation could be that different time periods were analyzed, which included

cycles of monetary policy tightening and easing. It is possible that the observed interactions with the control variables have only showed a relevance during monetary easing periods.

Table 1: Results interaction terms short- and long run pass-through of loans to households above median

| Loan to Households: Above | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 36% | 43% | 31% | 25% | 35% |
| | 2005 - 2008 | 30% | 17% | 19% | 17% | 15% |
| | 2022 - 2024 | 3% | 20% | 14% | 12% | 13% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 84% | 20% | 51% | 33% | 78% |
| | 2005 - 2008 | 80% | 81% | 55% | 78% | 58% |
| | 2022 - 2024 | 41% | 45% | 57% | 35% | 54% |
| Half-Life (in months) | 2000 - 2001 | 1.13 | 3.75 | 1.68 | 2.45 | 1.20 |
| | 2005 - 2008 | 1.18 | 1.17 | 1.57 | 1.20 | 1.52 |
| | 2022 - 2024 | 2.02 | 1.86 | 1.54 | 2.29 | 1.60 |

Table 2: Results interaction terms short- and long run pass-through of loans to households below median

| Loan to Households: Below | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 28% | 32% | 32% | 44% | 32% |
| | 2005 - 2008 | 14% | 21% | 21% | 23% | 30% |
| | 2022 - 2024 | 19% | 3% | 12% | 13% | 15% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 45% | -4% | -11% | -21% | 77% |
| | 2005 - 2008 | 59% | 69% | 112% | 75% | 80% |
| | 2022 - 2024 | 47% | 48% | 45% | 47% | 44% |
| Half-Life (in months) | 2000 - 2001 | 1.86 | -16.12 | -5.93 | -2.86 | 1.21 |
| | 2005 - 2008 | 1.50 | 1.32 | 0.92 | 1.23 | 1.18 |
| | 2022 - 2024 | 1.79 | 1.77 | 1.88 | 1.79 | 1.92 |

Regarding loans of over one million euros to NFCs there are several country-specific characteristics leading to heterogeneity in the short- and long run pass-through, as can be seen in *Table 3 & 4*. Over the 2000-2001 period, countries with an above average country risk premium and leverage ratio also have a significantly higher short-term pass-through, at 88% and 69% respectively, while the pass-through for countries with a below-median country risk premium and leverage ratio is 24% and 22% respectively. Analyzing the long run pass-through for the same period the same results are visible. This result could be explained by the fact that countries with a higher risk premium are associated to have also higher interest rates, leading to a greater increase in lending rates compared to countries with a lower risk premium. Between 2022 and 2024, similar trends are visible, though the disparities are less pronounced. For instance, the leverage ratio shows only a marginal difference of one percentage point for the observation of the above 50th percentile. In the same period industrial production and inflation also have a significant influence on the long-run pass-through. A higher industrial production is therefore, as expected, associated with a higher pass-through. However higher inflation heightens slightly the pass through, as with lower inflation 50% is passed through, against the 44% for countries with higher inflation. Comparing these findings with previous periods, despite the fact that they are not significant, it is evident that before the financial crisis in 2008 a higher inflation was associated with a higher pass-through. Logically, a higher inflation rate

should result in more frequent variations in prices, which would increase the probability that policy rate changes would have an immediate and long-term effect on bank rates (Saborowski & Weber, 2013).

Table 3: Results interaction terms short- and long run pass-through of big loans to NFC above median

| Loan to NFC Big Loans: Above | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 30% | 23% | 43% | 88%*** | 69%*** |
| | 2005 - 2008 | 33% | 30% | 27% | 21% | 38% |
| | 2022 - 2024 | 100% | 32% | 120% | 72% | 43% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 35% | 43% | 46%** | 69%*** | 63%*** |
| | 2005 - 2008 | 81% | 93% | 81% | 92% | 89% |
| | 2022 - 2024 | 52%** | 44%*** | 58% | 79%*** | 49%*** |
| Half-Life (in months) | 2000 - 2001 | 2.34 | 1.95 | 1.83 | 1.32 | 1.42 |
| | 2005 - 2008 | 1.16 | 1.05 | 1.16 | 1.06 | 1.09 |
| | 2022 - 2024 | 1.66 | 1.90 | 1.52 | 1.19 | 1.74 |

Table 4: Results interaction terms short- and long run pass-through of big loans to NFC below median

| Loan to NFC Big Loans: Below | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 43% | 46% | 31% | 24%*** | 22%*** |
| | 2005 - 2008 | 37% | 38% | 45% | 47% | 33% |
| | 2022 - 2024 | 67% | 118% | 53% | 54% | 84% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 22% | 13% | -5% | 25%*** | 11%*** |
| | 2005 - 2008 | 89% | 78% | 90% | 78% | 81% |
| | 2022 - 2024 | 49%** | 50%*** | 46% | 47%*** | 48%*** |
| Half-Life (in months) | 2000 - 2001 | 3.48 | 5.59 | -13.06 | 3.11 | 6.64 |
| | 2005 - 2008 | 1.09 | 1.21 | 1.08 | 1.20 | 1.16 |
| | 2022 - 2024 | 1.74 | 1.71 | 1.82 | 1.80 | 1.77 |

Analyzing the pass-through to loans of under one million euros to NFCs it is noticeable that in the period of 2005 to 2008, as for loans of over one million euros to NFCs, the pass-through for countries with higher inflation, yields in a higher pass through, as can be seen in *Table 5 & 6*. It is evident that countries with higher inflation almost have a complete pass-through of 92%. These findings are in line with the research of Holton & Rodriguez d'Acrici (2018) as their study has shown that the effect of inflation on long run pass-through is stronger for small loans to NFCs. Furthermore, for the same period higher industrial production also has a significant positive influence on the pass-through to NFC small loans with 74%. Regarding the influence of country risk premium, the periods of 2000 to 2001 as well as 2005 to 2008 show that a higher risk premium is associated with a lower long run pass-through. However, from 2022 onwards country risk premium appears to have a positive association with pass-through to small loans to NFC. As mentioned before, this could be attributed to countries with higher risk premiums also having higher interest rates, which leads to a more substantial pass-through effect. It appears that leverage ratio also has significant influence on the long-term pass-through for the periods 2000 to 2001 and 2005 to 2008. In the first observation period however leverage ratio has a strong positive effect on the pass-through, whereas in the second period it has a slightly negative impact.

Table 5: Results interaction terms short- and long run pass-through of small loans to NFC above median

| Loan to NFC Small Loans: Above | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 38% | -421% | 27% | 32% | 33% |
| | 2005 - 2008 | 24% | 327% | 18% | 13% | 9% |
| | 2022 - 2024 | 66% | 94% | 60% | 72% | 63% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 8% | -10% | 27% | 21%** | 57%*** |
| | 2005 - 2008 | 74%** | 92%** | 51% | 57%** | 71%** |
| | 2022 - 2024 | 45% | 63% | 42% | 60%*** | 42% |
| Half-Life (in months) | 2000 - 2001 | 9.23 | -6.48 | 2.86 | 3.64 | 1.54 |
| | 2005 - 2008 | 1.25 | 1.06 | 1.68 | 1.54 | 1.29 |
| | 2022 - 2024 | 1.87 | 1.42 | 1.97 | 1.47 | 1.99 |

Table 6: Results interaction terms short- and long run pass-through of small loans to NFC below median

| Loan to NFC Small Loans: Below | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 28% | 52% | 57% | 41% | 37% |
| | 2005 - 2008 | 7% | 7% | 20% | 25% | 26% |
| | 2022 - 2024 | 64% | 61% | 64% | 49% | 56% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 27% | 1% | 8% | 26%** | 12%*** |
| | 2005 - 2008 | 71%** | 75%** | 68% | 70%** | 74%** |
| | 2022 - 2024 | 53% | 40% | 52% | 49%*** | 49% |
| Half-Life (in months) | 2000 - 2001 | 2.88 | 76.90 | 9.03 | 3.00 | 6.12 |
| | 2005 - 2008 | 1.29 | 1.24 | 1.34 | 1.31 | 1.25 |
| | 2022 - 2024 | 1.64 | 2.05 | 1.65 | 1.74 | 1.73 |

Regarding household deposits, inflation, industrial production, and stock price index have significant⁸ influence on the long run pass-through, as can be seen in *Table 7 & 8*. During times of high inflation, savers are more sensitive to the real value of their deposits, which encourages banks to pass-through policy rates to deposit rates in a higher manner, as can be seen in all observation periods for household deposits (*Table 7*). Furthermore, stock price index has a positive influence on the long run pass-through, however industrial production has a negative impact⁹. In times of high industrial production, high economic activity can usually be observed, which leads banks to focus more on lending due to increased borrowing demands (Polo, 2021). Consequently, they become less likely to aggressively raise deposit rates, resulting in a less pronounced pass-through effect.

Table 7: Results interaction terms short- and long run pass-through of household deposits above median

| Deposits Households: Above | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 30% | 38% | 40% | 40% | 37% |
| | 2005 - 2008 | 49% | 50% | 34% | 49% | 32% |
| | 2022 - 2024 | 20% | 13% | 24% | 19% | 14% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 1% | 35% | 53% | 20% | 25%** |
| | 2005 - 2008 | 96% | 102% | 96% | 87% | 96% |
| | 2022 - 2024 | 61%** | 66%** | 65%** | 67% | 33% |
| Half-Life (in months) | 2000 - 2001 | 50.83 | 2.30 | 1.64 | 3.84 | 3.11 |
| | 2005 - 2008 | 1.03 | 0.98 | 1.03 | 1.11 | 1.03 |
| | 2022 - 2024 | 1.46 | 1.37 | 1.38 | 1.34 | 2.41 |

⁸ Only for the 2022 to 2024 period

⁹ Both are only significant in the period from 2022 to 2024.

Table 8: Results interaction terms short- and long run pass-through of household deposits below median

| Deposits Households: Below | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 33% | 28% | 27% | 28% | 30% |
| | 2005 - 2008 | 33% | 27% | 44% | 32% | 49% |
| | 2022 - 2024 | 18% | 23% | 14% | 17% | 22% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 10% | 13% | 16% | -5% | -18% |
| | 2005 - 2008 | 96% | 83% | 98% | 86% | 96% |
| | 2022 - 2024 | 69%** | 64%** | 61%** | 61% | 56% |
| Half-Life (in months) | 2000 - 2001 | 7.08 | 5.75 | 4.77 | -13.28 | -3.46 |
| | 2005 - 2008 | 1.03 | 1.14 | 1.02 | 1.12 | 1.03 |
| | 2022 - 2024 | 1.32 | 1.40 | 1.46 | 1.45 | 1.57 |

Finally, as determinants of the pass-through to NFC deposit rates stock price index and country risk premium can be identified, as can be seen in *Table 9 & 10*. Similar as for household deposits, countries with a higher stock price index have a greater pass-through in the long run, which is consistent with the findings of Beyer et al. (2024). However, in the short term, rapid changes in the stock price index could negatively impact pass-through due to market volatility and shifting investment behavior (Beyer et al., 2024). The results for the country risk premium vary over the periods considered. In the short run pass-through to NFC deposit rates for period 2000 to 2001 and 2005 to 2008¹⁰, a higher country risk premium is associated with a higher pass-through, which is contrary to the expectation. This might reflect the banks need to adjust rates quickly to compensate for perceived higher risks. Considering the long run, it is evident that the pass-through for the observation period from 2005 to 2008 is slightly higher for above average country risk premium countries with a complete pass-through. However, looking at the most recent hiking cycle country risk premium seems to have a negative impact on the pass-through with 55% for countries above the 50th percentile and 72% for the ones below. This recent sluggishness is likely due to the abundance of excess reserves and liquidity in the banking system, diminishing banks need to aggressively attract deposits (ECB, 2024b).

Table 9: Results interaction terms short- and long run pass-through of NFC deposits above median

| Deposits NFC: Above | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 45% | 51% | 51% | 58%*** | 53% |
| | 2005 - 2008 | 85% | 76% | 59%** | 91% | 68% |
| | 2022 - 2024 | 6% | 48% | 14% | 28% | 18% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 19% | 49%** | 69%** | 43% | 34%*** |
| | 2005 - 2008 | 97% | 103% | 102% | 108%*** | 94% |
| | 2022 - 2024 | 85% | 69% | 62% | 55%*** | 76% |
| Half-Life (in months) | 2000 - 2001 | 3.92 | 1.74 | 1.32 | 1.94 | 2.37 |
| | 2005 - 2008 | 1.02 | 0.98 | 0.99 | 0.95 | 1.04 |
| | 2022 - 2024 | 1.13 | 1.32 | 1.43 | 1.58 | 1.22 |

¹⁰ Country risk premium was not significant in this observation period.

Table 10: Results interaction terms short- and long run pass-through of NFC deposits below median

| Deposits NFC: Below | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|---|-------------|-----------------------|-----------|-------------------|----------------------|----------------|
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 39% | 32% | 37% | 31%*** | 36% |
| | 2005 - 2008 | 70% | 72% | 97%** | 61% | 84% |
| | 2022 - 2024 | 53% | 14% | 41% | 46% | 45% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 4% | -166%** | 31%** | 27% | -75%*** |
| | 2005 - 2008 | 108% | 104% | 106% | 94%*** | 97% |
| | 2022 - 2024 | 68% | 62% | 68% | 72%*** | 63% |
| Half-Life (in months) | 2000 - 2001 | 19.70 | | 2.57 | 2.92 | -0.50 |
| | 2005 - 2008 | 0.95 | 0.97 | 0.96 | 1.05 | 1.02 |
| | 2022 - 2024 | 1.34 | 1.44 | 1.33 | 1.28 | 1.42 |

5.1. Robustness Tests

To evaluate the robustness of the results different tests were performed. First, the shadow rate is used as a substitute for the policy rate. The shadow rate, which covered a period from September 2005 to August 2022, is therefore particularly relevant for the second observation period from 2005 to 2008. However, as *Figure 6* shows, in this period the shadow rate and the policy rate have moved in sync and therefore no major deviations from the obtained result are expected. Nevertheless, as can be seen in *Table A-24 & A-25* in the short-term the pass-through is slightly lower when compared to the policy rate. The long-term pass-through is, however, consistent with the previous findings. This confirms the stability and reliability of the results obtained in this study, as the qualitative nature of the findings remained consistent across all observation periods.

Furthermore, including GDP at market prices and bank sector concentration as part of the control variables in *equation 1*, all results stay robust. In addition, estimating *equation 2* with GDP at market prices the same results are obtained regarding the short- and long-term pass-through as with industrial production¹¹(*Table A-26 & A-27*). Looking at banking market concentration the results indicate that for small loans to NFCs a higher concentrated banking market hinders pass-through in the period of 2005 to 2008. For the same period this can also be said for households' deposits in the short-term. Finally, looking at the most recent observation period, banking market concentration appears to have significant influence on the short- and long run pass-through to NFC deposit rates. In the short run, the pass-through to NFC deposit rates, of countries with higher banking market concentration is considerably less with only 8%, however countries with lower concentration passed-through 80%. This result remains consistent for the long-term pass-through, even if the effect is not as strong. These results are in line with the expectations and previous research that a less competitive market can lead to

¹¹GDP at market prices was not significant for small loans to NFCs (2005-2008) and household deposits (2022-2024), whereas industrial production was significant in these periods.

banks exploiting their market power and hinder pass-through (Drechsler et al., 2017). This conclusion is also consistent with the results of long run pass-through to household deposit rates, as countries with lower banking market concentration pass-through 57%, whereby countries with a higher concentration only pass-through 44%. This is consistent with the findings of Kho (2024), who showed that in a higher concentrated banking sector, when monetary policy interest rates increase, the pass-through rate speed of deposits to households is slower.

5.2. Limitations

Addressing some limitations, the results may be impacted by the data availability on some key variables, such as lending and deposit interest rates, as they were not given equally for all countries with the same maturity. Furthermore, the first observed policy interest hiking cycle started in 1999, but due to data availability could only be included from January 2000 onwards and is therefore shorter than the other observation periods. Lastly, some data was only available in a quarterly or yearly frequency and was converted to monthly frequency using interpolation. These variables are GDP at market prices and banking market concentration and were only used for the robustness test of the results.

6. Conclusion and Future Research

The objective of this thesis is the examination of the policy interest rate pass-through to bank lending and deposit interest rates in distinct policy hiking cycles within the EMU. The focus was to identify country-specific characteristics that influence the pass-through in three distinct policy hiking cycles, particularly from 1999 to 2001, 2005 to 2008 and 2022 to 2023. As the policy interest rate pass-through mechanism is a key element of monetary policy, it is highly relevant to identify how the pass-through is affected in different times of crisis or during periods of significant economic adjustments, when the ECB intervenes to stabilize prices and maintain economic balance. The examination of the distinct hiking cycles allows for accurate and comparable analyses, which yield crucial insights regarding policy interest rate pass-through.

To examine the policy interest rate pass-through, two models were employed. First, an ARDL error correction model estimated by panel regression was used to capture the effect of short- and long-term pass-through. The results indicate that for big and small loans to NFCs, the immediate adjustment speed is significantly higher for 2022 than for the 2000 and 2005 periods. However, the long-term pass-through is notably smaller from 2022 to 2024 compared to the other observation periods, which contrasts with recent studies conducted by Beyer et al. (2024). Regarding deposit rates to households and NFCs a near complete and fully complete pass-through can be observed in the long-term for the 2005 to 2008 period, respectively. However, in the most recent hiking cycle the short- and long-term pass-through declined sharply, reflecting a more sluggish adjustment compared to the earlier periods. This heterogenous pass-through can be attributed to several factors, including negative interest rates, changes in consumer, firm and bank behavior and the still existing high excess liquidity. The coming out of the low interest rate period and the still existing high excess liquidity, banks may have a reduced incentive to adjust interest rates on deposits. Additionally, in times of low and negative deposit interest rates, banks absorbed these rather than passing them through to consumers and firms. Comparing these results with a larger sample of European countries, similar trends are revealed, highlighting that these results stay robust in different economic contexts.

The second model is an extension of the first, in which interaction terms were incorporated to analyze the influence of country-specific characteristics on the pass-through. The analysis showed that the control variables (industrial production, inflation, stock price index, country risk premium and leverage ratio) had no significant influence on the pass-through to household loans. Regarding loans of over one million Euro to NFCs the short- and long-term pass-through

is affected by variables that include the country risk premium and leverage ratio, whereas the effect varies in different observation periods. In the period of 2022 to 2024 countries with higher industrial production and lower inflation are associated with a higher pass-through rate, particularly long-term. This results from higher industrial production signaling a stronger economy and higher demand for credit. For small loans to NFCs, higher inflation and industrial production positively impacted the pass-through, while country risk premium showed mixed effects across different periods. Higher inflation tends banks to adjust their lending interest rates more often, due to frequent changes in prices and money market rates.

Inflation, industrial production, and stock price index have significant influence on the pass-through to household deposits. Higher inflation leads to a more sensitive view of consumers on their deposits and in times of higher stock price indexes banks typically focus more on lending due to increased demand for borrowing (Polo, 2021). For NFC deposits, stock price index and country risk premium have significant impact on the pass-through. Due to market volatility and shifting investment behavior stock price index has a negative short-term impact, however in the long-term it has a positive impact on the pass-through. Short-term, higher country risk premiums were associated with higher pass-through rates in the periods of 2000-2001 and 2005-2008. This might reflect banks' need to adjust rates quickly to compensate for perceived higher risks. In the most recent hiking cycle, a higher country risk premium negatively affected the pass-through, which could be attributed to the abundance of excess reserves and liquidity in the banking system, diminishing the banks need to aggressively attract deposits (ECB, 2024b).

Finally, this thesis provided deeper understanding of the determinants of policy interest rate pass-through to bank lending and deposit interest rates in the EMU. Especially important is the comparison of different policy interest hiking cycles, highlighting the differences between the cycles and their implications for monetary policy. These findings contribute to a broader knowledge of the effectiveness of the policy interest rate transmission mechanisms. Further research should focus on analyzing the pass-through of fintech banks, which have grown fast in recent years. Fintech banks differ from traditional banks in terms of their business models, working methods and operating costs. It would be interesting to see which fintech banks' unique characteristics have an impact on the pass-through to bank lending and deposit interest rates.

7. Appendix

Table A-11: Overview dependent, independent and control variables

| Variable | Symbol | Frequency | Explanation | Expectation | Source |
|------------------------------------|------------|-----------|---|-------------|------------|
| Dependent Variables | | | | | |
| Loans to HH | loa_hh | Monthly | Loans to households for house purchase (Average of different maturities, new business) | N.a | ECB |
| Loans to NFC BL | loa_nfc_bl | Monthly | Loans to non financial corporations for loans > 1M EUR (Average of different maturities, new business) | N.a | ECB |
| Loans to NFC SL | loa_nfc_sl | Monthly | Loans to non financial corporations for loans < 1M EUR (Average of different maturities, new business) | N.a | ECB |
| Deposit to HH | dep_hh | Monthly | Deposits to households (Average of different maturities, new business) | N.a | ECB |
| Deposit to NFC | dep_nfc | Monthly | Deposits to non financial corporations (Average of different maturities, new business) | N.a | ECB |
| Independent Variables | | | | | |
| EONIA/€STR | pr | Monthly | European overnight index average & Euro short term rate (proxy for key interest rate) | N.a | ECB |
| Shadow rate | sr | Monthly | Estimate the behavior of short-term interest rates when conventional monetary policy is constrained | N.a | Wu & Xia |
| Control Variables | | | | | |
| Macroeconomic Indicators | | | | | |
| Industrial Production | ipr | Monthly | Economic indicator reflecting the output of industries like mining, manufacturing, and energy supply | + | Eurostat |
| Inflation | ifl | Monthly | Harmonised Index of Consumer Prices | + | ECB |
| GDP at Market Prices | gdp_mp | Monthly | Total value of all goods and services produced within a country over a specific period | + | ECB |
| Financial Market Indicators | | | | | |
| Stock Price Index | spi | Monthly | Average of daily closing prices of common shares traded on domestic or international exchanges | + | OECD |
| Country Risk Premium | crp | Monthly | Spread between a country's ten-year bond rate and a risk-free bond, represented by Germany's 10y Bond | - | OECD & ECB |
| Bank Sector Indicators | | | | | |
| Leverage Ratio | lr | Monthly | Tier 1 capital of Monetary Financial Institutions (excluding the ESCB) divided by their total leverage exposure | -/+ | ECB |
| Banking market concentration | hhi | Monthly | Herfindahl-Hirschmann Index calculated from the total assets of banks within a country | - | ECB |

Note: “+” indicates an expected higher pass-through, “-” indicates an expected lower pass-through

Table A-12: Correlation analysis between bank rates and policy rate

| Dependent variable | Period | Policy rate |
|-------------------------|-------------|-------------|
| Loan to Households | 2000 - 2001 | 0.83*** |
| | 2005 - 2008 | 0.95*** |
| | 2022 - 2024 | 0.96*** |
| Loan to NFC Big Loans | 2000 - 2001 | 0.81*** |
| | 2005 - 2008 | 0.63*** |
| | 2022 - 2024 | 0.85*** |
| Loan to NFC Small Loans | 2000 - 2001 | 0.66*** |
| | 2005 - 2008 | 0.85*** |
| | 2022 - 2024 | 0.74*** |
| Deposits Households | 2000 - 2001 | 0.83*** |
| | 2005 - 2008 | 0.87*** |
| | 2022 - 2024 | 0.86*** |
| Deposits NFC | 2000 - 2001 | 0.90*** |
| | 2005 - 2008 | 0.94*** |
| | 2022 - 2024 | 0.94*** |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$)

Table A-13: Panel unit root using a Harris-Tzavalis test

| | Period | Levels | | First Difference | |
|------------------------------|-------------|---------|---------|------------------|---------|
| | | Z-Value | P-Value | Z-Value | P-Value |
| Policy Rate | 2000 - 2001 | -0.71 | 0.23 | -17.1 | 0.00*** |
| | 2005 - 2008 | 1.32 | 0.91 | -6.08 | 0.00*** |
| | 2022 - 2024 | 2.38 | 0.99 | -9.38 | 0.00*** |
| Loan to Household | 2000 - 2001 | 0.87 | 0.81 | -11.59 | 0.00*** |
| | 2005 - 2008 | 0.97 | 0.83 | -52.04 | 0.00*** |
| | 2022 - 2024 | 1.11 | 0.87 | -18.28 | 0.00*** |
| Loan to NFC Big Loan | 2000 - 2001 | -0.65 | 0.26 | -11.89 | 0.00*** |
| | 2005 - 2008 | -0.74 | 0.38 | -14.82 | 0.00*** |
| | 2022 - 2024 | -0.86 | 0.48 | -18.83 | 0.00*** |
| Loan to NFC Small Loan | 2000 - 2001 | -0.31 | 0.38 | -10.92 | 0.00*** |
| | 2005 - 2008 | 0.41 | 0.66 | -52.53 | 0.00*** |
| | 2022 - 2024 | 0.61 | 0.76 | -29.92 | 0.00*** |
| Deposit Household | 2000 - 2001 | 1.03 | 0.85 | -8.41 | 0.00*** |
| | 2005 - 2008 | 1.56 | 0.94 | -53.94 | 0.00*** |
| | 2022 - 2024 | 2.31 | 0.99 | -16.52 | 0.00*** |
| Deposit NFC | 2000 - 2001 | 0.65 | 0.74 | -9.88 | 0.00*** |
| | 2005 - 2008 | -0.29 | 0.39 | -59.11 | 0.00*** |
| | 2022 - 2024 | 1.61 | 0.95 | -20.88 | 0.00*** |
| Industrial Production | 2000 - 2001 | -13.81 | 0.00*** | - | - |
| | 2005 - 2008 | -68.31 | 0.00*** | - | - |
| | 2022 - 2024 | -30.22 | 0.00*** | - | - |
| Inflation | 2000 - 2001 | -1.03 | 0.15 | 17.92 | 0.00*** |
| | 2005 - 2008 | -1.56 | 0.06 | -37.71 | 0.00*** |
| | 2022 - 2024 | 2.36 | 0.99 | -16.88 | 0.00*** |
| GDP at Market Prices | 2000 - 2001 | 1.64 | 0.95 | -6.46 | 0.00*** |
| | 2005 - 2008 | 7.03 | 1.00 | -15.38 | 0.00*** |
| | 2022 - 2024 | 2.69 | 0.99 | -5.13 | 0.00*** |
| Stock Price Index | 2000 - 2001 | -13.86 | 0.00*** | - | - |
| | 2005 - 2008 | -25.68 | 0.00*** | - | - |
| | 2022 - 2024 | -20.65 | 0.00*** | - | - |
| Country Risk Premium | 2000 - 2001 | -4.73 | 0.00*** | - | - |
| | 2005 - 2008 | 13.62 | 1.00 | -43.17 | 0.00*** |
| | 2022 - 2024 | -0.98 | 0.16 | -22.69 | 0.00*** |
| Leverage Ratio | 2000 - 2001 | -5.82 | 0.00*** | - | - |
| | 2005 - 2008 | -8.92 | 0.00*** | - | - |
| | 2022 - 2024 | 3.01 | 0.99 | -21.59 | 0.00*** |
| Banking Market Concentration | 2000 - 2001 | 3.21 | 0.99 | 25.33 | 0.00*** |
| | 2005 - 2008 | 6.81 | 0.95 | 39.18 | 0.00*** |
| | 2022 - 2024 | 3.19 | 0.99 | -30.21 | 0.00*** |

Note: ***($p < 0.01$), **($p < 0.05$), *($p < 0.1$); Results of the panel unit root test using the Harris-Tzavalis method. p -values are provided for both levels and first differences across different periods. The Z-Value represents the test statistic. The tests were conducted with robust standard errors and consider the panel structure of the data.

Table A-14: Westerlund cointegration test

| Bank rate | Period | Variance Ratio Statistic | p-value |
|-------------------------|-------------|--------------------------|---------|
| Loan to Households | 2000 - 2001 | -1.55 | 0.06 |
| | 2005 - 2008 | -1.89 | 0.03** |
| | 2022 - 2024 | -2.29 | 0.01** |
| Loan to NFC Big Loans | 2000 - 2001 | -2.45 | 0.00*** |
| | 2005 - 2008 | -2.76 | 0.00*** |
| | 2022 - 2024 | -3.14 | 0.00*** |
| Loan to NFC Small Loans | 2000 - 2001 | -1.98 | 0.02** |
| | 2005 - 2008 | -1.99 | 0.02** |
| | 2022 - 2024 | -2.88 | 0.00*** |
| Deposits Households | 2000 - 2001 | -1.92 | 0.03** |
| | 2005 - 2008 | -1.41 | 0.07 |
| | 2022 - 2024 | -2.05 | 0.02** |
| Deposits NFC | 2000 - 2001 | -2.34 | 0.00*** |
| | 2005 - 2008 | -2.25 | 0.01** |
| | 2022 - 2024 | -2.75 | 0.00*** |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); H_0 : no cointegration

Table A-15: Regression output 11 EMU countries during periods of hiking interest rates

| Dependent variable: $\Delta br_{i,t}$ | Period | Loan to Households | Loan to NFC Big Loans | Loan to NFC Small Loans | Deposits Households | Deposits NFC |
|---------------------------------------|-------------|--------------------------|-------------------------|-------------------------|-----------------------|------------------------|
| $\Delta br_{i,t-1}$ | 2000 - 2001 | - 0.2407*** (- 12.76) | -0.3668*** (- 18.02) | -0.2647*** (-13.62) | -0.0386** (-2.04) | -0.2619*** (-14.09) |
| | 2005 - 2008 | - 0.1158** (- 2.21) | -0.2016*** (- 3.62) | -0.0242 (-0.48) | -0.2406*** (-4.46) | -0.1492*** (-2.78) |
| | 2022 - 2024 | -0.1209 (-1.49) | 0.1976* (1.95) | -0.1478* (-1.68) | 0.0254 (0.32) | -0.0494 (- 0.63) |
| $\Delta pr_{i,t}(\beta_0)$ | 2000 - 2001 | 0.2141*** (6.02) | 0.4206*** (4.53) | 0.3242*** (6.81) | 0.3134*** (13.88) | 0.5210*** (14.52) |
| | 2005 - 2008 | 0.2147*** (2.61) | 0.3789*** (2.24) | 0.1848** (2.18) | 0.4027*** (5.30) | 0.7804*** (7.48) |
| | 2022 - 2024 | 0.1142 (1.40) | 0.6739** (2.06) | 0.6049*** (4.34) | 0.1854** (2.13) | 0.3226** (2.35) |
| $\Delta pr_{i,t-1}$ | 2000 - 2001 | 0.2102*** (5.89) | 0.2299 (2.47) | 0.1448*** (3.03) | 0.2555*** (10.79) | 0.3816*** (10.30) |
| | 2005 - 2008 | 0.1634*** (2.61) | 0.2233 (1.20) | 0.2165** (2.34) | 0.2648* (2.95) | 0.1309 (1.05) |
| | 2022 - 2024 | 0.0297 (0.35) | 0.2321 (0.66) | 0.3580** (2.35) | 0.0655 (-0.66) | 0.3577** (2.25) |
| $br_{t-1}(\delta)$ | 2000 - 2001 | -0.0433*** (- 7.64) | -0.2089*** (-12.81) | -0.0490*** (-7.33) | -0.0493*** (-9.38) | -0.1170*** (-12.04) |
| | 2005 - 2008 | -0.0867*** (- 3.88) | -0.5761*** (-8.61) | -0.3187*** (-8.48) | -0.2040*** (-4.58) | -0.5980*** (-9.14) |
| | 2022 - 2024 | -0.2671*** (-5.23) | -0.9961*** (-8.07) | -0.5477*** (-8.26) | -0.2372*** (-4.92) | -0.4854*** (-6.17) |
| $pr_{t-1}(\theta)$ | 2000 - 2001 | 0.0280*** (5.47) | 0.1639*** (10.81) | 0.0353*** (5.63) | 0.0362*** (9.19) | 0.0989*** (11.44) |
| | 2005 - 2008 | 0.0633*** (3.66) | 0.4911*** (8.19) | 0.2241*** (7.49) | 0.1938*** (4.79) | 0.6151*** (8.88) |
| | 2022 - 2024 | 0.1289** (4.50) | 0.4759*** (5.50) | 0.2553*** (5.69) | 0.1482*** (4.28) | 0.3210*** (4.59) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t -value in parentheses; results of the panel data estimation with fixed effect at country level with robust standard errors. Independent variables in column 1 as defined in equation 1. Dependent variables in the first row

Table A-16: Short- and long run pass-through 11 EMU countries during periods of hiking interest rates

| | Period | Loan to Households | Loan to NFC Big Loans | Loan to NFC Small Loans | Deposits Households | Deposits NFC |
|---|-------------|--------------------|-----------------------|-------------------------|---------------------|--------------|
| Short-term pass-through (β_0) (in percent) | 2000 - 2001 | 21%*** | 42%*** | 32%*** | 31%*** | 52%*** |
| | 2005 - 2008 | 21%*** | 38%*** | 18%*** | 40%*** | 78%*** |
| | 2022 - 2024 | 11% | 67%** | 60%*** | 19%*** | 32%*** |
| Long-term pass-through ($-\theta/\delta$) (in percent) | 2000 - 2001 | 65%*** | 78%*** | 72%*** | 73%*** | 85%*** |
| | 2005 - 2008 | 73%*** | 85%*** | 70%*** | 95%*** | 103%*** |
| | 2022 - 2024 | 48%*** | 48%*** | 47%*** | 62%*** | 66%*** |
| Half-Life (in months) | 2000 - 2001 | 1.39 | 1.20 | 1.28 | 1.26 | 1.13 |
| | 2005 - 2008 | 1.26 | 1.12 | 1.30 | 1.04 | 0.98 |
| | 2022 - 2024 | 1.76 | 1.78 | 1.81 | 1.42 | 1.37 |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); results of the panel data estimation with fixed effect at country level with robust standard errors. Size and speed of pass-through in column 1 as defined in equation 1. Dependent variables in the first row.

Table A-17: Regression output euro area during periods of hiking interest rates

| Dependent variable: $\Delta br_{i,t}$ | Periods | Loan to Households | Loan to NFC Big Loans | Loan to NFC Small Loans | Deposits Households | Deposits NFC |
|---------------------------------------|-------------|------------------------|-------------------------|-------------------------|-----------------------|-----------------------|
| $\Delta br_{i,t-1}$ | 2000 - 2001 | 0.1064* (1.84) | -0.3379*** (- 5.92) | 0.0488 (0.84) | -0.2115*** (3.89) | -0.2283*** (-3.92) |
| | 2005 - 2008 | 0.2794* (1.69) | 0.1602 (1.05) | 0.0352 (1.05) | 0.1193 (0.75) | -0.1742 (-0.98) |
| | 2022 - 2024 | -0.5075 (-2.00) | 0.1183 (0.51) | 0.1087 (0.40) | -0.1018348 (-0.37) | -0.5676** (-2.11) |
| $\Delta pr_{i,t}(\beta_0)$ | 2000 - 2001 | 0.1787*** (4.92) | 0.3572*** (5.04) | 0.1872*** (4.97) | 0.2214*** (6.30) | 0.4864*** (9.72) |
| | 2005 - 2008 | 0.1661* (2.02) | 0.2338 (1.40) | 0.1399 (1.29) | 0.2479** (2.17) | 0.5471*** (3.21) |
| | 2022 - 2024 | -0.1445 (-1.18) | 0.4979 (1.50) | 0.3004** (2.35) | 0.3392*** (3.22) | 0.4342** (2.37) |
| $\Delta pr_{i,t-1}$ | 2000 - 2001 | 0.1427*** (3.73) | 0.2481*** (3.41) | 0.1382*** (3.84) | 0.1955*** (5.11) | 0.2974*** (4.26) |
| | 2005 - 2008 | -0.0037 (-0.04) | -0.2444 (-1.17) | 0.0256 (0.20) | -0.0702 (-0.44) | -0.1269 (-0.53) |
| | 2022 - 2024 | -0.0501 (-0.39) | -0.4107 (-1.06) | -0.0581 (-0.34) | 0.2192* (1.76) | 0.5748** (2.45) |
| $br_{i-1}(\delta)$ | 2000 - 2001 | -0.0197*** (- 2.71) | -0.0391** (-2.25) | -0.0185** (-7.33) | -0.0093 (-1.35) | -0.0303* (-1.93) |
| | 2005 - 2008 | -0.3048*** (- 3.22) | -1.0618*** (-4.96) | -0.4471*** (3.98) | -0.3728*** (-2.96) | -0.6100** (-2.66) |
| | 2022 - 2024 | 0.2002 (1.54) | -0.6905586** (-2.73) | -0.0140 (0.10) | -0.1348 (-0.90) | 0.1351 (0.55) |
| $pr_{i-1}(\theta)$ | 2000 - 2001 | 0.0114** (1.72) | 0.0261* (1.79) | 0.0088*** (1.35) | 0.0079 (1.52) | 0.0233* (1.47) |
| | 2005 - 2008 | 0.1906*** (3.30) | 0.8144*** (4.96) | 0.2967*** (4.21) | 0.3175*** (3.04) | 0.5707*** (2.77) |
| | 2022 - 2024 | 0.116 (-1.51) | 0.4533** (2.52) | 0.0030 (0.30) | 0.0999 (1.08) | -0.0972 (-0.47) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t-value in parentheses; results of the panel data estimation with fixed effect at country level with robust standard errors. Independent variables in column 1 as defined in equation 1. Dependent variables in the first row.

Table A-18: Short- and long run pass-through euro are regression output euro area during periods of hiking interest rates

| | Period | Loan to Households | Loan to NFC Big Loans | Loan to NFC Small Loans | Deposits Households | Deposits NFC |
|---|-------------|--------------------|-----------------------|-------------------------|---------------------|--------------|
| Short-term pass-through (β_0) | 2000 - 2001 | 18%*** | 36%*** | 19%*** | 22%*** | 49%*** |
| | 2005 - 2008 | 17%* | 23% | 14% | 25%*** | 55%*** |
| | 2022 - 2024 | | 50% | 30%** | 34%*** | 43%** |
| Long-term pass-through ($-\theta/\delta$) | 2000 - 2001 | 58%*** | 67%** | 48%*** | 85% | 77%* |
| | 2005 - 2008 | 63%*** | 77%*** | 66%*** | 85%*** | 93%*** |
| | 2022 - 2024 | | 66%** | 22% | 74% | 72% |
| Half-Life | 2000 - 2001 | 1.52 | 1.36 | 1.78 | 1.13 | 1.22 |
| | 2005 - 2008 | 1.43 | 1.22 | 1.36 | 1.13 | 1.05 |
| | 2022 - 2024 | | 1.37 | 3.52 | 1.25 | 1.28 |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t -value in parentheses; results of the panel data estimation with fixed effect at country level with robust standard errors. Size and speed of pass-through in column 1 as defined in equation 1. Dependent variables in the first row. For loans to households in the 2022 to 2024 period, the short- and long-term pass-through are not included as they are strongly negative.

Table A-19: Regression output Interaction terms Loan to Households for country panel data during periods of hiking interest rates

Loan to Households

| Dependent variable: $\Delta br_{i,t}$ X_i | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|--|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| $\Delta pr_{i,t}(\beta_0)$ | 2000 - 2001 | 0.2811*** (3.60) | 0.3210*** (5.09) | 0.3184*** (4.94) | 0.4363** (4.77) | 0.3201*** (4.48) |
| | 2005 - 2008 | 0.1428 (1.36) | 0.2083 (1.89) | 0.2146** (2.04) | 0.2252** (2.01) | 0.3010*** (2.69) |
| | 2022 - 2024 | 0.1860 (1.82) | 0.0319 (0.31) | 0.1216 (1.17) | 0.1290 (1.27) | 0.1457 (1.27) |
| $br_{t-1}(\delta)$ | 2000 - 2001 | -0.1186*** (-7.08) | -0.2566*** (-6.34) | -0.1033 (-1.11) | -0.0926 (-1.04) | -0.0666 (-2.83) |
| | 2005 - 2008 | -0.0865*** (-3.58) | -0.1074 (-1.20) | -0.0534 (-0.97) | -0.0269 (-0.38) | -0.1674** (-2.10) |
| | 2022 - 2024 | -0.1909** (-2.24) | -0.2767*** (-3.64) | -0.3244*** (-3.76) | -0.3190*** (-4.78) | -0.3745*** (-3.29) |
| $pr_{t-1}(\theta)$ | 2000 - 2001 | 0.0535 (0.62) | -0.0108 (-0.67) | -0.0114 (-0.55) | -0.0199 (-0.89) | 0.0513 (-1.22) |
| | 2005 - 2008 | 0.0508** (2.53) | 0.0742 (1.16) | 0.0599** (2.07) | 0.0203 (0.37) | 0.1334** (2.29) |
| | 2022 - 2024 | 0.0903 (1.86) | 0.1330*** (4.10) | 0.1448*** (3.41) | 0.1510*** (4.66) | 0.1630*** (3.21) |
| $\Delta pr_{i,t} X_{i,t-1}(\beta^*)$ | 2000 - 2001 | 0.0797 (1.40) | 0.1087 (0.71) | -0.0107 (-0.17) | -0.1864 (-1.01) | 0.0278 (1.01) |
| | 2005 - 2008 | 0.1551 (1.10) | -0.039 (-0.27) | -0.0264 (-0.19) | -0.0522 (-0.36) | -0.1505 (-1.06) |
| | 2022 - 2024 | -0.1540 (-1.11) | 0.1640 (1.17) | 0.0224 (0.15) | -0.0065 (-0.04) | -0.0147 (-0.10) |
| $\Delta br_{i,t-1} X_{i,t-1}(\delta^*)$ | 2000 - 2001 | 0.0225 (1.26) | 0.0738 (0.54) | -0.0706 (-1.11) | -0.1020 (-1.13) | -0.1132 (0.67) |
| | 2005 - 2008 | -0.0773 (-0.95) | 0.0210 (0.23) | -0.0503 (-0.97) | -0.0635 (-0.85) | 0.0801 (0.98) |
| | 2022 - 2024 | -0.2161 (-1.76) | 0.0659 (0.55) | 0.1032 (0.96) | 0.13 (1.27) | 0.1222 (0.94) |
| $\Delta pr_{i,t-1} X_{i,t-1}(\theta^*)$ | 2000 - 2001 | 0.0274 (1.39) | 0.0479 (0.38) | 0.1005 (0.75) | 0.0835 (1.36) | 0.0886 (1.36) |
| | 2005 - 2008 | 0.0801 (1.27) | -0.0044 (-0.06) | -0.0025 (-0.07) | 0.0502 (0.85) | -0.0829 (-1.13) |
| | 2022 - 2024 | 0.076 (1.38) | -0.0379 (-0.69) | -0.0193 (-0.38) | -0.0841 (-1.68) | -0.0262 (-0.45) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t -value in parentheses; results of the panel data estimation with interaction terms on country level with robust standard errors. Estimated coefficients in column 1 as defined in equation 2. Dependent variables in the first row

Table A-20: Regression output Interaction terms Loan to NFC Big Loan for country panel data during periods of hiking interest rates

| Loan to NFC Big Loan | | | | | | |
|---|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Dependent variable: Δbr_{it} | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
| X_i | | | | | | |
| $\Delta pr_{it}(\beta_0)$ | 2000 - 2001 | 0.4270*** (3.91) | 0.4621*** (4.06) | 0.3107 (1.01) | 0.2370** (1.98) | 0.2180 (0.69) |
| | 2005 - 2008 | 0.3724 (1.68) | 0.3831 (1.18) | 0.4537** (2.03) | 0.4723** (2.21) | 0.3271 (1.50) |
| | 2022 - 2024 | 0.6676 (1.87) | 1.1788*** (2.65) | 0.5254 (1.45) | 0.5420 (1.48) | 0.8421*** (2.24) |
| $br_{t-1}(\delta)$ | 2000 - 2001 | -0.3196*** (-8.28) | -0.2796** (-2.35) | -0.3617** (-2.24) | -0.255** (-1.86) | -0.2406 (-1.16) |
| | 2005 - 2008 | -0.6085*** (-8.28) | -0.6112*** (-6.24) | -0.5013*** (-4.03) | -0.5503*** (-6.06) | -0.4490*** (-3.41) |
| | 2022 - 2024 | -0.8641*** (-6.31) | -1.3164*** (-8.41) | -1.0114*** (-7.14) | -1.4606*** (-8.91) | -1.2788*** (-8.44) |
| $pr_{t-1}(\theta)$ | 2000 - 2001 | 0.0705 (0.34) | 0.0369 (0.49) | -0.0187 (-0.89) | 0.0636 (0.46) | 0.0258 (0.87) |
| | 2005 - 2008 | 0.5432*** (7.43) | 0.4744*** (5.55) | 0.4511*** (3.93) | 0.4286*** (5.15) | 0.3655*** (3.23) |
| | 2022 - 2024 | 0.4233*** (4.38) | 0.6622*** (6.47) | 0.4686*** (5.01) | 0.692*** (6.98) | 0.6118*** (6.27) |
| $\Delta pr_{it} X_{i,t-1}(\beta^*)$ | 2000 - 2001 | -0.1278 (-1.46) | -0.2280 (-0.74) | 0.1180 (1.12) | 0.6438*** (4.32) | 0.4721*** (5.37) |
| | 2005 - 2008 | -0.0395 (-0.14) | -0.0874 (-0.31) | -0.1811 (-0.64) | -0.2614 (-0.93) | 0.0452 (0.16) |
| | 2022 - 2024 | 0.3280 (0.58) | -0.8784 (-1.67) | 0.6767 (1.15) | 0.1799 (0.36) | -0.4089 (-0.76) |
| $\Delta br_{i,t-1} X_{i,t-1}(\delta^*)$ | 2000 - 2001 | -0.9782 (-0.68) | -0.2333 (-1.32) | -0.0544 (-0.47) | -0.8111*** (-3.65) | -0.6332*** (-3.25) |
| | 2005 - 2008 | 0.1605 (1.17) | 0.0292 (0.27) | -0.1122 (-0.84) | -0.0603 (-0.56) | -0.1592 (-1.13) |
| | 2022 - 2024 | -0.4215** (-2.30) | 0.5481*** (2.98) | 0.0492 (0.25) | 0.5382*** (2.76) | 0.5648*** (2.96) |
| $\Delta pr_{i,t-1} X_{i,t-1}(\theta^*)$ | 2000 - 2001 | 0.3773 (1.45) | 0.1818 (1.21) | 0.2121** (1.98) | 0.6765*** (2.87) | 0.5246*** (2.79) |
| | 2005 - 2008 | -0.1784 (-1.39) | 0.0664 (0.62) | 0.0478 (0.37) | 0.1348 (1.28) | 0.1775 (1.35) |
| | 2022 - 2024 | 0.2440** (2.18) | -0.3240*** (-3.04) | 0.0851 (0.63) | 0.0383 (0.32) | -0.2602 (-1.92) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t-value in parentheses; results of the panel data estimation with interaction terms on country level with robust standard errors. Estimated coefficients in column 1 as defined in equation 2. Dependent variables in the first row

Table A-21: Regression output Interaction terms Loan to NFC Small Loan for country panel data during periods of hiking interest rates

Loan to NFC Small Loan

| Dependent variable: Δbr_{it} X_{it} | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
|--|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| $\Delta pr_{it} (\beta_0)$ | 2000 - 2001 | 0.2780*** (2.79) | 0.5216** (2.65) | 0.5731*** (3.57) | 0.4050*** (4.38) | 0.3730*** (2.25) |
| | 2005 - 2008 | 0.0697 (0.65) | 0.0712 (0.33) | 0.1989 (1.85) | 0.2534** (2.25) | 0.2627** (2.33) |
| | 2022 - 2024 | 0.6356*** (3.76) | 0.6052 (1.23) | 0.6401*** (3.96) | 0.4942*** (3.03) | 0.5627*** (3.26) |
| $br_{t-1} (\delta)$ | 2000 - 2001 | -0.3251*** (-4.56) | -0.5964*** (-4.36) | -0.4627*** (-4.62) | -0.3169*** (-2.98) | -0.2998*** (-3.85) |
| | 2005 - 2008 | -0.3571*** (-8.26) | -0.4556*** (-5.89) | -0.3321*** (-6.20) | -0.2003*** (-3.12) | -0.2062*** (-3.12) |
| | 2022 - 2024 | -0.6678** (-5.45) | -0.6658*** (-6.34) | -0.6476*** (-5.44) | -0.4487*** (-4.42) | -0.4281*** (-3.45) |
| $pr_{t-1} (\theta)$ | 2000 - 2001 | 0.0886 (0.79) | 0.0054 (1.17) | 0.0369 (0.39) | 0.0818 (0.84) | 0.0374 (1.17) |
| | 2005 - 2008 | 0.253*** (7.28) | 0.3417*** (5.49) | 0.2249*** (5.70) | 0.1403*** (2.74) | 0.1528*** (3.05) |
| | 2022 - 2024 | 0.3513*** (4.41) | 0.2684*** (2.91) | 0.3381*** (4.53) | 0.2182*** (3.76) | 0.2111*** (2.67) |
| $\Delta pr_{it} X_{it-1} (\beta^*)$ | 2000 - 2001 | 0.1027 (0.58) | -4.7252 (-0.59) | -0.2966 (-0.47) | -0.0935 (-0.64) | -0.0376 (-0.58) |
| | 2005 - 2008 | 0.1741 (1.23) | 3.1981 (0.48) | -0.0191 (-0.13) | -0.1262 (-0.88) | -0.1732 (-1.23) |
| | 2022 - 2024 | 0.0206 (0.09) | 0.3302 (0.06) | -0.039 (-0.16) | 0.2266 (0.95) | 0.0735 (0.32) |
| $\Delta br_{it-1} X_{it-1} (\delta^*)$ | 2000 - 2001 | 0.1314 (1.20) | 10.0587 (1.16) | 0.1980 (1.23) | -0.0491 (0.81) | -0.5336** (2.02) |
| | 2005 - 2008 | 0.1497** (1.98) | 4.6729** (1.98) | 0.0199 (0.28) | -0.1778** (-2.38) | -0.1555** (-2.05) |
| | 2022 - 2024 | 0.1198 (0.91) | 1.2006 (1.33) | 0.1012 (0.78) | -0.2566** (-2.34) | -0.2039 (-1.55) |
| $\Delta pr_{it-1} X_{it-1} (\theta^*)$ | 2000 - 2001 | -0.0735 (-0.96) | 0.9552 (0.49) | 0.0358 (0.64) | -0.1591** (-2.46) | 0.4353*** (3.43) |
| | 2005 - 2008 | -0.0996 (-1.61) | -4.2223** (-2.01) | 0.0014 (0.03) | 0.1201** (1.97) | 0.1022 (1.66) |
| | 2022 - 2024 | -0.1048 (1.35) | 0.0671 (0.07) | -0.1083 (-1.32) | 0.2085*** (2.67) | 0.0523 (0.61) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t -value in parentheses; results of the panel data estimation with interaction terms on country level with robust standard errors. Estimated coefficients in column 1 as defined in equation 2. Dependent variables in the first row

Table A-22: Regression output Interaction terms Deposit Household for country panel data during periods of hiking interest rates

| Deposit Household | | | | | | |
|--|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Dependent variable: $\Delta br_{i,t}$ | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
| X_i | | | | | | |
| $\Delta pr_{i,t} (\beta_0)$ | 2000 - 2001 | 0.3346*** (4.32) | 0.2776*** (3.34) | 0.2665*** (3.84) | 0.2774*** (4.41) | 0.2989*** (3.18) |
| | 2005 - 2008 | 0.3252*** (3.38) | 0.2749*** (2.67) | 0.4382*** (4.47) | 0.3158*** (3.04) | 0.4940*** (4.72) |
| | 2022 - 2024 | 0.1776 (1.66) | 0.2347** (2.16) | 0.1427 (1.37) | 0.1661 (1.53) | 0.2178** (1.99) |
| $br_{t-1} (\delta)$ | 2000 - 2001 | -0.1391*** (-3.68) | -0.1084** (-4.52) | -0.1501*** (-2.96) | -0.0806 (-0.34) | -0.0776 (-0.92) |
| | 2005 - 2008 | -0.1867*** (-3.51) | -0.2493*** (-3.80) | -0.1808*** (-3.68) | -0.2401*** (-3.65) | -0.2361*** (-3.35) |
| | 2022 - 2024 | -0.1737** (-3.03) | -0.3302*** (-4.81) | -0.1731*** (-2.98) | -0.2206*** (-3.52) | -0.2066*** (-3.21) |
| $pr_{t-1} (\theta)$ | 2000 - 2001 | 0.0143 (0.48) | 0.0139 (0.36) | 0.0235 (0.45) | -0.0041 (-0.82) | -0.0141 (-0.18) |
| | 2005 - 2008 | 0.1792*** (3.83) | 0.2074*** (3.62) | 0.1763*** (3.91) | 0.2054*** (3.33) | 0.2276*** (3.37) |
| | 2022 - 2024 | 0.1192*** (2.99) | 0.2103*** (4.74) | 0.1057*** (2.72) | 0.1352*** (3.28) | 0.1147*** (2.71) |
| $\Delta pr_{t-1} X_{i,t-1} (\beta^*)$ | 2000 - 2001 | -0.0371 (-0.85) | 0.1073 (0.56) | 0.1331 (0.84) | 0.1196 (0.62) | 0.0667 (0.40) |
| | 2005 - 2008 | 0.1655 (1.26) | 0.2251 (1.70) | -0.0956 (-0.72) | 0.1701 (1.29) | -0.1717 (-1.31) |
| | 2022 - 2024 | 0.0195 (0.14) | -0.10051 (-0.71) | 0.0975 (0.66) | 0.0242 (0.16) | -0.0794 (-0.55) |
| $\Delta br_{i,t-1} X_{i,t-1} (\delta^*)$ | 2000 - 2001 | 0.0517 (0.52) | -0.0831 (-1.21) | -0.0932 (-1.15) | -0.1291 (-0.89) | -0.1339** (-3.04) |
| | 2005 - 2008 | -0.0481 (-0.64) | 0.0353 (0.48) | -0.0599 (-0.79) | 0.0411 (0.57) | 0.0491 (0.65) |
| | 2022 - 2024 | -0.2099** (-2.02) | 0.1771 (1.82) | -0.1888* (-1.87) | -0.0558 (-0.58) | -0.0985 (-1.07) |
| $\Delta pr_{i,t-1} X_{i,t-1} (\theta^*)$ | 2000 - 2001 | -0.0131 (-0.69) | 0.0534 (0.73) | 0.1043 (0.52) | 0.0456 (1.18) | 0.0664 (0.28) |
| | 2005 - 2008 | 0.0468 (0.62) | 0.0116 (0.16) | 0.0538 (0.68) | -0.0063 (-0.09) | -0.0478 (-0.63) |
| | 2022 - 2024 | 0.1141** (2.01) | -0.1092** (-2.01) | 0.1282** (2.26) | 0.0512 (0.92) | 0.0995 (1.81) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t-value in parentheses; results of the panel data estimation with interaction terms on country level with robust standard errors. Estimated coefficients in column 1 as defined in equation 2. Dependent variables in the first row

Table A-23: Regression output Interaction terms Deposit NFC for country panel data during periods of hiking interest rates

| Deposit NFC | | | | | | |
|---|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Dependent variable: $\Delta br_{i,t}$ | Period | Industrial production | Inflation | Stock price index | Country risk premium | Leverage ratio |
| X_i | | | | | | |
| $\Delta pr_{i,t}(\beta_0)$ | 2000 - 2001 | 0.3876*** (4.26) | 0.3157*** (3.72) | 0.3703*** (3.81) | 0.3146*** (4.82) | 0.3576*** (5.81) |
| | 2005 - 2008 | 0.6964** (5.34) | 0.7248*** (5.19) | 0.9735*** (7.35) | 0.6133*** (4.39) | 0.8355*** (5.95) |
| | 2022 - 2024 | 0.5276*** (3.09) | 0.1441 (0.79) | 0.4141** (2.54) | 0.4614*** (2.75) | 0.4502** (2.59) |
| $br_{i,t}(\delta)$ | 2000 - 2001 | -0.1592*** (-5.71) | -0.0371 (-0.71) | -0.1511*** (-5.81) | -0.1351** (-2.06) | -0.0507 (-1.31) |
| | 2005 - 2008 | -0.6727*** (-9.68) | -0.5218*** (-4.59) | -0.6943*** (-8.99) | -0.4495*** (-4.27) | -0.4811*** (-3.33) |
| | 2022 - 2024 | -0.5569*** (-5.31) | -0.4221*** (-4.14) | -0.5722*** (-5.37) | -0.7579*** (-6.63) | -0.6015*** (-5.49) |
| $pr_{i,t}(\theta)$ | 2000 - 2001 | 0.0057 (0.71) | -0.0616 (-0.71) | 0.0466 (0.81) | 0.0362 (0.51) | -0.0382 (-1.10) |
| | 2005 - 2008 | 0.7244*** (9.21) | 0.5421*** (4.43) | 0.7341*** (8.52) | 0.4244*** (3.94) | 0.4673*** (3.15) |
| | 2022 - 2024 | 0.3761*** (4.18) | 0.2619*** (3.04) | 0.3905*** (4.45) | 0.5475*** (5.63) | 0.3777*** (4.32) |
| $\Delta pr_{i,t} X_{i,t-1}(\beta^*)$ | 2000 - 2001 | 0.0577 (0.71) | 0.1871 (1.15) | 0.1415 (0.29) | 0.2747*** (4.81) | 0.1683 (0.81) |
| | 2005 - 2008 | 0.1542 (0.88) | 0.0431 (0.24) | -0.3847** (-2.17) | 0.3039* (1.17) | -0.1574 (-0.90) |
| | 2022 - 2024 | -0.4657 (-1.93) | 0.3388 (1.44) | -0.2747 (-1.14) | -0.1844 (-0.81) | -0.2711 (-1.16) |
| $\Delta br_{i,t-1} X_{i,t-1}(\delta^*)$ | 2000 - 2001 | 0.0864 (0.85) | -0.1941** (-4.46) | -0.2231** (-2.17) | -0.0945 (-0.81) | -0.2119*** (-4.71) |
| | 2005 - 2008 | 0.1848 (1.25) | -0.0898 (-0.75) | 0.1421 (1.38) | -0.2611** (-2.25) | -0.1865 (-1.26) |
| | 2022 - 2024 | 0.1101 (0.79) | -0.1388 (-1.01) | 0.1665 (1.20) | 0.3122** (2.16) | 0.1014 (0.75) |
| $\Delta pr_{i,t-1} X_{i,t-1}(\theta^*)$ | 2000 - 2001 | 0.0084 (0.91) | 0.1751** (2.16) | 0.1911** (2.01) | 0.0624 (0.71) | 0.1278 (1.14) |
| | 2005 - 2008 | -0.2502 (-1.58) | 0.0881 (0.66) | -0.1975 (-1.7) | 0.3397*** (2.68) | 0.2526 (1.59) |
| | 2022 - 2024 | 0.0041 (1.12) | 0.1241 (1.20) | -0.1375 (-1.35) | -0.3051*** (-2.9) | 0.0041 (0.04) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t-value in parentheses; results of the panel data estimation with interaction terms on country level with robust standard errors. Estimated coefficients in column 1 as defined in equation 2. Dependent variables in the first row

Table A-24: Robustness regression output 11 EMU countries during periods of hiking interest rates with shadow rate

| Dependent variable: $\Delta br_{i,t}$ | Period | Loan to Households | Loan to NFC Big Loans | Loan to NFC Small Loans | Deposits Households | Deposits NFC |
|---------------------------------------|-------------|------------------------|------------------------|-------------------------|------------------------|-----------------------|
| $\Delta br_{i,t-1}$ | 2000 - 2001 | -0.2031*** (-10.84) | -0.3249*** (-15.87) | -0.0481 (-0.95) | 0.1232*** (9.37) | -0.1631*** (-8.54) |
| | 2005 - 2008 | -1.172** (-2.24) | -0.2273*** (-4.07) | -0.0242 (-0.48) | -0.2737*** (-5.14) | -0.1674*** (-3.26) |
| | 2022 - 2024 | -0.1415 (-1.77) | 0.2014* (2.02) | -0.0822 (0.94) | 0.0143 (1.9) | -0.0726 (-1.05) |
| $\Delta pr_{i,t}(\beta_0)$ | 2000 - 2001 | 0.1636*** (4.47) | 0.3224*** (4.18) | 0.2194*** (4.68) | 0.2574*** (8.26) | 0.3879*** (9.08) |
| | 2005 - 2008 | 0.1926*** (2.91) | 0.2603*** (3.76) | 0.1848** (2.18) | 0.3624*** (6.990) | 0.4978*** (7.61) |
| | 2022 - 2024 | 0.0897*** (2.91) | 0.5218 (1.45) | 0.6111** (2.06) | 0.1093*** (3.22) | 0.2611*** (4.91) |
| $\Delta pr_{i,t-1}$ | 2000 - 2001 | 0.0501*** (4.2) | 0.0747** (2.56) | 0.0104 (0.24) | 0.0459*** (5.61) | 0.1019*** (7.86) |
| | 2005 - 2008 | 0.1104*** (2.86) | -0.0755 (-0.91) | 0.2165** (2.34) | 0.1168** (2.45) | -0.1007 (-1.51) |
| | 2022 - 2024 | 0.0344 (1.14) | -0.0881 (1.45) | 0.0066 (0.13) | 0.0259 (-0.81) | 0.0809 (1.61) |
| $br_{t-1}(\delta)$ | 2000 - 2001 | -0.0349*** (-10.86) | -0.1287*** (-15.33) | -0.0352*** (-8.21) | -0.0201*** (-10.27) | -0.0239*** (-9.19) |
| | 2005 - 2008 | -0.0838*** (-3.78) | -0.5552*** (-8.43) | -0.3187*** (-8.48) | -0.1927*** (-4.53) | -0.5946*** (-9.82) |
| | 2022 - 2024 | -0.2557*** (-5.31) | -1.019*** (-8.41) | -0.5796*** (-9.07) | -0.2207*** (-5.71) | -0.4837*** (-8.36) |
| $pr_{t-1}(\theta)$ | 2000 - 2001 | 0.0211*** (8.92) | 0.0953*** (13.76) | 0.0277*** (8.28) | 0.0149*** (9.37) | 0.0216*** (8.53) |
| | 2005 - 2008 | 0.0654*** (-3.78) | 0.4937*** (8.23) | 0.2228*** (8.01) | 0.2007*** (5.09) | 0.6447*** (9.85) |
| | 2022 - 2024 | 0.1018*** (5.36) | 0.3761*** (2.02) | 0.2446*** (7.34) | 0.1178*** (6.23) | 0.2859*** (8.17) |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); t -value in parentheses; results of the robustness panel data estimation with fixed effect at country level with robust standard errors and shadow rate. Independent variables in column 1 as defined in equation 1. Dependent variables in the first row

Table A-25: Short- and long run pass-through 11 EMU countries during periods of hiking interest rates with shadow rate

| Loan to NFC Big Loans: Above | Period | Loan to Households | Loan to NFC Big Loans | Loan to NFC Small Loans | Deposits Households | Deposits NFC |
|---|-------------|--------------------|-----------------------|-------------------------|---------------------|--------------|
| Short-term pass-through (β_0) (in percent) | 2000 - 2001 | 16%*** | 32%*** | 21%*** | 26%*** | 39%*** |
| | 2005 - 2008 | 19%*** | 26%*** | 18%** | 36%*** | 50%*** |
| | 2022 - 2024 | 9%*** | 52% | 61%** | 11%*** | 26%*** |
| Long-term pass-through $-(\theta/\delta)$ (in percent) | 2000 - 2001 | 60%*** | 74%*** | 79%*** | 74%*** | 90%*** |
| | 2005 - 2008 | 78%*** | 89%*** | 70%*** | 104%*** | 108%*** |
| | 2022 - 2024 | 40%*** | 37%*** | 42%*** | 53%*** | 59%*** |
| Half-Life (in months) | 2000 - 2001 | 1.47 | 1.25 | 1.83 | 1.32 | 1.42 |
| | 2005 - 2008 | 1.20 | 1.09 | 1.31 | 0.97 | 0.94 |
| | 2022 - 2024 | 1.66 | 1.90 | 1.97 | 1.19 | 1.74 |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); results of the panel data estimation with fixed effect at country level with robust standard errors and shadow rate. Size and speed of pass-through in column 1 as defined in equation 1. Dependent variables in the first row.

Table A-26: Results Interaction terms short- and long run pass-through of GDP at Market Prices and Banking Market Concentration for bank loan and deposit rates above median

| Above | Period | Loan to Households | | Loan to NFC Big Loans | | Loan to NFC Small Loans | |
|---|-------------|----------------------|------------------------------|-----------------------|------------------------------|-------------------------|------------------------------|
| | | GDP at Market Prices | Banking Market Concentration | GDP at Market Prices | Banking Market Concentration | GDP at Market Prices | Banking Market Concentration |
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 38% | 28% | 23% | 24%*** | 37% | 41% |
| | 2005 - 2008 | 33% | 6% | 62% | 18% | 30% | 0% |
| | 2022 - 2024 | 4% | 11% | 68% | 45% | 68% | 74% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | -5% | -25% | 51%** | 23% | 47%*** | 12% |
| | 2005 - 2008 | 60% | 54% | 81% | 74% | 91% | 60%*** |
| | 2022 - 2024 | 39%*** | 34% | 77%*** | 60% | 54% | 60% |
| Half-Life (in months) | 2000 - 2001 | -13.51 | -2.41 | 1.68 | 3.35 | 1.80 | 6.12 |
| | 2005 - 2008 | 1.47 | 1.12 | 1.17 | 1.12 | 1.07 | 1.47 |
| | 2022 - 2024 | 2.10 | 1.78 | 1.21 | 1.78 | 1.61 | 1.47 |

| Above | Period | Deposits Households | | Deposits NFC | |
|---|-------------|----------------------|------------------------------|----------------------|------------------------------|
| | | GDP at Market Prices | Banking Market Concentration | GDP at Market Prices | Banking Market Concentration |
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 31% | 31% | 33% | 41% |
| | 2005 - 2008 | 37% | 49%** | 67% | 91% |
| | 2022 - 2024 | 17% | 7% | 18% | 8%*** |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 7% | 22% | 26% | 73% |
| | 2005 - 2008 | 89% | 100% | 97% | 101% |
| | 2022 - 2024 | 64% | 44%*** | 53%** | 48%*** |
| Half-Life (in months) | 2000 - 2001 | 10.24 | 3.49 | 3.00 | 1.26 |
| | 2005 - 2008 | 1.09 | 1.00 | 1.02 | 0.99 |
| | 2022 - 2024 | 1.40 | 1.90 | 1.63 | 1.77 |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); Robustness results of the panel data estimation with interaction terms on country level with robust standard errors for GDP at Market Prices and Banking Market Concentration. Size and speed of pass-through in column 1 as defined in equation 2. Dependent variables in the first row.

Table A-27: Results interaction terms short- and long run pass-through of GDP at Market Prices and Banking Market Concentration for bank loan and deposit rates below median

| Below | Period | Loan to Households | | Loan to NFC Big Loans | | Loan to NFC Small Loans | |
|---|-------------|----------------------|------------------------------|-----------------------|------------------------------|-------------------------|------------------------------|
| | | GDP at Market Prices | Banking Market Concentration | GDP at Market Prices | Banking Market Concentration | GDP at Market Prices | Banking Market Concentration |
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 20% | 23% | 41% | 37%*** | 18% | 25% |
| | 2005 - 2008 | 7% | 32% | 19% | 45% | 4% | 18% |
| | 2022 - 2024 | 25% | 26% | 47% | 69% | 66% | 55% |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 24% | 8% | 3%** | 22% | 20%*** | 18% |
| | 2005 - 2008 | 71% | 91% | 91% | 94% | 60% | 86%*** |
| | 2022 - 2024 | 48%*** | 48% | 47%*** | 48% | 56% | 56% |
| Half-Life (in months) | 2000 - 2001 | 3.22 | 9.01 | 1.68 | 3.49 | 1.80 | 4.19 |
| | 2005 - 2008 | 1.29 | 1.12 | 1.07 | 1.12 | 1.47 | 1.47 |
| | 2022 - 2024 | 2.10 | 1.78 | 1.21 | 1.78 | 1.56 | 1.56 |

| Below | Period | Deposits Households | | Deposits NFC | |
|---|-------------|----------------------|------------------------------|----------------------|------------------------------|
| | | GDP at Market Prices | Banking Market Concentration | GDP at Market Prices | Banking Market Concentration |
| Short-term pass-through ($\beta_0 + \beta^*$) (in percent) | 2000 - 2001 | 30% | 36% | 54% | 44% |
| | 2005 - 2008 | 35% | 50%** | 84% | 61% |
| | 2022 - 2024 | 14% | 32% | 50% | 80%*** |
| Long-term pass-through $-(\theta + \theta^*/\delta + \delta^*)$ (in percent) | 2000 - 2001 | 29% | 40% | 49% | 55% |
| | 2005 - 2008 | 103% | 91% | 107% | 100% |
| | 2022 - 2024 | 50% | 57%*** | 69%** | 66%*** |
| Half-Life (in months) | 2000 - 2001 | 2.72 | 2.06 | 1.74 | 1.58 |
| | 2005 - 2008 | 0.98 | 1.07 | 0.95 | 1.00 |
| | 2022 - 2024 | 1.71 | 1.90 | 1.63 | 1.77 |

Note: ***($p < 0.01$) **($p < 0.05$) *($p < 0.1$); Robustness results of the panel data estimation with interaction terms on country level with robust standard errors for GDP at Market Prices and Banking Market Concentration. Size and speed of pass-through in column 1 as defined in equation 2. Dependent variables in the first row.

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