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The Pass-Through Effect of Monetary Policy: An Analysis of Deposit and Lending Rate Dynamics in Portugal

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Abstract

This dissertation examines the transmission of monetary policy in Portugal, assessing whether the pass-through to deposits and lending rates is symmetric – that is, whether increases and decreases in interest rates are transmitted to banks' retail rates to the same extend – and whether bank size influences these adjustments. The work builds on a strand of literature that emphasises the importance of banks in ensuring the effectiveness of monetary policy transmission, while recognising the absence of universal conclusions and the need to consider multiple dimensions such as product type, client segment, and institutional characteristics.

To address these questions, the dissertation adopts an econometric approach based on Valadkhani and O'Mahony (2024), which is subsequently adapted to expand the analysis. The empirical strategy combines both aggregate and panel data.

At the aggregate level, no clear evidence of asymmetry was observed when examining only increases and decreases in the Euro short-term rate (€STR). However, when different thresholds of the €STR were considered, asymmetry emerged, particularly for household house-purchase and corporate loans during periods of relatively low rates, with upward adjustments being more strongly transmitted than downward ones. At the institution level, statistical evidence confirms asymmetry in loan rates, with upward adjustments more strongly transmitted than downward ones, while deposits display no asymmetry. For the largest banks, a further layer appears: asymmetry in deposits, with downward adjustments being more fully passed through than upward ones, alongside confirmation of asymmetry in loans for specific categories.

While this study offers a comprehensive view of monetary policy transmission in Portugal, it has limitations, particularly regarding certain specification and model choices, leaving room for future research, including the assessment of other factors influencing the transmission mechanism.

Keywords: Monetary Policy Transmission, Banks, Deposit Rates, Lending Rates, Portugal

JEL-Codes: E43, E52, G21.

Sumário

Esta dissertação analisa a transmissão da política monetária em Portugal, avaliando se a repercussão nas taxas de depósitos e crédito é simétrica – ou seja, se os aumentos e diminuições das taxas de juro se refletem de forma equivalente nas taxas praticadas pelos bancos junto dos clientes – e se o tamanho dos bancos influencia esse ajustamento. O trabalho segue uma linha de investigação que evidencia a importância dos bancos na eficácia da transmissão da politica monetária, reconhecendo a ausência de conclusões universais e a necessidade de considerar múltiplas dimensões, como o tipo de produto, o segmento de clientes e as características institucionais.

Para responder às questões, a dissertação segue uma abordagem econométrica baseada em Valadkhani e O'Mahony (2024), adaptada para alargar a análise, combinando dados agregados e em painel ao nível das instituições.

Ao nível agregado, não se observou evidência de assimetria ao analisar os aumentos e diminuições da Taxa de juro de curto prazo do euro (€STR). No entanto, ao considerar diferentes limiares da €STR, surgiu evidencia de assimetria, particularmente para empréstimos a particulares para habitação e a empresas durante períodos de taxas relativamente baixas, com os aumentos a serem transmitidos de forma mais intensa do que as diminuições. Ao nível dos dados em painel, a evidência estatística confirma a existência de assimetria nas taxas de empréstimo, com os aumentos a serem transmitidos mais fortemente do que as diminuições, enquanto os depósitos não apresentam assimetria. Nos maiores bancos, verifica-se assimetria nos depósitos, com as diminuições a serem transmitidas de forma mais completa do que os aumentos, juntamente com a confirmação da assimetria nos empréstimos para algumas categorias.

Embora este estudo forneça uma visão abrangente da transmissão da política monetária em Portugal, apresenta limitações relacionadas com especificações e modelação, abrindo espaço para investigação futura, incluindo avaliação de outros fatores que influenciam o mecanismo de transmissão.

Palavras chave: Transmissão da Política Monetária, Bancos, Taxas de Depósito, Taxas de Juro de Empréstimo, Portugal

Códigos JEL: E43, E52, G21

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List of Acronyms

APB. Associação Portuguesa de Bancos

APP. Asset Purchase Programme

BPLIM. Banco de Portugal Microdata Research Laboratory

ECB. European Central Bank

ECM. Error Correction Models

EONIA. Euro Overnight Index Average

€STR. Euro short-term rate

G#. Group #

H#. Hypothesis #

NARDL. Nonlinear Autoregressive Distributed Lag

NIRP. Negative Interest Rates Policy

PEPP. Pandemic Emergency Purchase Programme

PLP. Panel Local Projections

RBA. Reserve Bank of Australia

SLB. Historical Series of the Portuguese Banking Sector Database

TLTRO III. Third series of targeted longer-term refinancing operations

US. United States

1. Introduction

The financial system is essential for economic growth and stability, as it facilitates the efficient allocation of funds. Countries with more advanced financial systems tend to experience higher growth rates (Levine, 2002). Financial institutions serve as intermediaries, connecting individuals with surplus funds to those with investment opportunities, thus driving economic performance (Greenwood & Jovanovic, 1990).

Within financial institutions, banks stand out as key players due to their important role in effectively addressing informational problems, making them indispensable for many borrowers who thus develop a relationship of dependency (Bernanke & Gertler, 1995).

Perhaps the best way to demonstrate the importance of the role played by banks is to examine what occurs when this function is called into question. The most evident example of this is during a financial crisis. In a situation where informational problems significantly increase, the ability of financial markets to make the most efficient allocation of funds is undermined. In this scenario, banks, whether through a reduction in their number or the narrowing of their sources of funds, decrease their capacity as intermediaries, thereby contributing to a reduction in economic activity (Mishkin, 1996).

Beyond their role in allocating funds, banks play a crucial role in the transmission of monetary policy (i.e. the process by which central bank decisions affect the real economy) to achieve the corresponding mandate objectives. The effective transmission of monetary policy is seen not only as a part of a final goal to achieve but also as a key factor in the central bank decision-making process. In addition to the various obvious economic and financial indicators analysed in setting monetary policy, the way in which transmission reaches the real economy – smoothly, without time lags or disruptions to the mechanism – is also a crucial part of decision-making and necessarily influences it, potentially shaping future steps (ECB, 2021a).

The possibility of incomplete transmission, heterogeneity across different institutions or types of products offered, or asymmetries in the speed at which interest rates adjust in response to increases or decreases in the central bank's policy rate represents a set of relevant dimensions when analysing the transmission mechanism.

For the effective transmission of monetary policy, the characteristics of banks and the markets in which they operate can play a significant role in this process. These characteristics,

already well-documented in the literature, such as size (Kashyap & Stein, 1995; Kashyap & Stein, 2000; Kishan & Opiela, 2000), among others, may influence how banks pass on changes in central bank policy rates to their clients through the rates offered on deposits and loans.

In this way, understanding how the transmission of monetary policy occurs through lending and deposit rates, whether there is asymmetry between periods of rate increases and decreases, and how bank-size influence this transmission is essential to ensuring the achievement of mandate objectives and the predictability of monetary policy effects.

This study aims to explore how the central bank's interest rate affects the interest rates set by commercial banks in Portugal. Specifically, it seeks to determine whether there is heterogeneity in the transmission of monetary policy to deposit and lending rates for different consumer groups (e.g., non-financial corporations and households), whether the dynamics of rising and falling rates exhibit asymmetries, and how bank-size – examined exclusively, given the limited scope of this dissertation – may influence this transmission.

In order to achieve this, the discussion will be framed within the literature, and an econometric approach will be adopted to test a set of related hypotheses. The analysis will first look at aggregate interest rates, following the approach of Valadkhani and O'Mahony (2024), by examining the dynamics of increasing and decreasing rates. In the second stage, a similar exercise will be performed using individual institution-level interest rate data. Additionally, to account for the potential impact of bank size, the regression will be conducted for a selected group. The transmission of monetary policy through deposit and lending rates will be analysed separately for different types of consumers.

The aim is to contribute to the literature by approaching this topic in a holistic manner within the Portuguese context, as, to the best of our knowledge, no study has been conducted that simultaneously includes the analysis of all the proposed dimensions of transmission.

The empirical findings reveal limited evidence of asymmetry when using aggregate interest rates data, considering only increases and decreases in the €STR, which is used as a proxy for monetary policy. However, once different thresholds of the €STR are accounted for, asymmetries emerge, particularly for household house purchase and corporate lending rates during periods of relatively low interest rates, where upward adjustments are transmitted more strongly than downward ones. Similarly, within certain intervals of the €STR, asymmetries can also be identified in deposit rates, with decreases being passed through more strongly

than increases. At the institution level, panel data evidence points to the existence of asymmetry in lending rates, while deposit rates show no such pattern. Moreover, among the largest banks, measured by total assets, asymmetry also appears in deposits, with decreases being passed through more fully than increases, alongside further confirmation of asymmetry in loan households house purchases and corporate loans. These results highlight that the transmission of monetary policy in Portugal is not uniform, depending both on type of product and on the size of the institution.

The dissertation proceeds with Chapter 2 – Literature Review, where key concepts are developed, the current state of the literature is contextualised, and particular attention is given to the case of Portugal. This is followed by Chapter 3 – Research Question and Hypotheses, which sets the foundation for the empirical analysis. Chapter 4 – Methodology then presents the methodological frameworks, model specification, sample, and the limitations of the approach, along with stylized facts and an exploratory data analysis. The findings are examined in Chapter 5 – Results and Discussion. Finally, the dissertation concludes with Chapter 6.

2. Literature review

In this dissertation we evaluate the possible asymmetric features of the monetary policy interest rate pass-through. To understand the interest rate pass-through, we need first to review the objectives of monetary policy and how they shape decision-making, through its transmission channels. After that, we analyse the conclusions drawn from the empirical findings regarding the efficiency of the pass-through, namely whether it is complete or incomplete, and whether it exhibits any form of asymmetry or heterogeneity.

However, solely relying on these empirical findings is not sufficient to fully comprehend the interest rate pass-through in a holistic manner. These must be framed within the theoretical models that handle the impact of institutional context particularly by considering potential determinants such as market characteristics and specific bank features that may influence the strength and/ or the asymmetry of the pass-through. Such characteristics could potentially either amplify or dampen the transmission of interest rate changes, leading to a more pronounced or uneven pass-through.

2.1. Monetary Policy: Objectives and Transmission

Monetary policy is a fundamental tool for ensuring sustained growth and low inflation (Mischkin, 1996). In the euro area, the European Central Bank (ECB) primary objective is to maintain price stability. Subsidiarily, monetary policy should support general economic policies (ECB, 2021a).

The main monetary policy decisions by the ECB regard setting key interest rates, thereby influencing the cost and availability of money within the economy. Adjustments to these rates directly affect the interest rates of commercial banks, therefore impacting credit and lending conditions for businesses and consumers (ECB, 2021b).

However, the transmission of monetary policy effects may not occur smoothly, without time lags or disruptions to the mechanism. Various factors can influence this process, including the responsiveness of financial markets, the sensitivity of financial institutions to interest rate changes, and prevailing economic conditions. Therefore, it is essential to consider the timing and effects of policies to achieve desired objectives, through a comprehensive understanding of the various nuances of the mechanism by which monetary policy affects the economy (Mishkin, 1996).

The most recent revision of ECB monetary policy strategy, conducted in 2021, considered

the structural changes in the economy and additional challenges that have arisen since the previous review in 2003, such as global financial crises, the sovereign debt crisis, and the coronavirus pandemic. This revision introduced several changes to ensure the proper conduct of monetary policy. Among the main changes, there is a focus on the effective transmission of monetary policy, through the development of analytical tools necessary to understand the different dynamics and interconnections in the economy that affect this transmission. The relevance of the monetary policy transmission mechanism, particularly through lending, underscores the essential role of banks in this process (ECB, 2021c).

Monetary Policy channels

Delving into the channels through which the effects of monetary policy are realised provides valuable insights into its broader economic implications. One of the most significant channels is the traditional *interest rate channel* based on the traditional Keynesian IS-LM framework, according to which the interest rate influences the level of investment and, consequently, economic activity. Thus, hypothetically, an expansionary monetary policy leads to a reduction in the real interest rate, which in turn lowers the cost of capital, stimulating investment and output. Following this perspective, it is important to note that nominal movements in interest rates do not directly translate into real interest rates, and this is particularly relevant because it is the real rates that are the critical element in the transmission channel (Mishkin, 1996).

As a collection of factors that enhance and propagate the typical effects of the interest rate channel, as referred to by Bernanke and Gertler (1995), and rather than being a parallel and independent channel, the authors identified the *credit channel*, through which the effects of monetary policy via interest rates are amplified by what they define as an external financial premium (i.e. the difference between the costs of external and internal funds), which responds to changes in monetary policy. This idea is based on the premise that there is imperfect information and, therefore, monitoring and assessment costs (Bernanke & Gertler, 1995; Mishkin, 1996).

Two key mechanisms help explain the relationship between monetary policy and the external financial premium identified in the credit channel: the balance sheet channel and the bank lending channel.

- *The balance sheet channel*

According to the balance sheet channel, the financial position of the borrower plays a critical role in determining the external financial premium. A more comfortable financial position, characterised by a stable and higher net worth, helps to reduce conflicts of interest with the lender, thereby overcoming information asymmetries that directly affect the external financial premium. For instance, a tight monetary policy influences a borrower's balance sheet in two simultaneous ways. On the one hand, it reduces net income by increasing interest expenses as a result of rising interest rates. On the other hand, it generally decreases the value of the borrower's collateral, since higher interest rates are typically associated with lower asset prices. Consequently, fluctuations in the borrower's balance sheet influence their consumption and investment decisions through the external financial premium imposed upon them (Bernanke & Gertler, 1995).

This premium acts as a compensatory mechanism for the lender. Specifically, because the borrower's capacity to honour debt obligations has weakened due to reduced income and depreciated collateral. As the borrower's income declines and the value of their collateral falls, the cost of servicing the debt becomes a greater burden. In this context, banks demand a higher premium to account for the increased likelihood that the borrower will face difficulties in meeting their repayment obligations (Bernanke & Gertler, 1995).

This reasoning applies not only to business firms but also to households. As their balance sheets deteriorate through the aforementioned pathways of net income and collateral, consumers additionally anticipate the risk of financial distress and therefore avoid purchasing illiquid consumer durable goods or housing assets. If forced to sell under distress, they would likely incur substantial losses due to high information asymmetry regarding asset quality (Bernanke & Gertler, 1995; Mishkin, 1996).

- *The bank lending channel*

Regarding the bank lending channel, the external financial premium is affected by shifts in the supply of intermediated credit, such as loans from commercial banks. Currently, banks remain predominant in the intermediation of credit because they are better at resolving the problems of asymmetric information in credit markets (Bernanke & Gertler, 1995). From the perspective of banks, as Bernanke and Blinder (1988) highlight in their model, this channel manifests through the reduction of funds made available by the central bank as a result of tightening policies. The effect transmitted through the composition of banks' balance sheets arises when banks are unable to compensate for the shortage of funds with new

sources of funds.

Any disruption in the supply of credit has significant consequences, particularly from the perspective of borrowers. The effects are likely to be more pronounced when access to credit from alternative sources is restricted, especially for small and medium-sized firms. Due to the private nature of information, industry knowledge, local conditions, and other factors, banks often represent the main viable source of financing for such firms, as they achieve economies of scope in their monitoring processes (Mishkin, 1996; Peek & Rosengren, 1995).

Companies and households in Europe, when compared to the United States (US), remain significantly more reliant on bank financing. Although the US and European countries exhibited similar bank assets-to-GDP ratios – around 70% - from 1880 to the 1960s, a marked divergence has been observed since then. Despite the increasing role of non-bank financing, European firms continue to rely much more heavily on bank lending (Draghi, 2024), which could suggest a greater predominance of this channel, given the relatively limited depth of alternative financing options available to European firms, in particular capital markets.

The *deposit channel* of monetary policy, as proposed by Drechsler et al. (2017), offers an alternative way to understand the transmission of monetary policy, closely related to the bank lending channel. According to their model, when the central bank raises the interest rate, banks tend to increase the spreads they charge on deposits (i.e., the difference between the interest rate set by the central bank and the deposit rate), potentially leading to a non-trivial outflow of deposits from the banking system. This shift is more pronounced in less competitive markets or where there is low mobility among depositors across banks.

Since deposits are a stable and primary source of funding for banks, a contraction in deposits due to higher spreads results in a reduction in the availability of funds, and consequently, loans, particularly for risky or illiquid borrowers, such as small businesses (Drechsler et al., 2017).

2.2. Impaired Monetary Policy Transmission

The literature points to the existence of transmission and adjustments of interest rates that might vary between different countries, types of products, customer segments, and even historical and economic contexts. This suggests that, in some cases, the transmission is heterogeneous, incomplete, and the speed of adjustments may exhibit different types of

asymmetry. This will be detailed only after exploring the *theoretical reasons* that may lead to what we could call disruptions in the monetary policy transmission mechanism. Several factors may underlie the observed phenomenon of different intensities of adjustment and asymmetric effects in interest rates increases or decreases.

Degree of pass-through

Among these factors, several bank characteristics, may amplify the impact of monetary policy and are closely linked to the reasoning behind the bank lending channel.

Bank size is a key factor to consider. According to Boeckx et al. (2020), banks that are more constrained in raising external funding are expected to respond more strongly to central bank policies. In the case of large banks, since information costs are lower and there is greater asset diversification, the difficulty in raising funding is reduced.

Liquidity is another characteristic that follows a similar line of reasoning. Banks with lower liquidity are expected to respond more strongly to monetary policy, as more liquid banks have greater ease in protecting their loan portfolios by adjusting their stock of securities or using them as collateral to obtain external funding. In contrast, liquidity-constrained banks must compensate for the funding shortfall caused by a restrictive balance sheet shock (Boeckx et al., 2020).

Capital can also be a relevant factor, as banks with higher capitalization have easier access to funding, given that capital serves as a buffer to absorb potential losses. Consequently, capital-constrained banks experience a stronger impact from monetary policy (Boeckx et al., 2020).

In summary, hypothetically, in the face of a monetary contraction, the ease of substituting sources of external financing – which is greater for larger, better-capitalized, and more liquid banks – may lead to a more muted impact of monetary policy decisions (Altavilla et al., 2020).

Asymmetric effects in interest rates increases or decreases

As for asymmetric effects, one possible explanation is tacit collusion in concentrated markets, where explicit coordination of pricing is absent, yet banks can maintain supernormal profits as long as no competitor disrupts the equilibrium (Toolsema and Jacobs, 2007). According to Levieuge and Sahuc (2021), banks may find themselves in a situation where they refrain

from adjusting rates or wait for other banks to do so, ensuring such a change is not an act of cheating but merely a response to changes in market conditions.

Banks may also face menu costs, such as the costs of advertising new price lists or communicating with customers (Levieuge & Sahuc, 2021). Although these costs are relatively low compared to other sectors, they are not necessarily negligible (Neumark & Sharp, 1992). In this context, if the costs of adjustment exceed the expected benefits, banks may choose not to implement rate changes (Rosen, 2002; Toolsema & Jacobs, 2007). The effects of this factor may vary depending on the type of product and whether there is an increase or decrease in interest rates. In the case of loans, when interest rates rise, if the gain from higher interest income outweighs the menu costs, banks have an incentive to implement the adjustment. However, in the case of interest rate reductions, adjusting loan rates would result in losses due to both menu costs and the reduction in interest income (Levieuge & Sahuc, 2021).

Another contributing factor is a set of consumer characteristics, such as consumer sophistication, search costs, and switching costs. According to Rosen (2002), consumers can be divided into two groups: sophisticated and unsophisticated consumers. The key difference between them lies in how they assess the market. While sophisticated consumers are aware of the market interest rates, unsophisticated consumers have a more limited focus – for example, paying attention primarily to changes in their own bank's rates. As a result, banks may enjoy a certain degree of market power when the proportion of unsophisticated consumers is higher, allowing them to adjust rates asymmetrically to their advantage.

Consumer sophistication is also naturally linked to search costs, as the process of identifying more favourable rates can be costly, particularly in terms of time. Consequently, if consumers are disincentivised by these costs and do not seek alternative options, they grant banks a degree of market power. This allows banks to implement adjustments more slowly while temporarily maintaining high profit margins (Scholnick, 1999; Toolsema & Jacobs, 2007).

Additionally, switching costs may also exist if consumers face costs when changing banks, as this creates a lock-in effect. In such cases, banks have an incentive to increase their mark-up (Levieuge & Sahuc, 2021; Scholnick, 1999).

Regarding the *empirical evidence*, Hofmann (2006) and Sander and Kleimeier (2002) converge in identifying different patterns in the transmission of monetary policy across the countries that make up the euro area. According to Sander and Kleimeier (2002), for the period preceding the introduction of the European Monetary Union (EMU), the speed and nature of

adjustments vary between countries. These differing patterns among certain groups of countries persist even after the introduction of the EMU, as noted by Hofmann (2006), although it has made some rates more responsive in certain countries. The heterogeneity in the results found for different countries in the euro area is further corroborated by the empirical survey conducted by Andries and Billon (2016), which compiles various papers spanning multiple historical periods and countries. Beyond the theoretical factors already presented, which, depending on whether they are or not present in each country, may also contribute to heterogeneity across countries, there are also other factors unique to each country, such as the multiple degrees of proximity that banks establish with their clients (Sander and Kleimeier, 2002) or their exposure to domestic sovereign debt (Altavilla et al., 2020), both of which can contribute to heterogeneity of the interest rate pass through .

With regard to the extent of pass-through, the heterogeneity observed across countries also extends to different types of banking products, the majority of which exhibit an incomplete pass-through (De Graeve et al., 2007).

Some historical economic events have also brought about changes over time. Despite the heterogeneity observed at the introduction of the euro, according to Andries and Billon (2016), it is possible to document a decrease in the long-run pass-through, but an improvement in the short-run pass-through, which may indicate incomplete integration of the retail banking markets, yet a higher level of competitiveness. The implementation of negative interest rates (NIRP) has also affected the banking system and, consequently, the interest rate pass-through mechanism. One of the most widely documented effects is the compression of net interest margins (Boungou & Hubert, 2021). This compression stems primarily from the downward rigidity of deposit rates, particularly those on household deposits, which banks struggle to push into negative territory due to legal constraints, reputational concerns, and the risk of a shift to cash holdings (Scheiber et al., 2016; Heider et al., 2021; Demiralp et al., 2021). In contrast, for corporate clients, switching to cash is logistically more difficult and costly, and such firms tend to maintain more complex relationships with banks (Heider et al., 2021).

Beyond the specific issue of negative rates, differences in behaviour across client types and product categories remain evident more broadly. In the case of loans, there is considerable short-run stickiness, which is more pronounced for consumer loans than for corporate ones (Andries & Billon, 2016; De Graeve et al., 2007). This more competitive adjustment by

corporate loans is also observed in long-run adjustments (De Graeve et al., 2007).

Regarding deposits, these also exhibit rigidity, which is smaller the shorter the maturity of the products (Andries & Billon, 2016; De Graeve et al., 2007). The long-run pass-through is generally lower for deposit rates than for lending rates (Andries & Billon, 2016).

In addition to the extent of adjustments, it is also possible to analyse the interest rate pass-through from the perspective of the asymmetry of its adjustments – as briefly highlighted in the discussion of the NIRP framework, particularly regarding the downward rigidity of deposit rates. The asymmetric effects manifest in distinct ways between deposit and loan rates, revealing complex patterns in how commercial banks respond to changes in central bank reference rates, with various types of asymmetry identified in the literature.

A first type was addressed by Hannan and Berger (1991). The authors established foundational insights in this area, relating to the comparison of the response of retail rates when the wholesale rate increases versus when it decreases. This perspective of asymmetry can further be extended to the distinction between short and long run, meaning it is also possible to observe whether rates are adjusted with a shorter or longer lag time depending on whether we are dealing with increases or decreases in the reference rate (Lim, 2001).

On the other hand, another type of asymmetry assesses the response of retail rates in relation to their position relative to the long-run equilibrium. That is, it compares the adjustments of retail rates when they are above the long-run equilibrium with those when they are below this same equilibrium value (Neumark & Sharp, 1992; Scholnick, 1999).

It is also possible to analyse asymmetry from the perspective of the magnitude of deviations from equilibrium, examining separately upward and downward adjustments, as noted by De Graeve et al. (2007). This analysis assumes that the larger the equilibrium deviations, the greater the likelihood that banks will have incentives to adjust their offered rates. Consequently, small deviations may not lead to any changes. This perspective, in fact, closely aligns with the possible existence of menu costs.

In the case of the behaviour of bank lending rates, there is evidence that interest rates respond asymmetrically to increases and decreases. Several authors, such as Toolsema and Jacobs (2007), Craig and Dinger (2011), and Apergis and Cooray (2015), for both the long and short run, have found evidence that retail lending rates adjust more quickly to increases than to decreases in policy rates. Moreover, downward changes in policy rates significantly reduce

the likelihood of adjustments in lending rates compared to upward changes.

This conclusion, applied to short-term market rates, is also supported by Levieuge and Sahuc (2021), who, in addition to highlighting the greater rigidity and less complete adjustment of rates in response to downward impulses – an effect that intensifies when the policy rate is at its effective lower bound – also emphasise the potential macroeconomic consequences if this asymmetry is not considered in monetary policy decisions. Specifically, to achieve a symmetric medium-run impact on GDP, central bank rate cuts would need to be significantly larger than rate increases.

Valadkhani and O'Mahony (2024) provided a nuanced analysis of lending rate adjustments. They highlighted the well-established pattern of lending rates rising quickly in response to increases in the interest rate but declining more slowly during rate cuts. However, they were able to identify the potential existence of thresholds that influence the extent of rate adjustments. In particular, beyond a certain level, banks may be unwilling to reduce lending rates further, or, conversely, above another level, they may hesitate to increase rates due to concerns about unpopularity or the risk of social backlash. The same authors were able to determine specific thresholds where this asymmetrical behaviour emerges. They observed that the asymmetry dissipates when interest rates fall below the lower threshold or exceed the upper threshold.

However, these conclusions are not unanimous. For example, Lim (2001) found evidence of asymmetry only in the short run - dissipating in the long run - where, contrary to the previously cited authors, the asymmetry favours customers. That is, banks transmit decreases to loan rates more quickly than increases.

De Graeve et al. (2007) argue that the speed of adjustment in the case of loans tends to be symmetric. Scholnick (1999), focusing more on long-term products, had also previously rejected the hypothesis of asymmetry - both in terms of the speed of adjustment to increases and decreases and in relation to long-run equilibrium - in most cases. This conclusion applies broadly to both loans and deposits.

In addition to loans, deposits also warrant the same analysis, with much of the literature converging on a pattern that is often the opposite of that observed for lending rates. Specifically, there appears to be upward rigidity in the case of deposits, coupled with a faster downward adjustment, as noted by authors such as Hannan and Berger (1991) and Lim (2001) (although the latter does not validate asymmetry in the long run), as well as De Graeve et al.

(2007), Craig and Dinger (2011), and Apergis and Cooray (2015), the latter confirming these findings for both the short and long run.

However, according to De Graeve et al. (2007), this type of sign-based asymmetry is secondary in the adjustment behaviour of interest rates when compared to the effect of deviations from equilibrium markups. These deviations lead to faster adjustments the larger they are, regardless of their sign. This conclusion is also extended to loans.

According to Driscoll and Judson (2013), in the case of deposits, banks adjust their rates in response to changes in the policy rate twice as frequently during periods of rate decreases compared to periods of rate increases.

Nevertheless, some studies challenge the dominant pattern in the literature. Valadkhani and O'Mahony (2024) contest the universality of these findings, reporting no significant asymmetry in deposit rates when responding to changes in interest rates.

In the same vein, Kho (2024), although considering deposit rates relatively rigid, does not support the idea that deposit rates are upward rigid and downward flexible for the average euro area banking sector. However, the author offers an important consideration. Even though no asymmetry is identified for deposit rates on average, the possibility that concentration factors may explain some of the divergence in deposit rates in response to changes in the policy rate cannot be excluded.

Following this lead, Kho (2024) discovered that, in the case of a more concentrated banking sector, the transmission of changes in the policy rate is slower for upward adjustments and faster for downward adjustments.

The consideration of market characteristics or bank-specific factors for potential disruptions identified in the transmission of changes in the policy rate has also been extensively studied in the literature and is underpinned by strong theoretical foundations, as previously discussed before addressing the empirical evidence in this literature review. Therefore, it is now worth exploring what further empirical evidence suggests in this regard when this nuance is introduced, while simultaneously examining the economic foundations behind these results.

Kashyap and Stein (2000) identified that banks with limited liquidity, especially smaller ones, experience a stronger impact of monetary policy on lending. Similarly, Kishan and Opiela (2000) also found evidence that monetary policy has the greatest impact on the loans of small, undercapitalised banks.

The impact of these characteristics is also significant in a NIRP scenario. The narrowing of interest margins has compelled banks to seek strategies to mitigate its effects. Boungou and Hubert (2021) identify four main responses adopted by banks: (i) expanding credit supply to compensate for narrower margins through higher volumes; (ii) shifting income sources away from interest-based revenues towards non-interest income, such as fees and commissions; (iii) reducing operational costs, including staff-related expenses; and (iv) lowering interest paid on non-customer deposit liabilities.

Regarding profitability, Boungou and Hubert (2021) find that the decline in net interest income was not fully offset by cost-cutting measures or the increase in non-interest revenues. Large institutions, which are more dependent on deposits and exhibit higher leverage, were particularly affected by NIRP due to their limited flexibility in passing on negative rates to clients. On the other hand, Molyneux et al. (2020) argue that smaller banks face even greater challenges in maintaining profitability, given their stronger reliance on interest income and their limited capacity to diversify revenue streams.

However, it is also possible to go beyond the simple analysis of the intensity with which monetary policy is felt, extending it to possible implications for the symmetry of monetary transmission. This, as already mentioned, is something Kho (2024) explored with regard to concentration in the banking sector.

Hannan and Berger (1991) also revealed that market concentration is a factor that contributes to price rigidity, all else equal, for deposits. In line with Hannan and Berger's (1991) observation, Neumark and Sharp (1992) found evidence that in these more concentrated markets, banks are slower to increase deposit interest rates and quicker to reduce deposit interest rates in response to a decrease in interest rates. Neumark and Sharp (1992) further assert that banks in more concentrated markets are slower to make upward adjustments in deposit rates when rates are below their estimated long-run equilibrium and quicker to adjust downward when rates are above equilibrium.

In addition to concentration, Craig and Dinger (2011) also analysed bank size and market share and found that while market concentration and bank size reduce the likelihood of increases in deposit rates slightly more than deposit decreases, market share has a much stronger effect in reinforcing the asymmetry.

Market share is also analysed by De Graeve et al. (2007), who reveal that banks with larger market shares adjust their lending rates less completely in response to changes, and charge

higher loan markups, offering less competitive prices. According to these same authors, well-capitalized and highly liquid banks also tend to be less responsive to changes in market conditions, both in the case of loans and deposits, a conclusion that aligns perfectly with the bank lending channel theory.

Driscoll and Judson (2013) also highlight size as a relevant characteristic, noting greater upward stickiness for deposits in the case of large institutions by total deposits compared to smaller ones, which converges with the findings of Craig and Dinger (2011). However, for this latter author, as previously mentioned, the effect of bank size does not significantly affect the asymmetry.

Nevertheless, there are also opposing results. Hannan and Berger (1991), despite highlighting market concentration as a factor that increases rigidity, also argue that, all else being equal, bank size, measured by the natural log of bank i's total assets, contributes to a higher likelihood of interest rate adjustments by banks in response to changes in reference rates, whether in the case of increases or decreases.

This intriguing finding, in light of some of the theoretical foundations already discussed and the underlying conclusions from the discoveries of Kashyap and Stein (2000) or Kishan and Opiela (2000), is justified by the authors as the result of a possible greater perception of changes in market conditions by larger banks. This could be due to a stronger orientation towards wholesale funds markets or because the costs of price adjustments are lower the larger the bank.

2.3. Interest Rate Transmission in Portugal

Regarding the specific context of Portugal, recent research by Bonfim and Queiró (2024) provides a comprehensive analysis of the transmission of monetary policy to deposit interest rates, covering the period from the fourth quarter of 1997 to the fourth quarter of 2023. The study reveals that the pass-through of monetary policy changes to deposit rates is incomplete. Time deposits held by non-financial corporations are found to be more sensitive and actively managed compared to those held by households (Bonfim & Queiró, 2024).

While the transmission to loan rates is also incomplete, Bonfim and Queiró (2024) find that the transmission for new deposits is higher than for new loans. This suggests that, over the period considered, the transmission of monetary policy was stronger for deposits than for loans, although both were incomplete.

Finally, Bonfim and Queiró (2024) highlight that the transmission to both deposits and loans is relatively similar for non-financial corporations. However, for households, banks tend to adjust loan rates more quickly than deposit rates, reflecting different sensitivities between the two categories.

Although Bonfim and Queiró (2024) do not distinguish between upward and downward adjustments in monetary policy rates, they argue that the limited magnitude of transmission observed in deposit rates may reflect the existence of the effective lower bound. Accordingly, even when offering deposit rates close to zero, banks incurred losses on deposits during this period by setting rates above their own financing costs in monetary policy operations – a situation that was particularly pronounced in the case of households and consistent with the arguments put forward by Heider et al. (2021). For this reason, when comparing the transmission of deposits with that of loans, while the patterns are broadly similar in the case of corporate clients, in the case of households a divergence arises not because loan transmission is close to complete – which it is not, and in fact remains lower than observed for non-financial corporations – but rather because deposit transmission is comparatively weaker.

For this analysis, it is also important to consider additional factors, such as the types of contracts typically established between parties, as well as the level of indebtedness. Variable rate loans tend to respond more quickly to changes in market interest rates. Moreover, higher levels of indebtedness may constrain this transmission when interest rates fall, due to the persistence of risk premia (Banco de Portugal, 2025a).

Beginning with the first factor, in the case of mortgage lending in Portugal, variable rate contracts have historically dominated the market and still represent a substantial share. According to Banco de Portugal (2024b), 74.7% of outstanding contracts at the end of 2024 were variable rate, although this represents a decline relative to 2023. In fact, 2023 represented a turning point, reversing the long-standing trend in which variable rate contracts were the predominant choice – a shift that not only persisted but intensified in 2024. The growing importance mortgage contracted at mixed or fixed rates – which offer borrowers greater protection from interest rate volatility – has occurred in the context of rising interest rates. Variable rate loans also dominate corporate lending (Banco de Portugal, 2025a).

Regarding indebtedness, the deleveraging of the Portuguese economy over the past decade has helped to reduce friction in the transmission. This has been particularly relevant during the recent phase of interest rate reductions (Banco de Portugal, 2025a).

3. Research Question and Hypotheses

As previously highlighted in the literature review, the interest rate pass-through is a complex topic with multiple layers, and there is a vast body of evidence pointing to different conclusions. Different studies reveal a multifaceted picture: while some researchers find clear patterns of rate transmission, others uncover contextual specificities that challenge universal explanations.

Instances of unanimity are rare, yet despite the lack of complete agreement, it is possible to establish some overarching trends. The transmission mechanism seems to be characterised by heterogeneity, incompleteness, and potential asymmetries across different market segments and bank characteristics and may also reflect banking industry market structures.

This inherent complexity demands a nuanced approach to understanding monetary policy transmission. The divergence in existing research is an opportunity to reflect on the intricate economic mechanisms at play. And it is this opportunity that this study aims to explore, applied to the Portuguese context.

The Portuguese banking sector presents a particularly intriguing case study. Recent research by Bonfim and Queiró (2024) has already highlighted characteristics of monetary policy transmission in the country, notably the incomplete pass-through to both deposit and lending rates. However, numerous questions remain unanswered, particularly regarding the possible existence of asymmetry or possible differences in the underlying mechanisms that drive this transmission dynamics based on the structural differences and characteristics of banks.

The central focus of this study will be to investigate whether asymmetry exists in the transmission of interest rate increases versus decreases. This analysis will be extended across various financial products, including different types of loans and deposits, to assess whether asymmetric transmission patterns are consistent or vary by product category. Additionally, this research will examine if transmission effectiveness differs between household and corporate clients, as these market segments may exhibit distinct sensitivities to monetary policy changes.

Furthermore, based on the existing literature, this study will attempt to determine whether bank size, as identified by previous researchers, plays a significant role in monetary policy transmission in Portugal. By considering this factor, this research aims to provide a more comprehensive understanding of the mechanisms driving interest rate pass-through in the

Portuguese context.

This study is particularly relevant as it adds to but also contributes a different perspective to the recent analysis by Bonfim and Queiró (2024) by introducing several important factors that were not considered in their work. As far as we know, no study of this breadth has been conducted for Portugal since Rocha (2012), which, while examining some similar points, was carried out before the introduction of the euro and therefore applies to a fundamentally different economic and monetary context.

Building upon this foundation and addressing the identified gaps in the existing literature, this study aims to answer the following research questions:

Research Question 1: How do changes in central bank policy rates impact deposit and lending rates in Portugal?

Hypothesis 1 (H1): Policy rate changes significantly influence commercial bank interest rates.

The first hypothesis directly addresses the core of monetary policy transmission in the Portuguese banking sector. Drawing from theoretical frameworks, this hypothesis examines how policy rate changes propagate through the commercial banking system, particularly focusing on asymmetric responses to interest rate movements. Specifically, we hypothesize that banks respond differently to policy rate increases versus decreases, potentially passing on interest rate hikes more than rate cuts. This asymmetry may be explained by factors such as menu costs, consumer sophistication, as identified in the literature review. The study will assess this transmission mechanism separately for deposits and loans, and examine whether the transmission patterns vary between household and corporate segments.

Sub-hypotheses:

- H1a: The magnitude of rate transmission is influenced by the direction of policy rate changes (i.e. increases or decreases of the policy rate).
- H1b: The pass-through of policy rate changes differs between deposit and lending rates.
- H1c: The transmission varies between non-financial corporations and households.

Research Question 2: How does bank size influence monetary policy transmission?

Hypothesis 2 (H2): Bank size modulates the pass-through mechanism.

Following the theoretical foundations established by Boeckx et al. (2020) and empirical evidence from Kashyap and Stein (2000), this hypothesis investigates how bank size mediates the transmission of monetary policy.

Sub-hypotheses:

- H2a: Bank size significantly influences the magnitude of interest rate adjustments.
- H2b: The impact of bank size varies between deposit and lending rate transmissions.

While there are several bank characteristics that may potentially play a role, given the limited scope of this master dissertation, we only looked at size.

4. Methodology

This chapter begins with a review of the methodological frameworks adopted by other authors in relation to the research question, aiming to provide a comprehensive overview of existing approaches. This serves not only to contextualise the study within the broader academic discourse but also to justify the methodological choices adopted in this research. The chapter then introduces the model we propose, followed by the description of the sample and the stylised facts, where key technical concepts related to monetary policy and its implementation will be discussed to establish a solid foundation for the subsequent analysis. Finally, potential methodological limitations of the study will be acknowledged.

4.1. Review of Methodological Frameworks

To analyse the interest rate pass-through, the literature presents several econometric models that are tailored to the specific context under examination. As highlighted in the literature review – particularly in the analysis of asymmetric effects – various forms can be identified, and naturally, the chosen model must be adapted to the particular features of the issue being assessed. This subsection aims to provide a brief overview of some of the models commonly employed, with a clear focus on their relevance to the present research question. Accordingly, the discussion will highlight selected approaches adopted by different authors, especially those most aligned with the objectives of this study.

One of the pioneering studies in the identification of asymmetry is that of Hannan and Berger (1991), who employed a multinomial logit estimation procedure to capture the probability of deposit rate increases, decreases, or no changes in response to variations in the security rate measured by the three-month Treasury-bill rate. Their model is grounded in a theoretical framework where banks adjust rates only if the expected benefit of doing so exceeds a certain cost threshold. This benefit depends on the square of the change in the security rate, weighted by a coefficient that reflects the perceived elasticity of deposit supply. Structural characteristics such as market concentration, customer base, and bank size are explicitly incorporated, as they influence the slope of the perceived supply curve and, in turn, the incentives to adjust prices. The model also allows for asymmetries by estimating separate equations for rate increases and decreases, thus capturing potential differences in both adjustment costs and behavioural responses. This approach provides a structured way to test for asymmetric behaviour in rate-setting decisions by banks, particularly under conditions of imperfect competition.

An additional widely adopted approach consists in employing Error Correction Models (ECM). This logic has been employed by various authors, albeit with different nuances.

Scholnick (1999) was one of the authors who followed this path. To implement this methodology, he first conducted Johansen's (1991) cointegration analysis to establish the long-term relationship between the rates. This stage is crucial, as the existence of cointegration is a prerequisite for the valid application of ECM models. After confirming the presence of cointegration, Scholnick (1999) proceeded with the estimation of asymmetric error correction models.

According to Scholnick (1999), the cointegration/ECM methodology offers three fundamental advantages: i) it handles non-stationary time series such as nominal interest rates; ii) it allows for the estimation of coefficients that indicate the short-term dynamics of retail rates following changes in wholesale rates; and iii) it enables the examination of different types of asymmetries within the error correction model, namely, the first type, which is the primary focus of our interest, the asymmetry when wholesale rates are rising versus when they are falling. The second type analyses the asymmetry when retail rates are above or below their long-term equilibrium with respect to the wholesale rate.

Other authors who adopted different versions of error correction models after conducting cointegration analysis include Lim (2001), Sander and Kleimeier (2002), Hofmann (2006), and Rocha (2012).

Another line of research examining interest rate asymmetries builds upon the Nonlinear Autoregressive Distributed Lag (NARDL) model introduced by Shin et al. (2013). This framework has been adopted by various authors, including Apergis and Cooray (2015) and more recently Bagas Herlambang et al. (2023).

According to Apergis and Cooray (2015), this framework offers several methodological advantages over various error correction-based models. Notably, the NARDL model enables the simultaneous modelling of short- and long-run relationships while allowing for asymmetries in both phases. One of its major strengths lies not only in its estimation simplicity but also in its ability to relax the assumption that time-series variables must be integrated of the same order – accommodating a mix of I(0) and I(1) series, in contrast to the ECM, which imposes the condition that all variables must be integrated of the same order. Furthermore, it excels in distinguishing between the absence of cointegration, linear cointegration, and nonlinear cointegration (Katrakilidis and Trachanas, 2012).

There are also other alternative methodologies that account for dynamic responses, such as the application of Panel Local Projections (PLP), as used by Kho (2024) to analyse the dynamic response of deposit rates to monetary policy shocks across different countries in the euro area. This methodology, proposed by Jordà (2005), allows for the estimation of impulse response functions without imposing strong assumptions about the underlying dynamic structure of the data. As it effectively handles asymmetries and non-linearities, it is particularly well-suited to the aim of Kho's research, which seeks to capture these central features in the responses of deposit rates to monetary policy shocks.

4.2. Model Specification

While various methodologies have been employed to analyse the specific asymmetries that our study addresses, the focus now shifts to the specific econometric modelling approach adopted herein.

Building upon the methodology of Valadkhani and O'Mahony (2024), who employed a multiple-threshold regression model, the objective of this study is to develop a model that not only addresses sign asymmetry, taking into account the magnitude of the reference interest rate, as done by the authors, but also extends the model by incorporating a different type of data – specifically, individual institution data in addition to aggregate data. Furthermore, an additional dimension is introduced (Research Question 2), which considers the influence of bank size. To accommodate these additional analysis dimensions, we need to reformulate the model.

We first outline the details of the model proposed by Valadkhani and O'Mahony (2024), and then we discuss the necessary adaptations to incorporate the additional objectives of this study.

The baseline model explores the dynamic relationship between changes in the policy rate, specifically the Reserve Bank of Australia (RBA) cash rate, and changes in lending and deposit rates.

Recognising that financial institutions can adjust interest rates at any time, changes in lending and deposit rates are modelled as a function of both contemporaneous and lagged changes in the policy rate.

This relationship is formally captured by the following model:

$$\Delta R_t = \alpha + \beta_0 \Delta C_t + \beta_1 \Delta C_{t-1} + \beta_2 \Delta C_{t-2} + \cdots + \beta_m \Delta C_{t-m} + \varepsilon_t \qquad (4.2.1)$$

Where α represents the intercept, ΔR_t refers to the monthly percentage changes in the lending (or deposit) rate at time t, with Δ being the first difference operator, indicating the change in the rate from one period to the next. Similarly, ΔC_t represents the monthly percentage changes in the policy rate at time t. The β_j coefficient measures the effect of changes in the policy rate (ΔC_t) on changes in the lending (or deposit) rate at time $t - j$ (where $j = 0, 1, 2, \ldots, m$). Finally, ε_t is the stochastic residual at time t.

To simplify the number of coefficients in the estimation, a Koyck lag structure is introduced. This approach assumes that the coefficients decline over time, reflecting the diminishing impact of past changes in the policy rate ($\beta_0 > \beta_1 > \beta_2 > \cdots > \beta_m$ and $\beta_m = 0$) on lending and deposit rates offered by financial institutions. Under this assumption, the model can be rewritten as follows:

$$\Delta R_t = \alpha + \beta \Delta C_t + \gamma \Delta R_{t-1} + \varepsilon_t \qquad (4.2.2)$$

In order to account for asymmetric effects of increases and decreases of the policy rates, the model is further extended by decomposing changes in the policy rate into their positive (ΔC_t^+) and negative (ΔC_t^-) components. This allows the effects of rate increases and decreases to be estimated separately:

$$\Delta R_t = \alpha + \beta^+ \Delta C_t^+ + \beta^- \Delta C_t^- + \gamma \Delta R_{t-1} + \varepsilon_t \qquad (4.2.3)$$

To implement this extension, the positive and negative components of ΔC_t are defined as follows:

$$\Delta C_t^+ = \Delta C_t \quad \text{if} \quad \Delta C_t > 0 \quad \text{and} \quad \Delta C_t^+ = 0 \quad \text{if} \quad \Delta C_t < 0$$

$$\Delta C_t^+ = max\{\Delta C_t^+, 0\} \qquad (4.2.4)$$

$$\Delta C_t^- = \Delta C_t \quad \text{if} \quad \Delta C_t \leq 0 \quad \text{and} \quad \Delta C_t^- = 0 \quad \text{if} \quad \Delta C_t > 0$$

$$\Delta C_t^- = max\{\Delta C_t^-, 0\} \qquad (4.2.5)$$

Finally, to capture potential non-linearities in the effect of policy rate, Valadkhani and O'Mahony (2024) incorporate the possibility of existence of multiple thresholds in the policy rate level that allows for the estimation of different effects depending on whether the cash rate is below, between, or above certain thresholds.

This idea is grounded, according to the authors, in the principle that banks may exhibit different behaviours depending on the level of the policy rate. For instance, beyond a certain threshold, they may refrain from further reducing lending rates, or conversely, may hold back on increasing them if the policy rate reaches a level that could provoke social backlash or potential unpopularity.

Formalising this reasoning, the model is accordingly redefined, where in the first case of the previous example the threshold is represented by τ_1, and in the second by τ_2:

$$\Delta R_t = \alpha + \gamma \Delta R_{t-1} + \varepsilon_t + \begin{cases} b_1^+ \Delta C_t^+ + b_1^- \Delta C_t^- & if \quad C_t < \tau_1 \\ b_2^+ \Delta C_t^+ + b_2^- \Delta C_t^- & if \quad \tau_1 \leq C_t < \tau_2 \\ b_3^+ \Delta C_t^+ + b_3^- \Delta C_t^- & if \quad C_t \geq \tau_2 \end{cases} \qquad (4.2.6)$$

Building on the framework proposed by Valadkhani and O'Mahony (2024), the present study extends the analysis by adopting a bank-level perspective. Rather than relying solely on aggregate lending and deposit rates, this approach uses panel data based on institution-specific observations, allowing for a more granular examination of how individual banks adjust their rates in response to changes in the policy rate. The relationship is expressed through the following specification, where μ_i stands for bank fixed effects:

$$\Delta R_{it} = \mu_i + \beta^+ \Delta C_t^+ + \beta^- \Delta C_t^- + \gamma \Delta R_{i\,t-1} + \varepsilon_{it} \quad (4.2.7)$$

To further explore how certain bank-specific characteristics influence the interest rate adjustment process and to address the Research Question 2, the regression will also be conducted for different groups based on bank size, measured by total assets. Banks will be segmented into groups according to quantiles of total assets, providing deeper insights into how this factor shapes the interest rate transmission process.

4.3. Sample

This subsection outlines the sample used in this study. The analysis is divided into two main parts: the first part follows the methodology proposed by Valadkhani and O'Mahony (2024), utilizing aggregated data; the second part focuses on bank-individual-level data. For both parts of the analysis, the period considered spans from 2009 to 2022, as bank-individual-level data with a wider range of variables has been available since 2009, and data beyond 2022 is not yet accessible; therefore, the entire study was uniformly conducted within these years.

Regarding the first part, it relies on aggregate data sourced from the ECB (n.d.). Further details on the variables are provided in Annex A. Although Valadkhani and O'Mahony (2024) used the RBA's cash rate, following the approach of Bonfim and Queiró (2024), this study opts to use the euro short-term rate (€STR)[1] as a proxy for the policy rate, with the original frequency modified to monthly. This choice is motivated by the fact that the ECB's main refinancing rate remained at zero for much of the period under analysis, while the €STR better captures the effects of a broader set of unconventional monetary policy instruments implemented by the ECB, which rendered monetary policy more accommodative.

With respect to the retail interest rates, the study utilizes monthly data from the ECB on Portuguese retail lending and deposit rates[2], specifically for new business in the following categories: loans to households for consumption, loans to households for house purchase,

[1] The €STR variable was constructed using two series: *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points* and *Euro short-term rate – Volume-weighted trimmed mean rate*. Since the latter series is only available from October 2019, to obtain the €STR variable for the full period, the *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points*, which spans from January 1999 to December 2021, was adjusted by removing the corresponding spread.

[2] According to the methodological information provided by the ECB (2025), for the aggregation of interest rates within each instrument category, the respective business volumes are used as weights. To calculate an individual institution's aggregate interest rate per instrument category, the volumes of each contract within that instrument category are used as weights.

loans to corporations, deposits from households with an agreed maturity, and deposits from corporations with an agreed maturity.

For the second part of the study, which focuses on individual bank-level data, the analysis also uses the €STR from the ECB, but with the original frequency modified to quarterly. This adjustment aligns with the data frequency of the individual retail interest rates, which are obtained from the Historical Series of the Portuguese Banking Sector Database (SLB) (Banco de Portugal Microdata Research Laboratory [BPLIM], 2023). This database reports a wide range of series on banks' financial statements, including interest rates, loans to customers, and other relevant financial data, on a consolidated basis. The data covers all resident institutions (except the central bank) operating in Portugal. The data on interest rates includes all institutions covered by the Monetary and Financial Institution Statistics ("Estatísticas Monetárias e Financeiras - EMF").

4.4. Limitations of the Methodology

In the selection of the methodology, several specific conditions led to the choice of this particular model. The use of the ECM, although considered due to its widespread application in the literature, was deemed unfeasible due to the requirement for cointegration, which was not established after the Johansen test was applied. Subsequently, the model proposed by Valadkhani and O'Mahony (2024) was adopted, as it provides a noteworthy aspect for exploration in addressing the research questions. However, it is important to highlight a potential limitation, namely endogeneity, which may arise from the impact that retail rates from the previous period ΔR_{t-1} may exert on current monetary policy decisions ΔC_t.

Nonetheless, despite acknowledging the potential existence of this limitation in the first part of the study, where aggregate data are employed, and its impact on the results and conclusions, this limitation can be mitigated in the second stage, where individual institution-level data are used. The use of individual data could reduce the likelihood of endogeneity, as it becomes highly improbable that the way in which an individual institution determines its interest rates would exert a substantial influence on the central bank's monetary policy decisions. The central bank's decisions are, in essence, based on broad macroeconomic indicators and are formulated in an aggregated context, reflecting the overall state of the economy rather than the decisions of any single financial institution.

4.5. Stylized Facts

The following subsection outlines key technical concepts related to monetary policy, before summarizing the evolution of interest rates and the broader monetary policy framework, and describing, and contextualizing the reality of the Portuguese banking system, providing the necessary foundation for understanding the study and its results.

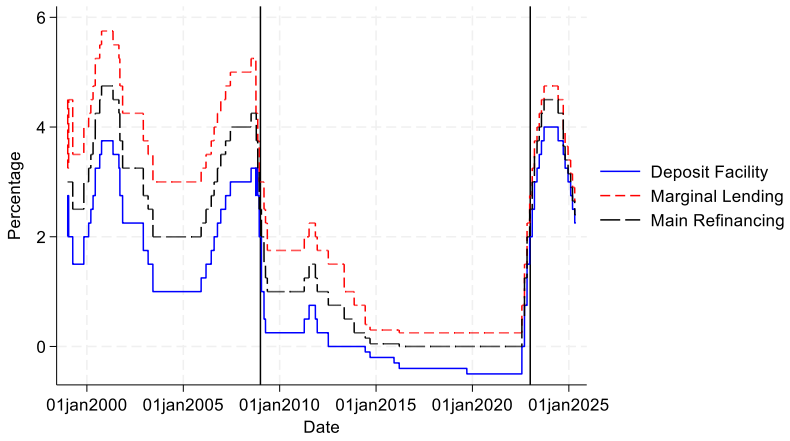
The ECB's main function is to maintain price stability within the euro area, targeting an inflation rate of 2% over the medium term. To achieve this objective, the most important decision in this regard is related to the key interest rates, which directly affect the rates charged by commercial banks to their customers, influencing private consumption and business investment. In addition to decisions regarding interest rates, the ECB has recently equipped itself with new instruments to address increased challenges, such as forward guidance, asset purchases, and longer-term refinancing operations (ECB, 2021b).

Regarding the key interest rates, as can be seen in Figure 1, the ECB sets three rates, reviewed every six weeks. The main refinancing operations rate is the rate that banks pay when borrowing for one week from the ECB, using collateral (ECB, 2024a). The marginal lending facility rate corresponds to the cost that banks incur when borrowing overnight, also against collateral (ECB, 2024b). Lastly, the deposit facility rate is the interest rate that banks receive when depositing funds overnight with the ECB. This last rate acts as a benchmark for money market rates, although some volatility is tolerated as long as it does not undermine the clarity of the policy guidance provided (ECB, 2024c).

Reference rates, including the €STR, are regularly updated, publicly accessible, and used as a basis for various financial contracts. When well-defined, they ensure impartiality, as neither party can influence their value. Effective since 2018, European reference rates underwent substantial reforms. It was in this context that the €STR replaced the Euro Overnight Index Average (EONIA) as the primary overnight reference rate. The €STR reflects the funding costs of euro area banks in unsecured one-day transactions, encompassing a broader range of market participants than EONIA, making it more robust, representative, and less susceptible to manipulation. These rates are a source of information for the ECB as they serve as a benchmark for the work carried out (ECB, 2024d).

These rates are widely used by individuals and organizations within the economic system. For instance, banks rely on them when granting loans to individuals or businesses (ECB, 2024d). For this reason, just as it is expected that the €STR follows the ECB's policy rate, it is also expected that the retail rates offered by banks reflect the same underlying principle.

Figure 1. Evolution of key ECB Interest Rates, 1999-2025



Note: Daily data from ECB, covering the period from January 1999 to May 2025. The sample period on which the study relies is highlighted between the two vertical black lines in the figure, corresponding to the years 2009 to 2022.

However, certain events can disrupt this transmission mechanism, leading to a divergence between the behaviour of the key interest rates, the €STR, and retail interest rates. In the context of a liquidity crisis, conventional monetary policy typically involves lowering key interest rates and injecting liquidity to act as a lender of last resort. However, when restoring the transmission mechanism requires further intervention, the central bank may also assume the role of investor of last resort by purchasing assets in secondary markets that have become illiquid (Fernandes & Mota, 2023).

Following the financial turbulence already evident in 2007, the ECB injected liquidity into the financial system on an unprecedented scale to ensure that the EONIA rate remained close to the policy rate. The collapse of the US investment bank Lehman Brothers in 2008 triggered a freeze in the money markets, necessitating a more forceful response from the ECB. This response included both conventional measures, such as a series of reductions in the key interest rate, and unconventional policies. Among the unconventional tools, the ECB modified its operational framework by moving to fixed-rate tenders with full allotment for its main refinancing operations. It also extended the maturities of refinancing operations, broadened the range of eligible collateral, and increased the number of counterparties authorised to participate, among other measures. These actions aimed to prevent disorderly deleveraging in the banking sector and to overcome blockages in the monetary policy transmission mechanism (Fernandes & Mota, 2023).

In 2010, renewed tensions in sovereign bond markets once again challenged the transmission process, prompting the ECB to implement further measures. These included purchases of sovereign bonds in secondary markets and additional liquidity provision programmes with increasingly accommodative conditions to support money market functioning (Fernandes & Mota, 2023). Nevertheless, these measures did not prevent two interest rate increases in 2011, aimed at safeguarding price stability in the euro area and ensuring that price developments did not trigger generalised inflationary pressures over the medium term. However, these increases were reversed within the same year, in response to the deteriorating economic situation and more favourable inflation prospects, which also compelled the adoption of further unconventional measures (Banco de Portugal, 2011).

Despite the substantial liquidity injections, this did not immediately translate into an increased supply of credit. Consequently, both conventional and unconventional policies were further deepened in the subsequent years. By 2014, faced with inflation forecasts persistently below the 2% target, the ECB deemed it necessary to reduce key interest rates further, even setting the deposit facility rate at -0.10%. This aimed to discourage banks from holding idle balances at the ECB and to encourage greater lending. In the environment of negative interest rates, some commercial banks began to reduce interest rates on savings accounts, with a few, in some selected countries, even applying negative rates to customers with large deposits (ECB, 2022a).

However, with inflation excessively low and interest rates approaching their effective lower bound, these measures alone proved insufficient. This justified the adoption of additional unconventional instruments, such as the Asset Purchase Programme (APP), designed to steer inflation back towards the target. Although net asset purchases under the APP ceased in July 2022, redemptions continued to be reinvested, either partially or fully, until reinvestments were discontinued in July 2023 (ECB, 2022b).

Before the phase-out of asset purchases, however, monetary policy was also impacted by the COVID-19 pandemic, which severely disrupted financial markets and economic expectations. The rapid spread of the virus in 2020 led to strict lockdown measures, triggering acute liquidity needs among firms. In response, the ECB expanded the APP and introduced the Pandemic Emergency Purchase Programme (PEPP), while also providing large-scale liquidity under highly favourable conditions (Banco de Portugal, 2021).

In 2021, inflation began to rise, reflecting what were initially understood as temporary

factors. These included not only a sharp increase in energy prices but also imbalances caused by a strong rebound in demand combined with global supply chain disruptions (Banco de Portugal, 2022). However, the definitive reversal of the highly accommodative monetary policy stance maintained for over a decade was driven by the persistent increase in inflation, further fuelled by Russia's invasion of Ukraine (Arce et al., 2023). Inflation remained above the ECB's 2% target, prompting a gradual reduction in net asset purchases during the first half of 2022. This culminated not only in the end of these purchases in July of that year, but also in a renewed reliance on ECB's primary monetary policy instrument: changes in key interest rates, which subsequently rose at the fastest pace in the euro area's history (Banco de Portugal, 2023).

As a result of highly complex and unusual period, financial institutions – including those in Portugal – underwent significant challenges and transformations. Without seeking to provide an exhaustive review, it is worth highlighting a number of indicators and structural changes over the period covered by this study.

Following the global financial crisis, the growth of Portuguese banks' assets persisted, but reversed in the wake of sovereign debt crisis. The effects of deleveraging became evident from 2012 onwards, reflected in the contraction of both credit and securities portfolios, a trajectory that extended throughout the decade until 2019 (Associação Portuguesa de Bancos [APB], 2014; APB, 2016; APB, 2023). In 2024, an annual increase of 5.9% was recorded, mainly driven by expansion of debt securities portfolio – largely composed of sovereign bonds – and by the rise in loans to clients (APB, 2025).

Non-performing credit began to rise from 2008, particularly in corporate segment, while mortgage-related non-performing exposures remained relatively stable. This deterioration persisted until 2016, when a steady decline in non-performing loans (NPLs) began, standing at 2.4% in December 2024, approaching the euro area average of 1.9% (APB, 2014; APB, 2023; APB, 2025).

On the solvency front, banks strengthened their capital ratios and reduced the risk profile of their assets (APB, 2023; APB, 2025). In terms of funding, client deposits have constituted the most important source of financing, accounting for a proportion higher than that observed in euro area. Despite the austerity measures implemented, deposits proved remarkably resilient, particularly those of households, which consistently followed an upward trajectory. The fall in total deposits in 2012 was driven by the contraction in the non-financial corporate

(NFC) segment, owing to financial difficulties and deleveraging needs. Nonetheless, until mid-2011, deposit growth in Portugal was not sufficient to match the expansion of banks' total assets (APB, 2014). During the period of very low interest rates, resulting from the ECB's accommodative monetary policy, there was a marked decline in share of time deposits and a corresponding increase in the share of demand deposits, a trend that reversed with the subsequent rise in interest rates (APB, 2024). In 2024, customer deposits increased and their weight in the sector's funding structure rose to 73.9% (APB, 2025).

Reliance on marked-based sources of funding is, at present, limited within the Portuguese banking system. Deposits from the monetary sector constitute the principal component of wholesale funding, accounting for 69.7% in 2024 (APB, 2025). By the end of June 2020, funding from Eurosystem – on a declining trend since 2012 – increased again as a result of monetary policy measures adopted in response to the COVID crisis, before declining once more in 2022, standing at €16.1 billion in December of that year. This was largely attributable to changes in the conditions applied to third series of targeted longer-term refinancing operations (TLTRO III) loans, which, from 23 November 2022 onwards, became indexed to the ECB key policy rates, prompting banks to repay a substantial share of these loans ahead of schedule (APB, 2023). By the end of 2024, the share of funding obtained from the Eurosystem had fallen to an almost negligible level (APB, 2025).

Therefore, the combination of atypical monetary policy conditions and their impact on the Portuguese banking system, alongside its distinctive structural features, may shape the results of our model estimation in a way that is not entirely in line with expectations.

Moreover, the reliance of Portuguese banks on deposits as an important source of funding may weaken the expected relationship in the regressions, given the likely low elasticity of deposits to interest rates.

4.6. Exploratory Data Analysis

In this subsection, descriptive statistics are presented and connected to key stylised facts. The distribution of the €STR reveals a predominance of negative values throughout a substantial part of the sample period. This is not surprising, considering the monetary policy stance adopted by the ECB. Nevertheless, although the ECB's policy rate directly influences the funding costs of euro area banks, its limited transmission to retail interest rates suggests the presence of an effective lower bound in the retail market rates.

Table 1. Descriptive statistics for €STR and Aggregate Retail Rates for Portugal, 2009-2022

	Mean	Std. Dev.	Min	p25	Median	p75	Max	N
€STR	0.356	1.266	-0.585	-0.448	-0.073	0.405	3.908	192
LHH	2.456	1.094	0.810	1.420	2.290	3.305	4.680	192
LHC	8.246	1.201	6.340	7.215	8.100	9.070	10.980	192
LCorp	3.963	1.520	1.440	2.415	4.185	5.385	6.850	192
DH	1.296	1.209	0.040	0.150	0.935	2.285	4.530	192
DCorp	1.138	1.203	0.030	0.130	0.655	1.880	4.500	192

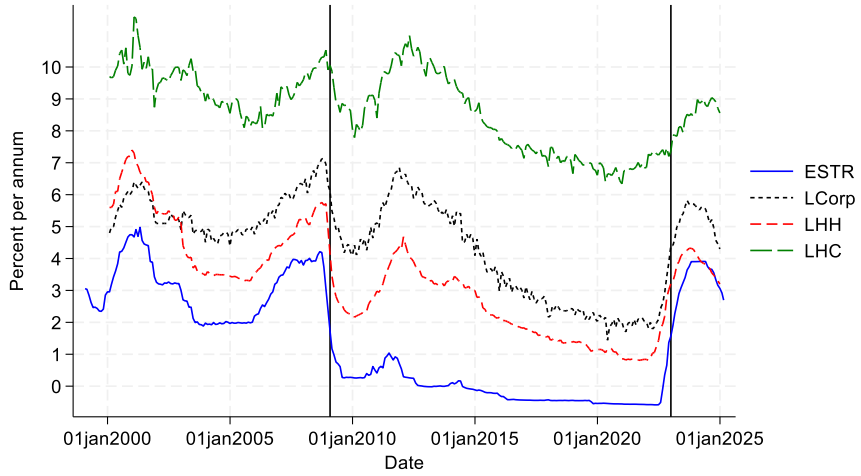
Note: €STR denotes the euro short-term rate. LHH, LHC, and LCorp represent the interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. DH and DCorp indicate the interest rates on newly originated deposits from households and corporations with an agreed maturity, respectively. All series are based in monthly data and span the period from January 2009 to December 2022.

Lending rates display a clear hierarchy across market segments, reflecting structural differences. Consumer credit rates are consistently the highest, primarily reflecting the higher credit risk perceived by financial institutions due to the typically unsecured nature and shorter maturity of such loans. In contrast, mortgage lending rates are lower, which may reflect both the presence of collateral and stronger competition among banks in this market segment.

Deposit rates, on the other hand, remain at very low levels on average, with minimum values close to zero. Moreover, the data show a marginally more favourable remuneration for household deposits compared to those of corporates.

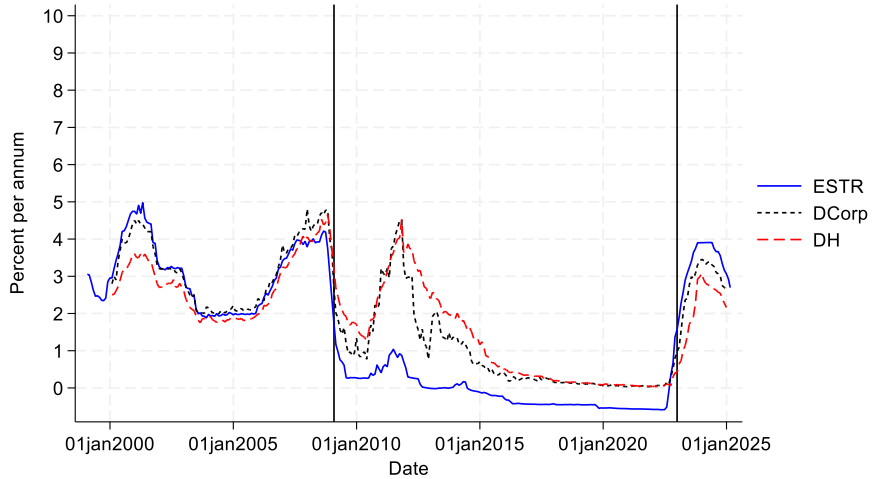
The contrast between the persistently negative minimum and the marked increases observed in the more recent part of the sample – as shown in Figure 2 and 3 – reflects significant variation in the level of the €STR over time. This variability suggests that banks were exposed to differing monetary policy environments throughout the period under analysis. While this is a fact already established by the stylised facts, it is important to emphasise that these environments may also affect the nature of the transmission to retail rates in different ways.

Figure 2. Evolution of €STR and Aggregate Retail Loan Rates for Portugal, 1999-2025



Note: ESTR denotes the euro short-term rate. LCorp, LHH, and LHC correspond to the interest rates on newly originated loans to corporations, households for house purchase, and households for consumption, respectively. The figure is based on monthly ECB data and covers the period from January 1999 to February 2025. The sample period on which the analysis relies is highlighted between the two vertical black lines in the figure, corresponding to the years 2009 to 2022.

Figure 3. Evolution of €STR and Aggregate Retail Deposit Rates for Portugal, 1999-2025



Note: ESTR denotes the euro short-term rate. DCorp, DH represent the interest rates on newly originated deposits from corporations and households, respectively. The figure is based on monthly ECB data and covers the period from January 1999 to February 2025. The sample period on which the analysis relies is highlighted between the two vertical black lines in the figure, corresponding to the years 2009 to 2022.

Regarding loans, Figure 2 confirms the scenario already suggested by the Table 1, which clearly outlines differences in the levels of the various types of loans under consideration. The figure further shows that the differential between retail loan rates and the €STR, which had already been gradually narrowing over time, contracts more markedly following the

upward shift in interest rates that began in 2022. This convergence is particularly noticeable for loans to households for house purchase and loans to corporates, whose rates increasingly align with the policy benchmark. In contrast, the interest rate on household loans for consumption, which remains clearly higher throughout the period, appears more stable. Even during the recent tightening cycle, while it does follow the €STR, its increase is less abrupt compared to the other two retail loan rates.

A similar pattern emerges in the case of deposits, Figure 3. Here too, the differential between the €STR and retail deposit rates narrows significantly in 2022, as the €STR begins its upward trajectory after several years in negative territory during which banks largely refrained from transmitting these negative rates to retail depositors. While deposit rates had been gradually declining in line with the €STR, they did not fully match its magnitude of change.

This descriptive analysis provides scope for analysing distinct regimes and appears to highlight three key features: the presence of a lower bound constraint on rates – particularly in the case of deposits and during periods with negative €STR values; asymmetry in transmission, whereby declines in the €STR appear to have limited impact, whereas increases tend to prompt a clearer response in both loans and deposits; and heterogeneity across market segments.

Focusing now on the individual institution-level data in order to understand the structure and dynamics of the Portuguese banking system – which will later be relevant for the analysis of results – Table 2 presents the distribution of key balance sheet and income statement variables across three bank size groups.

Several notable patterns and structural shifts emerge from the comparison, reflecting potential changes in the dynamics of the banking sector over time. While a consistent dominance of large banks (G3) is evident across all variables in both years, this dominance appears to have eroded slightly in certain areas – particularly in total assets, equity, and net interest income.

More striking, however, are the changes observed in the distribution of demand deposits in other credit institutions, which experienced a substantial reallocation. G3's share decreased sharply, while G2 – and, to a lesser extent, G1 – increased their respective shares. A similarly pronounced shift is evident in domestic credit for consumption and other purposes, potentially indicating a growing role of medium-sized banks (G2) in retail and

consumer lending markets.

Table 2: Institution-Level Descriptive Statistics by Institution Size Group (% of Total)

	2009Q1			2022Q4		
	G1	G2	G3	G1	G2	G3
Total assets	0.6	5.6	93.8	1.1	7.3	91.7
Cash and cash balances/ loans to central banks	0.3	2.2	97.5	1.0	4.0	95.0
Demand deposits in other credit institutions	3.2	14.2	82.5	8.9	52.3	38.8
Loan to other credit institutions – Carrying amount	1.4	10.9	87.7	0.9	23.1	76.0
Customer deposits	0.3	1.5	98.2	0.5	3.6	95.9
Net interest income	0.9	9.3	89.8	1.5	12.1	86.3
Equity	1.4	5.5	93.0	2.0	9.2	88.9
Gross loans to customers	0.2	5.9	93.9	0.8	6.4	92.8
Domestic credit to non-financial corporations	0.3	7.6	92.1	0.7	4.3	95.0
Domestic credit to households	0.2	4.4	95.5	0.8	8.4	90.8
Domestic housing credit	0.0	0.3	99.7	0.1	1.0	98.9
Domestic credit for consumption and other purposes	0.7	21.4	77.9	3.4	34.8	61.8

Note: Institutions are classified into three size groups based on total assets percentiles: G1 (below the 40th percentile), G2 (between the 40th and 80th percentiles), and G3 (above the 80th percentile). The values in the table represent the percentage share of each group in the total amount of the corresponding variable, for the first (2009Q1) and last (2022Q4) quarters of the sample period.

In contrast, variables such as domestic housing credit and domestic credit to non-financial corporations remained highly concentrated within G3 throughout the period, with the latter even showing an increase. This underscores the sustained dominance of large institutions in both corporate and mortgage lending.

5. Results and Discussion

This section first presents and discusses the results of the original model proposed by Valadkhani and O'Mahony (2024), which relies on aggregate data. Subsequently, the model based on individual institution-level data is introduced, along with the corresponding modifications and extensions aimed at addressing the additional research questions.

For all models, outliers were addressed through winsorisation of data prior to performing the regressions, as has become relatively common in the literature (Verbeek, 2017). Further details are provided in Annex B.

5.1. Aggregate Data Model

In H1, we examine the influence of the €STR, used as a proxy for policy rates, on commercial bank interest rates. Specifically, we compare the behaviour of bank rates during periods when the €STR is increasing versus when it is decreasing.

Table 3. Estimated Effects of €STR Variations on Retail Interest Rates (Aggregate Data)

	Loans			*Deposits*	
	$\Delta R^{LHH}{}_t$	$\Delta R^{LHC}{}_t$	$\Delta R^{LCorp}{}_t$	$\Delta R^{DH}{}_t$	$\Delta R^{DCorp}{}_t$
ΔC_t^+	0.295**	0.0743	0.724***	0.358*	0.280**
	(0.122)	(0.206)	(0.253)	(0.194)	(0.125)
ΔC_t^-	-0.215	0.0775	0.770	0.297	0.559
	(0.270)	(0.497)	(0.587)	(0.213)	(0.365)
$\Delta R^{LHH}{}_{t-1}$	0.399***				
	(0.114)				
$\Delta R^{LHC}{}_{t-1}$		-0.0455			
		(0.0687)			
$\Delta R^{LCorp}{}_{t-1}$			-0.264***		
			(0.0842)		
$\Delta R^{DH}{}_{t-1}$				0.0577	
				(0.187)	
$\Delta R^{DCorp}{}_{t-1}$					-0.00686
					(0.0710)
Constant	-0.00923	-0.0159	-0.00983	-0.0143	-0.00104
	(0.0117)	(0.0173)	(0.0184)	(0.0136)	(0.0149)
Observations	166	166	166	166	166

Note: Standard errors are reported in parentheses. Significance levels are indicated as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Columns (1), (2), and (3) correspond to loans, where *LHH*, *LHC*, and *LCorp*

represent interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. Columns (4) and (5) correspond to deposits, where *DH* and *DCorp* denote deposit rates for households and corporations, respectively. Estimation is conducted using the Newey-West procedure to account for heteroskedasticity and autocorrelation.

Additionally, we analyse whether this behaviour differs between deposits and loans, and between households and corporates. Table 3 presents the estimates derived from Equation 4.2.3, using the Newey-West method, in line with the approach adopted by Valadkhani and O'Mahony (2024), in order to provide consistent estimators in the presence of heteroskedasticity and autocorrelation.

The first three columns refer to loan interest rates (household house purchase, household consumption, and corporate), while the remaining columns refer to deposit rates (household and corporate).

With regard to loans, particularly household loans for house purchase, only the upward variations in the €STR (ΔC_t^+) exhibit a statistically significant coefficient. This suggest that loan rates offered by banks respond to, and move in tandem with, positive changes in the €STR. By contrast, negative variations do not yield statistically significant coefficients. Hence, one cannot conclude that cuts in the €STR are effectively transmitted to loan rates in this segment, or in any of the loan categories, since the coefficients for ΔC_t^- are not statistically significant in any instance.

A similar pattern emerges in the case of corporate loans, where positive variations in the €STR are likewise significant. Although the coefficient associated with downward adjustments is not statistically significant, it is also broadly comparable in magnitude to those relating to upward movements. A parallel situation is observed in household loans for consumption, however in this case neither coefficient attains statistical significance.

Table 4. F-tests on the Equality of Coefficients (Aggregate Data)

	Null hypothesis	F	p
LHH		2.17	0.142
LHC		0.00	0.995
LCorp	Reject H_0: $b_1^+ = b_1^-$	0.01	0.932
DH		0.04	0.850
DCorp		0.66	0.416

Note: *LHH*, *LHC*, and *LCorp* represent interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. *DH* and *DCorp* denote deposit rates for households and corporations, respectively

Therefore, and corroborated by the F-tests reported in Table 4, these findings do not provide sufficient evidence to support the existence of asymmetry in the transmission of adjustments, as the tests fail to reject the null hypothesis of coefficient equality across all loan categories.

When considering deposits, a broadly similar pattern emerges. For both households and corporate deposits, only the upward variations in the €STR display statistically significant coefficients, which again prevents drawing conclusions about transmission in the case of downward movements and does not rule out the possibility that such effects are effectively zero. This may appear counterintuitive, given the common argument that banks – by virtue of market collusion, consumer sophistication, search costs, and switching costs – possess a degree of market power that would lead them to refrain from raising deposit rates while readily transmitting rate cuts. However, in light of broader monetary policy context, and particularly the case of Portuguese banks, for which deposits constitute a major source of funding, it may also be that during a period in which monetary policy imposed negative rates, banks largely refrain from transmitting these do depositors. The coefficients associated with negative variations are not significant, so the observed pattern remains plausible in light of previous findings by Scheiber et al. (2016), Heider et al. (2021), and Demiralp et al. (2021), who argue that banks are reluctant to push deposit rates into negative territory due to legal constrains, reputational considerations, and the risk of a shift to cash holdings. Nevertheless, as with loans, the F-tests reported in Table 4 do not reject the null hypothesis of coefficient equality, and thus no evidence of asymmetry can be established in the case of deposits.

However, the absence of statistical evidence supporting asymmetry between upward and downward movements of the €STR does not preclude the existence of asymmetry across certain €STR thresholds, as suggested by Valadkhani and O'Mahony (2024). As evidenced in equation 4.2.6, the model yields three distinct regimes, represented in Table 5 as [1], [2], and [3], which are determined based on the thresholds (τ_1 and τ_2) of the €STR. These thresholds were calculated using the 25th and 75th percentiles of the €STR distribution, corresponding to values of -0.451 and 0.259, respectively. When interpreting these regimes, it is important to bear in mind that they almost perfectly overlap with specific time periods. With only a few exceptional cases, regime [3] includes the period from January 2009 to April 2012, regime [2] covers the period from May 2012 to December 2018, and regime [1] comprises the period

from January 2019 to July 2022. In the final months of 2022, there was an increase in interest rates, placing this period within regimes [2] and [3].

Table 5. Estimated Effects of €STR Variations on Retail Interest Rates Across Distinct Regimes (Aggregate Data)

	Loans			*Deposits*	
	$\Delta R^{LHH}{}_t$	$\Delta R^{LHC}{}_t$	$\Delta R^{LCorp}{}_t$	$\Delta R^{DH}{}_t$	$\Delta R^{DCorp}{}_t$
[1] ΔC_t^+	4.423***	1.483***	5.032***	0.660*	1.105***
	(0.468)	(0.360)	(0.804)	(0.334)	(0.291)
[1] ΔC_t^-	-0.528	0.443	-1.410	-0.310	0.184
	(0.346)	(1.601)	(1.006)	(0.442)	(0.510)
[2] ΔC_t^+	-0.0341	0.142	0.496***	-0.0229	-0.109
	(0.130)	(0.114)	(0.133)	(0.0533)	(0.0712)
[2] ΔC_t^-	0.388*	0.0727	2.834	0.674***	0.915***
	(0.229)	(0.584)	(1.834)	(0.249)	(0.309)
[3] ΔC_t^+	0.358***	0.0545	0.755**	0.435*	0.356**
	(0.127)	(0.264)	(0.302)	(0.222)	(0.155)
[3] ΔC_t^-	-0.315	0.0661	0.458	0.251	0.509
	(0.346)	(0.558)	(0.586)	(0.259)	(0.453)
$\Delta R^{LHH}{}_{t-1}$	0.378***				
	(0.124)				
$\Delta R^{LHC}{}_{t-1}$		-0.0438			
		(0.0690)			
$\Delta R^{LCorp}{}_{t-1}$			-0.287***		
			(0.0875)		
$\Delta R^{DH}{}_{t-1}$				0.0422	
				(0.186)	
$\Delta R^{DCorp}{}_{t-1}$					-0.0157
					(0.0750)
Constant	-0.00925	-0.0165	-0.00593	-0.0132	0.0000497
	(0.0102)	(0.0184)	(0.0211)	(0.0146)	(0.0160)
Observations	166	166	166	166	166

Note: Standard errors are reported in parentheses. Significance levels are indicated as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Columns (1), (2), and (3) correspond to loans, where *LHH*, *LHC*, and *LCorp* represent interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. Columns (4) and (5) correspond to deposits, where *DH* and *DCorp* denote deposit rates for households and corporations, respectively. [1], [2], [3] denote regimes 1,2 and 3, defined by the €STR thresholds τ_1 and τ_2 corresponding to the 25th and 75th percentiles of its

distribution (-0.451 and 0.259, respectively). Estimation is conducted using the Newey-West procedure to account for heteroskedasticity and autocorrelation.

With regard to upward variations in the €STR (ΔC_t^+), when the €STR is below τ_1 – that is, within the first regime – the coefficients for loans are highly significant, and no other regime exhibits coefficients of comparable magnitude in response to upward changes. These effects appear particularly pronounced in the case of loans to households for house purchase, as well as corporate loans. In the case of loans to households for consumption, although the reaction to upward movements in the €STR is more modest compared to other loan categories, the coefficient remains statistically significant and of considerable magnitude.

Still within this regime, downward variations in the €STR (ΔC_t^-) are not statistically significant for either type of loans. Given that this regime corresponds to a low-interest rate environment, it is plausible that consumers exhibit greater inertia or passivity in searching for better loan conditions, in contrast with situations of high-rate environments, where consumers are often under greater financial stress and may be more proactive in seeking alternative options. For this reason, banks may have greater power and may choose not to fully reflect downward movements in the €STR in the rates offered to borrowers.

Table 6. F-tests on the Equality of Coefficients for Loans Across Regimes (Aggregate Data)

Loans	Null hypothesis	HH		HC		Corp	
		F	p	F	p	F	p
1	Reject $H_0: b_1^+ = b_1^-$	66.93	0.000	0.37	0.545	29.13	0.000
2	Reject $H_0: b_2^+ = b_2^-$	3.45	0.065	0.01	0.909	1.60	0.208
3	Reject $H_0: b_3^+ = b_3^-$	2.48	0.117	0.00	0.985	0.29	0.594
4	Reject $H_0: b_1^+ = b_2^+$	154.95	0.000	13.59	0.000	36.10	0.000
5	Reject $H_0: b_1^+ = b_3^+$	118.87	0.000	11.03	0.001	36.75	0.000
6	Reject $H_0: b_2^+ = b_3^+$	28.86	0.000	0.06	0.800	1.13	0.290
7	Reject $H_0: b_1^- = b_2^-$	5.66	0.019	0.05	0.819	5.85	0.017
8	Reject $H_0: b_1^- = b_3^-$	0.18	0.670	0.05	0.822	2.29	0.133
9	Reject $H_0: b_2^- = b_3^-$	2.49	0.117	0.00	0.993	1.66	0.200

Note: *HH*, *HC* denote household house purchase and consumption, respectively, and *Corp* denotes corporations.

For these reasons, it can also be concluded that there is asymmetry in the response to upward versus downward adjustments of the €STR in the case of loans for household house

purchase and for corporate loans. This is confirmed by the F-tests presented in Table 6, where the null hypothesis H_0: $b_1^+ = b_1^-$ is rejected with p-values of 0.000 in both cases. This type of asymmetry – specifically, the rejection of the null hypothesis of coefficient equality – is almost exclusive to this regime in the case of loans, as it is not observed in any of the other regimes, with the exception of regime [2] for loans to households for house purchase. In that specific case, the null hypothesis is only marginally rejected if one considers a 10 per cent significance level (p = 0.065). Moreover, the conclusion regarding asymmetry is reversed, since upward changes are not significant, whereas downward changes are significant. This is a unique situation, given that in the third regime upward changes once again emerge as significant while downward changes remain non-significant. Indeed, apart from this case, none of the coefficients for downward variations are statistically significant in any loan category.

Turning to deposit rates, and starting with the first regime, while one might have expected a weaker reaction to upward adjustments of the €STR here – when considering arguments supporting banks' market power – the results indicate significant coefficients in response to positive adjustments of the €STR and non-significant coefficients for downward adjustments. However, the F-tests presented in Table 7 do not reject the equality of coefficients, meaning there is no evidence to support asymmetry in this regime for any deposit category, which resembles the situation observed in the third regime.

Table 7. F-tests on the Equality of Coefficients for Deposits Across Regimes (Aggregate Data)

Deposits	Null hypothesis	H		Corp	
		F	p	F	p
1	Reject H_0: $b_1^+ = b_1^-$	1.68	0.197	1.33	0.250
2	Reject H_0: $b_2^+ = b_2^-$	6.29	0.013	8.92	0.003
3	Reject H_0: $b_3^+ = b_3^-$	0.24	0.624	0.13	0.714
4	Reject H_0: $b_1^+ = b_2^+$	5.55	0.020	26.51	0.000
5	Reject H_0: $b_1^+ = b_3^+$	0.35	0.553	7.06	0.009
6	Reject H_0: $b_2^+ = b_3^+$	3.86	0.051	10.74	0.001
7	Reject H_0: $b_1^- = b_2^-$	6.45	0.012	3.71	0.056
8	Reject H_0: $b_1^- = b_3^-$	1.00	0.319	0.22	0.642
9	Reject H_0: $b_2^- = b_3^-$	1.49	0.225	0.50	0.483

Note: *H* and *Corp* denote households and corporations, respectively.

A distinct pattern emerges, one that is more consistent with the anticipated outcomes in the case of regime [2]. In this case, the coefficients for adjustments to downward movements in the €STR are statistically significant and substantial in magnitude – particularly for corporate deposits. Furthermore, the F-tests reject the null hypothesis H_0: $b_2^+ = b_2^-$ for both households and corporates p-values of 0.013 and 0.003, respectively, thereby supporting the conclusion that asymmetry is present in the adjustment process.

It is important to note that when the €STR is negative – which is especially relevant in regime [1] – downward adjustments in retail rates imply that, although data analysis shows that banks never offered negative nominal interest rates, the rates came very close to zero. Given the effective lower bound that prevents banks from passing on negative rates to retail clients, the decreases in the €STR did not result in downward adjustments of retail rates in practice.

Regarding corporate deposits, in addition to the significant coefficients found in the second regime – as was the case for household deposits – the stronger coefficients in face of a downward adjustment compared with households may align with the conclusion of Bonfim and Queiró (2024) that deposit rates are more actively managed in the case of corporate clients. Additionally, the finding that this pattern applies specifically to corporate deposits is consistent with the idea put forward by Heider et al. (2021), namely that, for corporate clients, switching to cash is logistically more difficult and costly, and such firms tend to maintain more complex relationships with banks.

Furthermore, the asymmetry found for both type of deposits in regime [2] suggests that banks adjust deposit rates more strongly in response to downward movements in the €STR than to upward ones. This type of asymmetry is consistent with the theoretical explanation provided by Kho (2024), who argues that banks tend to hold assets with longer fixed-rate periods than their liabilities. As a result, passing on higher policy rates quickly to deposit rates may be costly, with adverse consequences for bank profitability and their ability to fulfil intermediation functions. However, this explanation has is owns limitations in the Portuguese context, since, as highlighted in the literature review, at least in the mortgage lending, variable rate contracts have historically dominated the market and still represent a substantial share. Variable rates also show a dominance in corporate lending. On the other hand, since deposits are an important source of funding for Portuguese banks, as discussed in section 4.5., and given that they have proved to be relatively resilient even during periods of low interest rates – thus displaying low elasticity to such changes – they may confer additional market power

to banks, which is reflected in a more asymmetric transmission.

The reason why this asymmetry dissipates in regime [3] may be related to the possibility that, when rates are at higher levels, deposit remuneration receives greater attention from clients, which could limit asymmetric adjustments. In addition, in such contexts, attracting deposits may gain relevance as funding source, which might lead banks to adjust rates in a more balanced manner.

5.2. Individual Institution-Level Data Model

Building on the results from the aggregate data models, this subsection turns to the analysis of individual institution-level data. The estimation relies on equation 4.2.7.

Table 8. Estimated Effects of €STR Variations on Retail Interest Rates (Institution-Level Data)

	Loans			*Deposits*	
	$\Delta R^{LHH}{}_t$	$\Delta R^{LHC}{}_t$	$\Delta R^{LCorp}{}_t$	$\Delta R^{DH}{}_t$	$\Delta R^{DCorp}{}_t$
ΔC_t^+	0.989***	0.473***	0.880***	0.454***	0.381***
	(0.065)	(0.093)	(0.101)	(0.065)	(0.051)
ΔC_t^-	-0.256	-0.872**	-0.423	0.347***	0.419***
	(0.323)	(0.408)	(0.275)	(0.128)	(0.154)
$\Delta R^{LHH}{}_{t-1}$	-0.145***				
	(0.038)				
$\Delta R^{LHC}{}_{t-1}$		-0.264***			
		(0.041)			
$\Delta R^{LCorp}{}_{t-1}$			-0.159***		
			(0.023)		
$\Delta R^{DH}{}_{t-1}$				-0.034***	
				(0.011)	
$\Delta R^{DCorp}{}_{t-1}$					-0.075***
					(0.018)
Constant	0.316***	1.545***	0.613***	0.007	0.056***
	(0.083)	(0.247)	(0.094)	(0.011)	(0.016)
Observations	1114	1755	1921	1626	1674
Within R-sq.	0.170	0.139	0.111	0.091	0.087
F-statistic	81.94	41.21	63.73	34.28	38.71

Note: Standard errors are reported in parentheses. Significance levels are indicated as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Columns (1), (2), and (3) correspond to loans, where *LHH*, *LHC*, and *LCorp* represent interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. Columns (4) and (5) correspond to deposits, where *DH* and

DCorp denote deposit rates for households and corporations, respectively. Regressions include institution fixed effects, with standard errors clustered by institution.

Analogously to the aggregate analysis (see Table 3), retail interest rate dynamics are examined with respect to upward and downward variations in the €STR (ΔC_t^+ and ΔC_t^-). Regressions include institution fixed effects, and standard errors are clustered at the institution level to account for within-institution correlation over time and heteroskedasticity.

The results, reported in Table 8, reveal both parallels and contrasts with the aggregate findings, particularly when compared with Table 3.

Focusing first on loans, all adjustment coefficients to increases in the €STR are highly significant and of substantial magnitude, especially in the case of loans to households for house purchase and loans to corporates. For these two categories, however, the coefficients associated with decreases in the €STR are not statistically significant, which precludes drawing robust conclusions regarding downward adjustments. This mirrors the aggregate evidence. Nonetheless, the F-tests in Table 9 allow rejection of the null hypothesis of coefficient equality (Reject H0: $b_1^+ = b_1^-$, with p-values of 0.001 and 0.000), thereby supporting the presence of asymmetry. In other words, banks adjust lending rates more strongly in response to increases in the €STR than to decreases, a result consistent with findings in the literature such as Toolsema and Jacobs (2007), Craig and Dinger (2011), and Apergis and Cooray (2015).

Table 9. F-tests on the Equality of Coefficients (Institution-Level Data)

	Null hypothesis	F	p
LHH		13.50	0.001
LHC		10.14	0.002
LCorp	Reject $H_0: b_1^+ = b_1^-$	17.32	0.000
DH		0.51	0.478
DCorp		0.05	0.819

Note: *LHH*, *LHC*, and *LCorp* represent interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. *DH* and *DCorp* denote deposit rates for households and corporations, respectively

By contrast, the case of loans to households for consumption proves more complex. Here, both coefficients (ΔC_t^+ and ΔC_t^-) are significant, and asymmetry is again detected. Yet, the coefficient associated with decreases in the €STR is negative, implying an adjustment in the opposite direction to what would be theoretically expected. This unexpected result may

reflect specific features of consumer credit markets, such as higher risk premia or pricing rigidities. Though further investigation on this is warranted.

Turning to deposits, all estimated coefficients are significant and of comparable magnitude. Combined with the F-tests, this evidence rules out the presence of asymmetry in deposit rates. This finding aligns with Valadkhani and O'Mahony (2024).

5.3. Institution Size Analysis

In H2, we investigate the extent to which bank size conditions the transmission of monetary policy. To this end, the present subsection concentrates on the largest institutions within the sample, thereby enabling the derivation of insights that may subsequently be contrasted with those obtained for the full sample results.

Table 10. Estimated Effects of €STR Variations on Retail Interest Rates (Largest Institutions, G3)

	Loans			*Deposits*	
	$\Delta R^{LHH}{}_t$	$\Delta R^{LHC}{}_t$	$\Delta R^{LCorp}{}_t$	$\Delta R^{DH}{}_t$	$\Delta R^{DCorp}{}_t$
ΔC_t^+	1.009***	0.533***	1.301***	0.372***	0.391***
	(0.076)	(0.106)	(0.076)	(0.065)	(0.062)
ΔC_t^-	0.505***	0.334	0.700**	0.776***	0.833***
	(0.137)	(0.444)	(0.289)	(0.093)	(0.154)
$\Delta R^{LHH}{}_{t-1}$	-0.037***				
	(0.011)				
$\Delta R^{LHC}{}_{t-1}$		-0.190***			
		(0.040)			
$\Delta R^{LCorp}{}_{t-1}$			-0.030***		
			(0.010)		
$\Delta R^{DH}{}_{t-1}$				-0.001	
				(0.009)	
$\Delta R^{DCorp}{}_{t-1}$					-0.024
					(0.017)
Constant	0.062**	1.069***	0.076*	-0.020*	0.014
	(0.022)	(0.238)	(0.038)	(0.010)	(0.013)
Observations	649	664	683	689	696
Within R-sq.	0.339	0.121	0.258	0.131	0.139
F-statistic	97.50	26.43	106.10	67.75	88.70

Note: Standard errors are reported in parentheses. Significance levels are indicated as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Columns (1), (2), and (3) correspond to loans, where *LHH*, *LHC*, and *LCorp*

represent interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. Columns (4) and (5) correspond to deposits, where *DH* and *DCorp* denote deposit rates for households and corporations, respectively. Regressions include institution fixed effects, with standard errors clustered by institution. The results refer to the subset of institutions in G3, representing the top 20% of the sample by total assets.

Consistent with the approach outlined in Table 2, the sample is stratified into three groups according to total asset percentiles: G1 (below the 40th percentile), G2 (between the 40th and 80th percentiles), and G3 (above the 80th percentile). Table 10 reports the results for the subset of institutions classified in G3, estimated using equation 4.2.7.

This estimation introduces an additional layer of analysis: not only does it capture the role of bank size, but it also focuses on institutions that account for most loans in the system. For example, in 2022Q4, banks in G3 represented 98.9% of domestic housing credit (see Table 2). Starting with this category, for the first time both coefficients (corresponding to increases and decreases in the €STR) are significant. Compared to the full sample (Table 8), the magnitudes are larger, suggesting a stronger response of housing loan rates among the largest institutions. Moreover, the F-tests in Table 11 confirm the presence of asymmetry, with the response to upward adjustments in the €STR exceeding that to downward adjustments, as was also the case for the full sample results. This supports the idea that retail lending rates increase more when policy rates rise than they decrease when policy rates fall for the largest institutions.

Table 11. F-tests on the Equality of Coefficients (Largest Institutions, G3)

	Null hypothesis	F	p
LHH		9.84	0.006
LHC		0.16	0.694
$LCorp$	Reject $H_0: b_1^+ = b_1^-$	3.80	0.064
DH		10.35	0.005
$DCorp$		5.29	0.032

Note: *LHH*, *LHC*, and *LCorp* represent interest rates on newly originated loans to households for house purchase, households for consumption, and corporations, respectively. *DH* and *DCorp* denote deposit rates for households and corporations, respectively

A similar pattern is observed for corporate loans, which also display asymmetric adjustment, with stronger reactions to upward movements in the €STR. Again, magnitudes are higher than those obtained with the full sample. By contrast, the case of consumer loans diverges from the aggregate results. Here, the coefficient associated with decreases in the €STR

becomes not significant, meaning no robust conclusion can be drawn.

The most striking contrast with the full-sample analysis arises for deposits. When restricting attention to G3, the results in Table 11 indicate significant asymmetry in the opposite direction to that observed for loans: upward adjustments are smaller than downward adjustments. This finding is consistent with the literature (Hannan and Berger, 1991; De Graeve et al., 2007; Craig and Dinger, 2011; Apergis and Cooray, 2015). Several explanations have been advanced for such asymmetries, ranging from tacit collusion (Toolsema and Jacobs, 2007), menu costs (Levieuge & Sahuc, 2021), and consumer characteristics that grant institutions market power (Rosen, 2002), to switching costs that generate customer lock-in effects (Scholnick, 1999; Levieuge & Sahuc, 2021). These mechanisms allow banks to adjust deposit rates asymmetrically in ways that favour their own profitability. The results also align with Craig and Dinger (2011) and Driscoll and Judson (2013), who find stronger upward stickiness of deposits in large institutions.

Boeckx et al. (2020) highlighted bank size as a key factor, predicting that larger institutions should display weaker responses to monetary policy because of lower information costs, greater diversification, and fewer funding constraints. However, the G3 results in this study show broadly larger coefficients for both increases and decreases compared with the full-sample estimates. Although this appears contradictory, it is not unprecedented: Hannan and Berger (1991) also report that larger banks are more likely to adjust interest rates in response to changes in policy rates. One possible explanation, as noted by the authors, is that larger institutions have a heightened ability to perceive and react to changes in market conditions, which amplifies their responsiveness to monetary policy shocks.

6. Conclusion

The recognition of the importance of the financial system in the economy and of the effective transmission of monetary policy provided the starting point for addressing two central questions. First, whether the pass-through of changes in the central bank's policy rate to deposit and lending rates in Portugal occurs symmetrically, or whether differences emerge between increases and decreases; and second, whether bank size influences the magnitude of these adjustments. By raising these questions, the dissertation aimed to offer a more comprehensive understanding of the monetary policy transmission mechanism in the Portuguese context, incorporating the distinction between products (loans and deposits) and client segments (households and firms).

The study aimed to contribute to the literature in a field where no universal conclusions exist and where analysis must account for multiple dimensions and layers, as highlighted in the literature review. To address the research question, an econometric approach based on Valadkhani and O'Mahony (2024) was employed, which was subsequently adapted to meet the additional objectives of this study. This approach, utilising both aggregate data – as in the original study – and institution-level data, revealed differentiated results.

At the aggregate level, the analysis of upward and downward movements in the €STR did not provide sufficient evidence to confirm the existence of asymmetry in either loans or deposits; however, when examined across different €STR thresholds, asymmetry was observed for certain levels. This was particularly the case for household house-purchase loans and corporate loans when the €STR was relatively low, a finding consistent with the literature that suggests upward adjustments tend to be stronger than downward ones. Similarly, within an intermediate range of the €STR, asymmetries can also be identified in deposit rates, with decreases being passed through more strongly than increases.

Institution-level data, however, revealed a different reality: statistical evidence pointed to the presence of asymmetry in loan rates when considering exclusively increases and decreases, with upward adjustments being more fully transmitted than downward ones. For deposits, by contrast, asymmetry was excluded.

The analysis of the subset of institutions representing the top 20% of the sample by total assets introduced an additional layer. In this case, asymmetry was identified for deposits, in favour of banks, with downward adjustments of the €STR being transmitted more strongly

than upward ones. For loans, the asymmetry already identified in the full sample was confirmed, but only for household house-purchase loans and for corporate loans.

Overall, the results suggest that monetary policy transmission in Portugal is characterised by asymmetry, although the extent of this effect depends on whether the analysis is conducted with aggregate or institution-level data. Furthermore, bank size is shown to play a role in shaping the pass-through, with larger banks exhibiting differences in adjustment when compared to the full sample.

As highlighted in the methodology chapter, a potential limitation of the econometric specification is the risk of endogeneity, insofar as retail rates from the previous period may influence current monetary policy decisions. The use of individual bank-level data in the second stage could mitigate this limitation, since it is highly unlikely that the pricing decisions of a single institution would meaningfully affect the central bank's policy stance.

In addition, it would have been valuable to examine further bank characteristics, but this was not possible due to time constraints and the time-intensive nature of replication and coding with BPLIM data, notwithstanding the remarkable efficiency and availability of its staff.

Moreover, several relevant dimensions were not considered, including the role of maturity structures in deposits and loans. Future research could explore these gaps by examining maturity-specific effects, conducting comparative analyses across European countries, and incorporating structural aspects such as market concentration.

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8. Annexes

Annex A. List of Variables and Data Sources

Aggregate Data	Description	Source(s) of Data
€STR	The €STR variable was constructed using two series: *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points* and *Euro short-term rate – Volume-weighted trimmed mean rate*. Since the latter series is only available from October 2019, to obtain the €STR variable for the full period, the *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points*, which spans from January 1999 to December 2021, was adjusted by removing the corresponding spread.	European Central Bank. (2022, January 4). *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points (EONIA_TO.RATE)* [Dataset]. ECB Data Portal. Retrieved February 27, 2025, from https://data.ecb.europa.eu/data/datasets/EON/EON.D.EONIA_TO.RATE European Central Bank. (2025, February 26). *Euro short-term rate – Volume-weighted trimmed mean rate (EST.B.EU000A2X2A25.WT)* [Dataset]. ECB Data Portal. Retrieved February 27, 2025, from https://data.ecb.europa.eu/data/datasets/EST/EST.B.EU000A2X2A25.WT
LHH	Loans to households for house purchase (new business)	European Central Bank. (2025, February 4). *Bank interest rates - loans to households for house purchase (new business) - Portugal* [Dataset]. ECB Data Portal. Retrieved February 27, 2025, from https://data.ecb.europa.eu/data/datasets/MIR/MIR.M.PT.B.A2C.A.R.A.2250.EUR.N
LHC	Loans to households for consumption (new business)	European Central Bank. (2025, February 4). *Bank interest rates - loans to households for consumption (new business) - Portugal* [Dataset]. ECB Data Portal. Retrieved February 27, 2025, from https://data.ecb.europa.eu/data/datasets/MIR/MIR.M.PT.B.A2B.A.R.A.2250.EUR.N
LCorp	Loans to corporations (new business)	European Central Bank. (2025, February 4). *Bank interest rates - loans to corporations (new business) - Portugal* [Dataset]. ECB Data Portal. Retrieved March 3, 2025, from https://data.ecb.europa.eu/data/datasets/MIR/MIR.M.PT.B.A2A.A.R.A.2240.EUR.N
DH	Deposits from households with an agreed maturity (new business)	European Central Bank. (2025, February 4). *Bank interest rates - deposits from households with an agreed maturity (new business) - Portugal* [Dataset]. ECB Data Portal. Retrieved March 3, 2025, from https://data.ecb.europa.eu/data/datasets/MIR/MIR.M.PT.B.L22.A.R.A.2250.EUR.N
DCorp	Deposits from corporations with an agreed maturity (new business)	European Central Bank. (2025, February 4). *Bank interest rates - deposits from corporations with an agreed maturity (new business) - Portugal* [Dataset]. ECB Data Portal. Retrieved March 3, 2025, from https://data.ecb.europa.eu/data/datasets/MIR/MIR.M.PT.B.L22.A.R.A.2240.EUR.N

Panel Data	Description	Source(s) of Data
€STR	The €STR variable was constructed using two series: *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points* and *Euro short-term rate – Volume-weighted trimmed mean rate*. Since the latter series is only available from October 2019, to obtain the €STR variable for the full period, the *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points*, which spans from January 1999 to December 2021, was adjusted by removing the corresponding spread.	European Central Bank. (2022, January 4). *Rate for the overnight maturity calculated as the euro short-term rate plus a spread of 8.5 basis points (EONIA_TO.RATE)* [Dataset]. ECB Data Portal. Retrieved February 27, 2025, from https://data.ecb.europa.eu/data/datasets/EON/EON.D.EONIA_TO.RATE European Central Bank. (2025, February 26). *Euro short-term rate – Volume-weighted trimmed mean rate (EST.B.EU000A2X2A25.WT)* [Dataset]. ECB Data Portal. Retrieved February 27, 2025, from https://data.ecb.europa.eu/data/datasets/EST/EST.B.EU000A2X2A25.WT
LHH	Interest rates on new loans to households: Housing loans	
LHC	Interest rates on new loans: Credit for consumption and other purposes	Banco de Portugal Microdata Research Laboratory (BPLIM) (2023): Historical Series of the Portuguese Banking Sector. Extraction: October 2023. Version: V1. Banco de Portugal BPLIM. Dataset. https://doi.org/10.17900/SLB.Oct2023.V1
$LCorp$	Interest rates on new loans to non-financial corporations	
DH	Interest rates on deposits: New deposits to households	
$DCorp$	Interest rates on deposits: New deposits to non-financial corporations	
Size	Total assets	

Annex B. Outlier Treatment and Preliminary Tests

Before proceeding with the regressions, the data were subjected to outlier treatment. Outliers were identified using the classical method for each variable, defined as:

$$Lower\ Bound\ = Q_1 - 1{,}5 \times\ IQR \qquad Upper\ Bound\ = Q_3 + 1{,}5 \times\ IQR$$

Where Q_1 and Q_3 are the first and third quartiles, respectively, and $IQR = Q_3 - Q_1$ is the interquartile range. Once identified, the tails of the distribution were adjusted through a process known as winsorization. Specifically, all values exceeding the calculated upper or lower bounds were replaced with the respective bound values, ensuring that extreme observations did not unduly influence the regression results.

Additionally, before conducting the regressions – both for the aggregate data and the panel

data – preliminary tests were performed. Specifically, for the aggregated data, stationary and cointegration tests were carried out; after applying the Johansen test, the use of an ECM was deemed inappropriate. Regarding the institution-level panel data, the Hausman test was conducted to determine the appropriate model between random effects and fixed effects, and the results indicated that the fixed-effects model was more suitable.