Did the period of low interest rates undermine the European Central Bank's ability to effectively lower inflation in the post-COVID-19 economic environment?

Clemens Anton Christoph Born

Dissertation written under the supervision of professor Ekin Ilseven

Dissertation submitted in partial fulfilment of requirements for the MSc in Management with specialization in strategy, entrepreneurship and impact, at the Universidade Católica Portuguesa, 13.03.2025.

ABSTRACT

The thesis, “Did the period of low interest rates undermine the European Central Bank’s ability to effectively lower inflation in the post-Covid-19 economic environment” by Clemens Born, analyses how a low-interest-rate environment affected the ECB’s ability to combat inflation. In a normal fiscal environment, the central bank controls inflation through key interest rates and transmission mechanisms, which can lose effectiveness in an expansive monetary environment. While traditional monetary theory suggests a negative relationship between interest rates, lending, and inflation, empirical observations from the pre-pandemic period indicate a contrarian effect.

This study examines how prolonged low interest rates and quantitative easing (QE) impacted inflation dynamics in the euro area. Using Ordinary Least Squares (OLS) regressions and T-tests, it assesses monetary transmission before and after the Covid-19 pandemic. The results suggest that excess reserves, rather than supporting credit creation, contributed to inflationary pressures once economic activity resumed. Moreover, interest rate hikes failed to curb inflation effectively in an ultra-loose monetary environment.

By examining these dynamics, this thesis contributes to the debate on monetary policy effectiveness by empirically testing whether the ECB’s ability to control inflation was constrained. Unlike previous studies, it considers COVID-19 as a catalyst for inflation, as economic disruptions and fiscal and monetary interventions accelerated price dynamics. The findings suggest that excess liquidity entered the real economy through the credit channel, fueling inflation despite rising interest rates. Consequently, the ECB’s ability to manage inflation post-pandemic was limited, raising concerns about the long-term effectiveness of conventional monetary policy.

Key words: economics, multiple regression, inflation, excess reserves, European Central Bank, interest rate, monetary transmission

Resumo

A tese, “O período de taxas de juros baixas enfraqueceu a capacidade do Banco Central Europeu de reduzir efetivamente a inflação no ambiente econômico pós-Covid-19?”, de Clemens Born, analisa o impacto de juros baixos na capacidade do BCE de controlar a inflação. Normalmente, o banco central usa taxas de juros e canais de transmissão, mas esses mecanismos podem perder eficácia em um ambiente de liquidez excessiva. Embora a teoria monetária tradicional sugira uma relação negativa entre juros, crédito e inflação, evidências do período pré-pandemia indicam um efeito contrário.

Este estudo examina como taxas de juros baixas prolongadas e o afrouxamento quantitativo (QE) afetaram a inflação na zona do euro. Usando regressões OLS e testes T, avalia a transmissão monetária antes e depois da pandemia. Os resultados mostram que reservas excessivas, em vez de impulsionar o crédito, contribuíram para pressões inflacionárias quando a economia se recuperou. Além disso, aumentos nas taxas de juros não contiveram a inflação em um ambiente monetário expansionista.

A tese contribui ao debate sobre política monetária ao testar se a capacidade do BCE de controlar a inflação foi comprometida. Diferente de estudos anteriores, considera a Covid-19 um catalisador da inflação, intensificada por estímulos fiscais e monetários. Os achados indicam que a liquidez excessiva entrou na economia real via crédito, impulsionando a inflação, apesar do aperto monetário. Isso levanta dúvidas sobre a eficácia da política monetária convencional no longo prazo.

Economia, Regressão Múltipla, Inflação, Reservas em Excesso, Banco Central Europeu, Taxa de Juro, Transmissão Monetária

CONTENT

I. INTRODUCTION

After years of stability, inflation returned to the eurozone, reshaping its economies landscape. While the 2010s were characterized by price stability, the early 2020s brought a sharp increase in inflation, challenging economic expectations of companies and the purchasing power of private households and forcing policymakers to respond. Finally, the explosive pace of inflation raises doubts about the ECB's ability to react appropriately to extraordinary events in the real economy and to ensure price stability (Wullweber, 2025) – which is indeed its most important task:

> "[…] the primary objective of the ESCB shall be to maintain price stability." (European Union, 2016, Art. 2)

The ECB's monetary policy can affect the real economy via so-called transmission channels such as key interest rates, exchange rates or lending (European Union, 2016). The relevance and mode of action of monetary transmission mechanisms are therefore an important topic for both practical considerations and academic research. Boivin et al. state that

> "The monetary transmission mechanism is one of the most studied areas of monetary economics […]." (Boivin et al., 2010, 1)

Understanding how monetary policy affects the economy is essential to evaluating the stance of monetary policy. Monetary policymakers must accurately assess the timing and impact of their measures on the economy to determine how to set policy instruments effectively. To make this assessment, they need a deep understanding of the mechanisms through which monetary policy influences real economic activity and inflation (ibid, 1).

This study contributes to this by examining the impact of transmission mechanisms in a low-interest-rate environment, as it existed after the Covid crisis in Summer 2021 and asks whether and to what extent the period of low interest rates has altered the traditional monetary transmission mechanism and the European Central Bank's ability to lower inflation.

To explore these questions, we take a look at monetary theory, analyse the ECB's monetary policy measures, particularly the effects of quantitative easing (QE), the asset purchase program (APP), the pandemic emergency purchase programme (PEPP), and the associated development of excess reserves. Furthermore, we examine the extent to which these reserves

flowed into the real economy via the bank lending channel and potentially exerted inflationary pressure. To this end, we employ multiple regression analyses to systematically investigate economic variables such as inflation, key interest rates, bank lending, and bank interest rates. In our analysis we are interested in two periods: the pre-pandemic phase from 2010 to March 2020 (beginning of lockdowns) and the subsequent phase until the end of 2024. Using T-tests, we assess whether observed differences occurred randomly or were influenced by monetary policy measures, particularly interest rate hikes.

In examining this topic, this study aligns with previous research investigating central bank transmission mechanisms. For instance, Wullweber (2020) highlights how interest rate control can weaken when approaching the zero lower bound, suggesting that prolonged low rates may have led to a loss of monetary policy effectiveness. Similarly, Fricke et al. (2024) argue that central banks' quantitative easing measures have altered the transmission of monetary policy, particularly by changing the dynamics of credit supply among reserve-rich banks. Furthermore, recent studies have emphasized how liquidity traps, as described by Sinn (2020), can diminish the expected deflationary effect of rate hikes, creating an environment where excess reserves accumulate without stimulating proportional economic activity. Additionally, Wullweber et al. (2022) and Aruoba & Schorfheide (2016) have demonstrated that unconventional monetary policies have long-lasting effects on inflation expectations and financial stability, reinforcing concerns about the ECB's ability to manage inflation effectively in the post-pandemic period.

> "Overall, the literature on the bank lending channel has focused on evidence showing its potential importance, but little work has been developed to provide an overall assessment of the macroeconomic importance of this channel, rather than its importance for certain classes of firms or banks, or for certain episodes." (Boivin et al., 2010, 17-18)

This study differs by examining how the prolonged period of low interest rates, combined with the COVID-19 shock, affected the ECB's ability to control inflation. Unlike prior research that focuses on isolated disruptions, it assesses whether ultra-loose monetary policy structurally weakened transmission mechanisms. Integrating the quantity theory of money, it highlights how excess reserves and liquidity growth contributed to inflation with a delayed effect. COVID-19 acted as a stress test, revealing pre-existing weaknesses in monetary transmission. By comparing pre- and post-pandemic data, this research provides new insights into whether central banks still possess effective tools to curb inflation.

Furthermore, the findings contribute to the ongoing debate on monetary policy effectiveness by demonstrating how excess reserves influenced credit supply in an environment of rising interest rates. The study highlights that traditional monetary policy assumptions may no longer hold, particularly as interest rate hikes failed to contract credit availability. This has practical implications for financial managers and policymakers. For businesses, managing interest rate risk becomes increasingly complex, requiring strategies such as hedging against unpredictable rate changes. Banks and financial institutions, in turn, must rethink their credit allocation models, as excess liquidity may continue to distort lending patterns. These insights underline the necessity of adaptive financial planning in an era where monetary policy tools have diminished predictability.

Finally, if a currency continues to weaken significantly against others due to structural monetary policy constraints, businesses and investors may increasingly seek to reduce their exposure to it, either by shifting assets into stronger currencies or by diversifying international holdings. This could further exacerbate economic instability and complicate central bank interventions.

II. FUNDAMENTALS

A. Monetary Theory

Before examining the development of liquidity in the euro area we must first clarify the fundamental role of central banks, the instruments at their disposal, and how they influence inflation. Understanding the core functions of central banks and their monetary policy tools is crucial for assessing their ability to manage economic stability. With this foundation can we properly analyse how liquidity has evolved over time, the mechanisms through which it impacts monetary transmission, and its role in shaping inflation dynamics. As the focus of this paper will be on interest rates and bank lending channels, we will take a closer look at their transmission mechanisms.

1. Transmission of the Interest Rate Channel

The European Central Bank describes its main task as follows:

> "[…] [a] central bank is a public institution that manages the currency of a country or group of countries and controls the money supply – literally, the amount of money in circulation. The main objective of many central banks is price stability." (ECB, 2015a)

One of the central bank's most important and effective instruments for achieving this goal is the setting of interest rates. They determine the cost of money and therefore play a central role in monetary policy.

Unlike commercial banks, central banks do not accept deposits from individuals or offer loans to the public, nor are they driven by profit motives. Instead, their primary function is to regulate the supply of money and credit in the economy to maintain price stability. They serve as the bank for commercial banks, influencing liquidity conditions and the availability of credit. Commercial banks, in turn, can borrow from the central bank, typically to cover short-term liquidity needs. Such borrowing requires collateral**,** usually in the form of government or corporate bonds, which act as a guarantee for repayment (ibid).

Since commercial banks engage in maturity transformation, providing long-term loans while relying on short-term deposits, they may experience liquidity shortages, where they possess sufficient assets but lack the immediate cash required to meet obligations. In such situations, the central bank steps in as a lender of last resort, ensuring financial stability by providing liquidity to prevent disruptions in the banking system.

Beyond its monetary policy function, a central bank fulfils a broad range of additional responsibilities. It is typically responsible for issuing currency, ensuring the efficient functioning of payment systems**,** and managing foreign currency reserves. Moreover, central banks contribute to the stability of the financial system by supervising commercial banks, ensuring that excessive risk-taking is mitigated. However, the central task of central banks is to ensure price stability.

> "The conventional view among economists is that higher interest rates lead to lower inflation. The rationale behind this view is that higher interest rates increase the cost of borrowing and dampen demand across the economy, resulting in excess supply and lower inflation." (Matheson, 2022, 255)

Therefore, the relation between both variables is negative. If a central bank was to lower inflation, it only had to

> "[…] raise interest rates enough to increase the real (inflation-adjusted) cost of borrowing, thereby reducing aggregate demand and returning inflation back toward the desired level." (ibid)

Central banks do that via the key interest rate. The key interest rate is the interest rate designed to steer monetary policy. It determines the conditions at which commercial banks can borrow money from the central bank or invest surplus liquidity (Bundesfinanzministerium, n.d.).

The relationship exists because commercial banks are depended on central bank money to arrange transactions between them (Wullweber, 2020, 56).

> "As a rule, a central bank's interest rate influences the rate at which commercial banks lend money to one another and to private individuals. Other factors being equal, it is assumed that the lower the interest rate is, the higher the demand for credit will be. Central banks seek to achieve a macroeconomic effect on lending practices by adjusting their interest rates, and thus the price

> for central bank money." (McLeay et al. 2014a; Bank of England 2015, as cited in Wullweber, 2020, 56)

Traditional Keynesian IS-LM (Investment-Saving/Liquidity preference-Money supply) view displays this mechanism as follows:

$$M \uparrow \rightarrow i_r \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

> "Where M ↑ indicates an expansionary monetary policy leading to a fall in real interest rates ($i_r \downarrow$), which in turn lowers the cost of capital, causing a rise in investment spending (I ↑), thereby leading to an increase in aggregate demand and a rise in output (Y ↑)." (Mishkin, 1996, 2)

The money market (LM) has a direct influence on the real economy (IS). The price of credit significantly determines the demand for goods and services. Furthermore, the relationship shows that interest rates are prices that link the present to the future (Mankiw, 2017, 132). They represent the cost of borrowing money today to repay it back in the future, or the return earned by saving money now for future benefit.

2. Transmission of the Bank Lending Channel

Banks have a unique function in the financial system because of their capacity of addressing asymmetric information issues in credit markets. Due to the unique function of banks, some borrowers will only be able to access credit markets through bank loans. Bank loans become more available due to expansionary monetary policy, which raises bank reserves and deposits. This rise in loans will lead to an increase in investment and consumer spending, as many borrowers rely on bank loans to fund their activities (Boivin et al., 2010, 17-18). If banks were to increase their loan lending, investment and consumer spending would go up. This policy effect can be summarized with:

$$M \uparrow \rightarrow \text{bank deposits} \uparrow \rightarrow \text{bank loans} \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow$$

An increase in the money supply (M ↑) leads to a rise in bank deposits (bank deposits ↑) as additional liquidity enters the banking system. With higher reserves, banks have more funds available for lending, which encourages an expansion in bank loans (bank loans ↑). As credit conditions become more accommodative, businesses and households gain easier access to financing, stimulating investment (I ↑). Increased investment, particularly in capital goods,

fuels economic activity and contributes to higher aggregate output (Y ↑). This transmission mechanism highlights how monetary expansion influences the real economy by facilitating credit creation, fostering investment, and ultimately boosting economic growth.

It should be noted that the bank lending channel has an important implication: monetary policy will affect the spending of smaller firms, which are more reliant on bank loans, heavier than that of larger firms, which can access funds directly from stock and bond markets (not solely through banks) (ibid, 18).

Building on the theoretical foundation of monetary transmission mechanisms, we now turn to the empirical development of liquidity in the euro area. The period leading up to the COVID-19 pandemic and the following crisis provides a crucial case for assessing the effectiveness of monetary policy in practice. By examining the evolution of liquidity conditions in the Eurosystem since 2008, we can evaluate how prolonged low interest rates, excess reserves, and large-scale asset purchases influenced the economic environment and the broader economy. Did the excess liquidity have had any influence on the Eurosystem? And how did it come about in the first place?

B. Liquidity development of the Eurosystem

In January 2021 prices in the eurozone began to rise. One year later in November 2022, inflation had risen to a drastic 10.1%. This was the highest score it has ever been since the introduction of the Euro (ECB, n.d., a). As of December 2024, inflation went back to 2.4% (ibid), which still is 0,4% points over the ECB´s target inflation.
To address the risks of low and occasionally even negative inflation rates that had emerged in the euro area since 2013, Quantitative Easing (QE) was introduced in March 2015. QE is a large-scale asset purchase program within the European monetary union. It aimed to reduce long-term interest rates during those periods when short-term interest rates approached the Zero Lower Bound (ZLB). By lowering long-term interest rates, the goal was to improve financing conditions for households and businesses. This was intended to stimulate more consumption and investment in the euro area. Vice-President of the ECB Vítor Constâncio put it as follows:

> "[…] inflation developments alone go a long way in motivating the combination of the measures […] to provide additional monetary policy accommodation and to support lending to the real economy." (2014, June)

To achieve an inflation rate of below, but close to 2%, aggregate demand and price levels were increased (ECB, 2015, b). The ECB's large-scale asset purchases affect the real economy through various channels.

This thesis focuses on the bank lending channel and the excess reserves created in the banking sector in connection with QE and other monetary policies of the same fashion. In the following we will provide an overview of the relevant economic relationships and analyse their development since the issuance of QE in more detail.

1. Excess Reserves

Minimum reserves are legally required balances that all credit institutions must hold with their central bank. An excess reserve is the credit balance of a commercial bank at the central bank that exceeds the minimum reserve requirement (Samuelson, Nordhaus 1998, 570-75). Normally it only arises

> "[…] if the reserves would generate the same return as other secure forms of investment […]" (Samuelson, Nordhaus 1998, 575)

because commercial banks lack the incentive to lend their liquidity or invest it themselves (ibid.). Excess reserves play a central role in this study, which is why they need to be examined more closely.

Bank reserves consist of physical cash plus deposits held by national central banks in current accounts for commercial banks. Banks are required to maintain minimum reserves amounting to 1% of their liabilities (Deutsche Bundesbank, n.d., a). This allows banks to

> "[...] react to short-term changes in the money markets by adding to or withdrawing funds from their reserves." (ECB, 2016, a)

This thesis analyses the excess reserves of reserve-requiring credit institutions in the euro area. Due to the extensive asset purchases of the Eurosystem (QE), aggregate excess reserves

have increased significantly until July of 2022 where they reached their climax (ECB, n.d., b). While approximately €117.812 billion were held at European national banks in March 2015, this figure had risen to an astonishing €3.888 trillion by June 2022 (ECB, n.d., b).

Apart from meeting the ECB's minimum reserve requirement banks hold reserves for other reasons too. They ensure sufficient liquidity for cash withdrawals and maintain liquidity buffers in case of dysfunction in the interbank system. This rationale underscores that bank deposits are a key determinant of banks' demand for reserves (Bucher et al., 2020, 166). Commercial banks create deposits when they issue loans. As more loans are granted, the demand for reserves increases. This creates a connection between monetary policy and banks' credit supply, as the central bank in its role of the monopoly supplier of money, determines both the cost of reserves and the quantity of reserves available to the banking sector.

2. Liquidity Expansion, the Marginal Operations Rate and Credit Supply

Until September 2008, the interbank market operated efficiently, ensuring the smooth distribution of reserves among commercial banks. However, the collapse of Lehman Brothers marked the beginning of the financial crisis, disrupting financial markets and increasing liquidity pressures. Despite the initially efficient distribution of bank reserves, the euro area's liquidity needs were structurally constrained.

To meet these needs the Eurosystem primarily relied on main refinancing operations (MROs), which serve as liquidity-providing instruments (ECB, n.d., d).

> "The main refinancing operations rate is the interest rate banks pay when they borrow money from the ECB for one week. When they do this, they have to provide collateral to guarantee that the Eurosystem will receive the amount lent even if the bank does not repay the money borrowed" (ECB, 2018).

The MRO rate is one of three key interest rates set by the ECB, which all shape liquidity conditions. By influencing the cost and availability of reserves, these monetary policy tools directly impact banks' ability to extend credit. Banks' credit supply is shaped by two key factors:

i. The main refinancing rate (MRO rate), which determines the cost of banks obtaining reserves and long-term refinancing operations (LTROs).

ii. The minimum reserve ratio, which dictates the required amount of reserves (Deutsche Bundesbank, n.d., a).

In this environment, monetary policy could achieve its intended effects and

> "[…] before August 2007, euro area money markets were functioning smoothly." (ECB, 2009, 141)

However, as the crisis deepened, the balance between liquidity-providing and liquidity-absorbing factors was disrupted (Österreichische Nationalbank, n.d., a). Raising either instrument exerted a contractionary influence, increasing the cost of credit issuance (Österreichische Nationalbank, n.d.,). The balance in the interbanking market was at distress as

> "[…] banks […] hoarded liquidity instead of lending excess funds […]." (ECB, 2009, 142)

The efficient distribution of reserves in the interbank market, could no longer be maintained after September 2008, when the financial crisis peaked with the collapse of Lehman Brothers (Deutsche Bundesbank, 2014, 45). Banks' demand for reserves significantly exceeded their structural needs. Contributing factors included increased risk aversion, and informational asymmetries, which created additional stress in the banking sector (Frutos et al., 2016, 3, 11).

In response to these developments, the monetary policy framework for the interbank money market changed in the summer of 2009, initially because the Eurosystem repeatedly conducted refinancing operations with very long maturities and at very favourable interest rates compared to market conditions. The extensive use of long-term credit operations generated additional liquidity, usually on a large and in some cases unprecedented scale.

Beyond its direct impact on liquidity, excess reserves influenced banks' balance sheets in unexpected ways. Traditionally, rising interest rates reduce the market value of bank assets more sharply than liabilities, leading to a decline in net worth and a contraction in credit supply. However, in an environment characterized by extensive reserves, this mechanism functioned differently. Banks holding substantial reserves benefited from increased interest

income, mitigating the typical negative effects of monetary tightening on their balance sheets. Furthermore, if interest rate hikes were not fully passed on to depositors, the relative cost of refinancing remained more stable, further cushioning the impact on lending activity (Greppmair et al., 2023).

Thus, in addition to the minimum reserve ratio and the MRO rate, a third instrument now influences credit supply. This shift is significant for monetary policy effectiveness because it alters the traditional transmission mechanism. Notably, credit facilities had no impact on credit issuance before the financial crisis. The interbank market functioned well up to this point. An increase in the deposit facility rate positively impacts banks' credit supply (Bucher/Neyer, 2014, 8). This circumstance was to have far-reaching economic consequences.

Figure 1 provides an overview of the total excess reserves held by credit institutions. These fluctuations highlight the evolving role of central bank interventions in shaping liquidity dynamics. It is worth noting that between August 2012 and September 2022, excess reserves in the euro area nearly expanded sevenfold.

Figure 1: (European Central Bank, n. d., b)

3. Asset Purchase Program and Pandemic Emergency Purchase Programme

Up to now, unconventional monetary policies and the related expansion of liquidity in the eurozone has primarily been due to the collapse of the interbank market and to the extremely favourable interest rates on long-term refinancing operations offered by the eurozone.

> "Unconventional monetary policies in the euro area gained prominence in the wake of the 2007–08 financial crisis as traditional monetary policy tools proved less effective in tackling the financial crisis, providing the required liquidity, and fighting disinflation." (Evgenidis/Papadamou, 2020, 5684)

The asset purchase program (APP) should drive these developments forward in a swifter fashion. The ECB launched the APP in mid-2014 as part of a broader set of non-standard monetary policy measures. These measures also included targeted longer-term refinancing operations (TLTROs). They were designed to improve the effectiveness of monetary policy and provide the necessary support to maintain price stability (ECB, n.d., e).

> "These operations received considerable interest from banks and as a result, they led to a boost in the ECB's balance sheet." (Evgenidis/Papadamou, 2020, 5684)

In addition to several other asset programmes

> "[…] the ECB expanded massively its balance sheet by introducing the public sector asset purchase programme, otherwise known as quantitative easing (QE)." (ibid, 5685)

Furthermore, the covered bond purchase programs and the Securities Markets Programme between 2009 and 2012 further enlarged the balance sheet. The refinancing operations starting in 2014, which provided banks with funding for up to four years, were merely a precursor to what unfolded in 2015: the reduction of the deposit facility rate into negative territory (Evgenidis/Papadamou, 2020, 5684).

Beginning in 2015, the ECB significantly expanded its purchase of public sector assets (ibid, 2020, 5684). It was argued that the introduction of the purchase program would enable the ECB to achieve its primary objective of price stability. The ECB comments as follows:

> "[…] [a]sset purchases, also known as quantitative easing or QE, are one of the tools that we at the ECB use to support economic growth across the euro area and bring inflation to our 2% target." (ECB, 2016 b)

However, due to persistently low inflation rates, weak economic growth, and the purchase programs that had already been in place for years, some policymakers and researchers questioned whether these measures had any impact on the ECB's goals (Evgenidis/Papadamou, 2020, 5685).

The largest component of the APP was the PSPP (Public Sector Purchase Programme). It involved the purchase of bonds issued by European central governments, agencies, and institutions within the euro area. Despite the doubts mentioned, a press release from the ECB Governing Council on October 26, 2017, stated,

> "[…] [f]rom January 2018 the net asset purchases are intended to continue at a monthly pace of €30 billion until the end of September 2018, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim." (ECB, 2017)

In Frankfurt am Main, there was confidence that the measures would lead to the desired results, and it was believed that they simply needed to be sustained long enough to achieve the intended effect. The purchase of APP securities created new reserves within the euro area. Under these circumstances, not only reserves but also central bank and excess liquidity increased. For comparison, one can look at the development of central bank money (M0) in Figure 2.

> "At the end of 2020 monetary policy-related assets accounted for 79% of the total assets on the Eurosystem's balance sheet." (ECB, 2021)

At that time, the amount involved was 5.5 trillion euros (ibid). This amount did not even represent the peak of growth.

When looking at figure 2 one can see the drastic increase in base money since early 2020. The growth in money supply was in fact not only caused by the APP alone. On March 26th the pandemic emergency purchase programme (PEPP) was introduced. The PEPP included a total of 1,850 billion euros in purchases.

> "They were made to the extent deemed necessary and proportionate to counter the threats posed by the extraordinary economic and market conditions on the

ability of the Eurosystem to fulfil its mandate." (Deutsche Bundesbank, n.d., c)

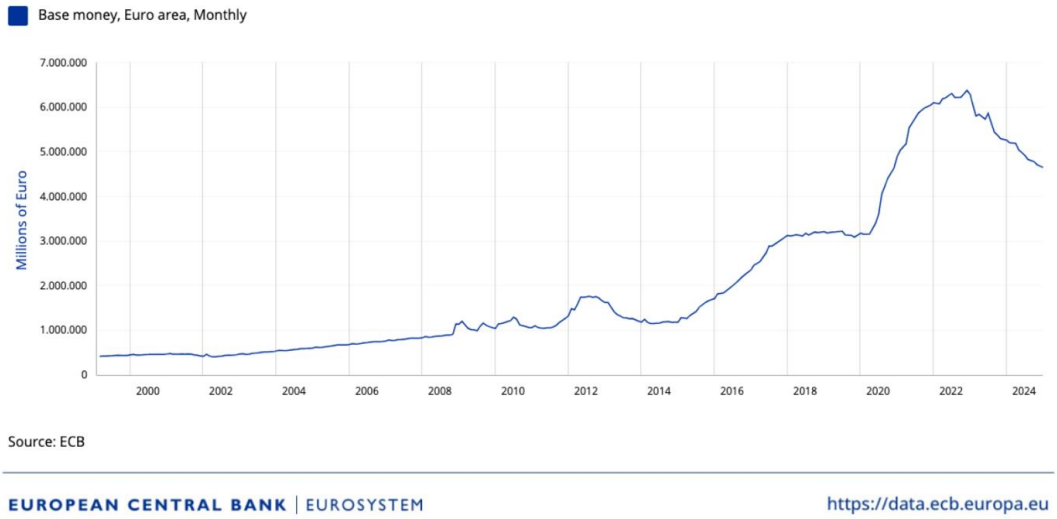

Figure 2: (ECB, n.d., f)

Figure 2 displays M0 also referred to as central bank money. It includes cash in circulation as well as the funds that commercial banks hold with the European Central Bank. It thus also reflects our excess reserves. M0 is also known as the "monetary base" (Deutsche Bundesbank, 2022, 73, a). As previously discussed, bank deposits at the central bank are particularly affected by asset purchases. In March 2015, the monetary base amounted to €1,273,080 million. By December 2022, it had increased to €6,296,159 million, nearly five times its 2015 value (ECB, n.d., f).

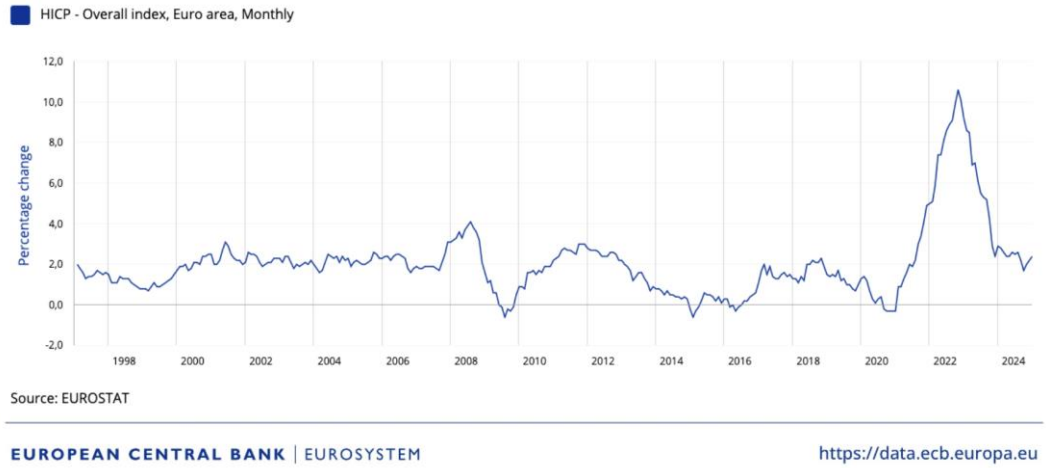

Figure 3: (ECB, n.d., a)

In the eurozone, not only had reserves increased, but inflationary pressures also began to emerge. As the pandemic gradually receded, prices started rising in January 2021, driven by

a combination of supply-side factors. By November of the same year, inflation had surged to 10.1%, the highest level recorded since the introduction of the euro (ECB, n.d., a). Policymakers and central bankers assured the public that every effort was being made to restore price stability. Indeed, by December 2024, inflation had declined to 2.4% (ibid), just 0.4 percentage points above the ECB's target inflation rate (cf. Figure 3). One might think that the damage caused by inflation has been averted, as the rate of price increases has almost returned to its previous level.

It is important to remember, however, that inflation is not an absolute figure but a rate of increase. Even when inflation declines, it merely indicates that the pace of price growth is slowing, not that prices themselves are falling.

III. METHOD

A. General Considerations

After first looking at the theoretical background of the transmission mechanisms of monetary policy followed by an analysis of liquidity developments in the euro area, we now turn to the heart of this paper. The key aspect of this investigation is whether the period of low interest rates has undermined the European Central Bank's ability to effectively lower inflation. We are therefore taking a closer look at the interest rate and bank lending channels and how interest rates, liquidity and Covid may have affected them.

Building on the analytical framework, the following section outlines the methodological approach used to empirically assess the impact of the above-described dynamics. By employing a t-test, we aim to evaluate whether and to what extent Covid-19 has affected the transmission mechanisms. Using multiple regression analysis, we evaluate the interrelationships among key economic variables and quantify the influence of monetary policy interventions on recent macroeconomic developments.

Our statistical tests conducted is based on figures 4. The graph visually represents the conventional theoretical relationships of the two key transmission mechanisms analysed in this thesis. They aim is to illustrate how monetary policy variables, such as key interest rates, money supply, and excess reserves, interact with macroeconomic indicators, including inflation, GDP, bank interest rates, and loans.

Furthermore, this framework is expanded by incorporating the economic effects of the Covid-19 crisis, highlighting its impact on the two transmission mechanisms. The visualization provides a structured overview of these relationships, helping to contextualize the statistical findings and assess how well theoretical expectations align with empirical results.

In addition of the theoretical relationships, the graph also includes the conventional theoretical correlations between the variables. They are indicated by the arrows and their respective positive or negative notion (green and red). The dashed arrows represent the effects of Covid-19. This approach is intended to help conceptualize the empirical findings

discussed later. By illustrating these relationships, we can assess whether the observed patterns align with conventional expectations or reveal anomalies.

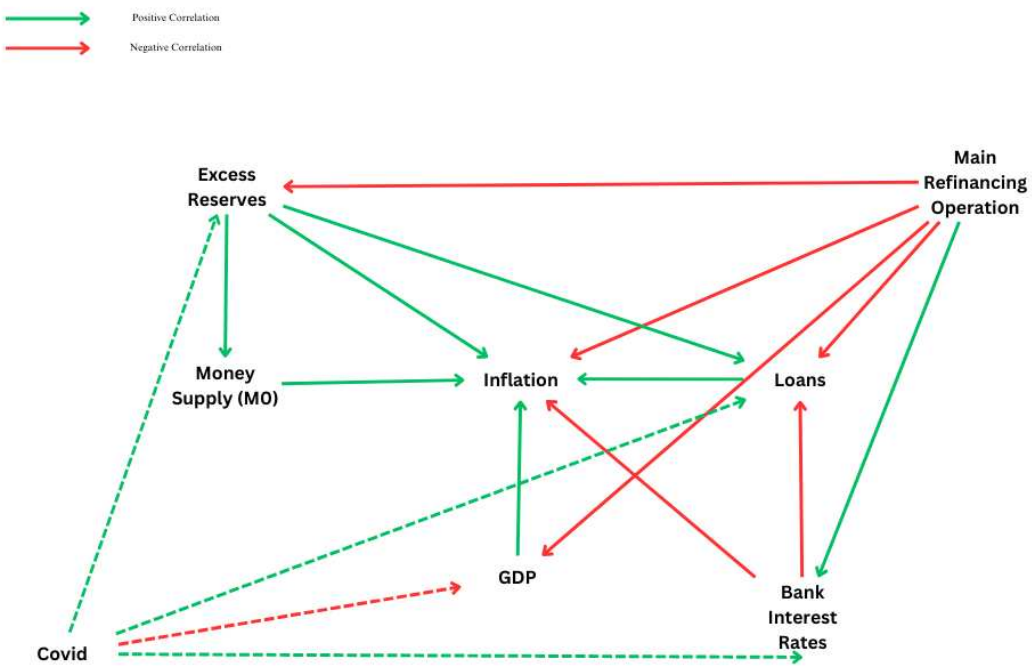

Figure 4: Conventional transmission mechanism and the Covid-19 influence

The T-tests conducted in this study are based on Figure 4. Each variable identified as being affected by Covid-19, according to the framework of this analysis, was subjected to a T-test to assess significant differences before and after the pandemic.

This paper also employs five OLS regression models, each designed to reflect the transmission mechanisms illustrated in Figure 4. In these models, every variable that has arrows pointing toward it serves as a dependent variable, while the variables from which the arrows originate act as independent variables. Since there are five variables receiving directional influences, we construct five distinct regression models, each capturing a different aspect of monetary transmission.

B. Data

The data used for this study was sourced entirely from the European Central Bank (ECB) Database**,** accessible via the following link: ECB Data Portal. The data was manually

collected through the ECB's online portal and organized into an Excel file for further processing. The variables used in the analysis include:

i. Main refinancing operations (MRO) (ECB, n.d., g).

Again, the main refinancing operations is one of the three key interest rates of the ECB. It is the rate banks pay when they borrow money from the ECB for one week (ECB,2018). For the purposes of this paper, we are examining this interest rate as it determines the cost at which banks obtain reserves. Its unit is percent per annum.

ii. Base Money (M0) (ECB, n.d., f).

Base Money consists of cash money and deposits of commercial banks with the ECB (Meyer, 2021, 19). It therefore is the total amount of money created by a central bank. Base money is measured in millions of euros. It corresponds to money supply (M0) in figure 4.

iii. Harmonized Index of Consumer Prices (HICP) (ECB, n.d., a).

The Harmonized Index of Consumer Prices is the reference of measurement for inflation. It "is a measure of how prices change over time" (ECB, n.d., h), and also compares how prices have changed over the period of one year. Inflation is being measured in percent per annum. It is represented in figure 4 as inflation.

iv. Total excess reserves of credit institutions subject to minimum reserve requirements in the euro area (ECB, n.d., b).

They represent the amount of account balances that exceed the minimum reserve requirements of national commercial banks (Deutsche Bundesbank, n.d., b). We measure them in millions of euros. This variable corresponds to excess reserves in figure 4.

v. Loans vis-a-vis euro area NFCs reported by MFIs excl. ESCB in the euro area (stocks) (ECB, n.d., i).

This term refers to the total amount of loans in millions of euros granted by monetary financial institutions (MFIs), such as commercial banks, savings banks, and other credit institutions, to non-financial corporations (NFCs) in the euro area, excluding loans issued by the European System of Central Banks (ESCB). It serves as an important indicator of corporate financing conditions, reflecting the extent to which private banks provide credit to businesses in the euro area economy. It is represented by loans in figure 4.

vi. Bank interest rates - loans to corporations of over EUR 1M with an IRF period of over three months & up to one year (new business) - euro area, Euro area (changing composition) (ECB, n.d., j).

These are interest rates applied by banks on loans exceeding EUR 1 million granted to corporations in the euro area. Those loans have an initial rate fixation period of more than three months but no longer than one year and are classified as new business, meaning they represent newly agreed loans rather than renegotiations or outstanding credit. They are measured in percent per annum and are corresponded to bank interest rates in figure 4.

vii. Gross domestic product at market prices (ECB, n.d., k), measured in millions of euros. The GDP is

"[…] the value of an economy's total output of goods and services less intermediate consumption, plus net taxes on products and imports." (ECB, n.d., l).

It is represented by GDP in figure 4.

C. Approach

To assess the impact of low interest rates on the effectiveness of the European Central Bank's monetary policy, we employ two key statistical methods: t-tests and Ordinary Least Squares (OLS) regression. These methods allow us to examine the effect of Covid-19 on the transmission channels and the relationships among key economic variables. This approach enables us to determine whether monetary policy interventions have had a significant effect on inflation and credit dynamics.

1. T-Tests

To determine whether significant differences exist between the pre-pandemic (2010 – March 2020) and post-pandemic (March 2020 – 2024) periods for the selected monetary and economic indicators, we conducted several paired T-test. The goal is to find whether the transmission of monetary policy was structurally altered by the macroeconomic disruptions and liquidity interventions that followed the Covid-19 crisis.

This method uses the mean values of two independent samples to check how the mean values of two basic quantities relate to each other. In our context it tests whether the mean values

of each variable differ systematically between the two periods, helping to assess structural changes in monetary transmission. A paired T-test follows the general form:

$$t = \frac{\overline{X_d}}{\frac{s_d}{\sqrt{n}}}$$

where:

$\overline{X_d}$ is the mean difference between pre- and post-pandemic observations for each variable
s_d is the standard deviation of the differences
n is the number of paired observations
t follows a student's t-distribution with $n - 1$ degrees of freedom.

The selection of variables for this test follows from their central role in the monetary transmission mechanism and their direct relationship with our regression models (figure 4; variables with dashed arrows). It should not be overlooked that Covid-19 directly influenced the main refinancing operations, which then impacted bank interest rates. However, due to data limitations, there were not enough data points to include the former variable explicitly in the dataset. Since, we are particularly interested in the effectiveness of monetary policy in influencing liquidity, credit supply, interest rates, and overall economic output, we focus on four key indicators:

i. Total Excess Reserves of Credit Institutions

ii. Loans to Non-Financial Corporations (NFCs)

iii. Bank Interest Rates loans to corporations of over EUR 1M with an IRF period of over three months & up to one year (new business) - euro area, Euro area (changing composition) (ECB, n.d., j).

iv. Gross Domestic Product (GDP) at Market Prices

To assess the persistence of these effects, the T-tests are conducted across three different time horizons (1-year, 2-year, and 3-year periods) following the pandemic onset. This approach allows us to distinguish between short-term disruptions and potential longer-term structural shifts in monetary transmission.

2. Ordinary Least Squares Regression (OLS)

The ordinary least squares regression is the standard mathematical method for balancing calculations to estimate the unknown parameters of a statistical model for a series of measurement data. The method is used to estimate the relationship between inflation and its potential determinants, such as interest rates, liquidity measures, and bank lending activity. By including multiple explanatory variables, we aim to isolate the effect of each factor while controlling for other influences. The general regression model can be expressed as:

$$Y_t = \alpha + \beta_1 X_{\{1t\}} + \beta_2 X_{\{2t\}} + \ \dots \ + \beta_n X_{\{nt\}} + \varepsilon_t$$

where:

Y_t	represents inflation (HICP) at time t_1
$X_{\{it\}},\ i = 1, 2, \dots, n$	are explanatory variables such as interest rates, base money, excess reserves, and loans
$\beta_i,\ i = 1, 2, \dots, n$	are the corresponding coefficients to be estimated
ε_t	is the error term

To assess whether the monetary transmission mechanism has changed over time, we divide the dataset into two distinct periods:

i. Pre-pandemic phase (2010 – March 2020)
ii. Post-pandemic phase (March 2020 – 2024)

The model described above is a level model**,** in which both the dependent and independent variables are used in their original, untransformed form. That means that raw values are directly modeled without any transformation. However, economic relationships are often not instantaneous**.** Changes in monetary policy, such as interest rate adjustments, typically take time to affect the real economy. To account for these delayed effects, this paper has also conducted OLS regressions with lagged variables for both periods. This allows us to capture the time it takes for monetary impulses to influence inflation, lending activity, and other key indicators. The regression model for lagged variables can be expressed as:

$$Y_t = \alpha + \beta_1 X_{1t} + \beta_2 X_{2t-1} + \beta_3 X_{3t-1} + \cdots + \beta_n X_{nt-k} + \varepsilon_t$$

where:

X_{it}	represents an independent variable measured at the current time t,

X_{it-1}	is a lagged variable that takes the value of the independent variable from the previous period $(t-1)$
X_{it-k}	a variable with a delay of k periods,
α	the intercept (constant term) and
ε_t	the error term

This study incorporates a one-month lag, as transmission mechanisms can take anywhere from one to several months (Deutsche Bundesbank, 2022). The choice of a one-month lag is primarily due to the limited time frame available for both regressions after the COVID-19 pandemic, covering only the period from March 2020 to December 2024.

By estimating two different regression models, one non-lagged and one lagged, separately for each period, we aim to identify structural changes in the relationships between key monetary variables. The segmentation into two time periods, which we also conducted for the lagged model, allows us to test whether the prolonged period of low interest rates before the pandemic influenced the effectiveness of monetary policy in controlling inflation after the crisis. The division at the time of March 2020 seemed logical for the division of the two periods, as the lockdowns that were introduced in many countries at that time led to an economic change.

Additionally, a comparison of the regression results across both periods will indicate whether the interest rate channel and bank lending channel, have weakened, remained stable, or adapted in response to the changing macroeconomic environment. The variables chosen in this study try to follow standard monetary transmission models as the reflect key components of both the interest rate and bank lending channel discussed in section II, A.
To ensure a comprehensive analysis of the interdependencies between monetary policy variables, we estimated additional regression models. These models examine how key monetary indicators influence one another, allowing us to assess indirect effects and potential feedback loops. By including models where excess reserves, GDP, loans, and bank interest rates serve as dependent variables, we aim to capture the broader transmission dynamics and interactions within the monetary system. Remember, each regression model for one dependent variable is based on the number of arrows pointing towards it from other variables. The t-tests orientate themselves on the arrows leaving Covid (figure 4).

IV. RESULTS

Bevor we can tell if the prolonged period of low interest rates had any effect on the effectiveness of the ECB's monetary policy in reducing inflation we need to assess the empirical findings of our analysis.

Prior to the Covid-19 pandemic, the euro area experienced a sustained phase of low interest rates, moderate inflation, and stable credit dynamics. However, in the wake of the pandemic, inflation skyrocketed, central banks modified their policy rates, and there were considerable changes to liquidity conditions. One must keep that on mind as we go on in presenting the empirical findings.

A. T-Test

The T-Test results are structured into a table (figure 5), summarizing the statistical comparison of key economic variables between the pre-pandemic (2010-March 2020) and post-pandemic (March 2020–2024) periods. To ensure a systematic and clear presentation, the analysis is divided into three accumulation periods: one, two, and three years before and after March 2020.

Period	Variable	t_stat	p_value
Accumulated 1 year(s)	Gross Domestic Product at market prices	2.429	0.093
Accumulated 1 year(s)	loans	-17.328	0
Accumulated 1 year(s)	bank_interest_rates	1.933	0.068
Accumulated 1 year(s)	excess_reserves	-4.909	0.001
Accumulated 2 year(s)	Gross Domestic Product at market prices	1.494	0.176
Accumulated 2 year(s)	loans	-19.688	0
Accumulated 2 year(s)	bank_interest_rates	3.649	0.001
Accumulated 2 year(s)	excess_reserves	-8.564	0.00000
Accumulated 3 year(s)	Gross Domestic Product at market prices	-0.220	0.829
Accumulated 3 year(s)	loans	-14.951	0
Accumulated 3 year(s)	bank_interest_rates	-1.727	0.093
Accumulated 3 year(s)	excess_reserves	-5.964	0.00000

Figure 5: Table 1

Table 1 provides an overview of the statistical measures: the t-statistic (t-Value), which quantifies the difference between the pre- and post-pandemic periods, and the p-value (p-

Value), which indicates whether these differences are statistically significant. A p-value below 0.05 suggests that the observed change has unlikely occurred by chance, indicating a statistically significant shift in economic conditions.

For the 1-year period, loans (p = 0) and excess reserves (p = 0.001) are significant. In the 2-year period, all variables apart from GDP (p = 0.176) are significant. Loans (p = o), bank interest rates (p = 0.001) and excess reserves (p = 0,000). In the 3-year period, loans (p = 0) and excess reserves (p = 0.000) are both significant.

B. OLS Regressions

Regression Results 2010–2020

	Dependent variable:				
	HICP	Excess Reserves	GDP	Loans	Bank Interest Rates
z_refinancing	0.144	-0.113***	-0.212***	1.024***	0.629***
	(0.278)	(0.025)	(0.054)	(0.077)	(0.048)
z_reserves	1.297***			0.080	
	(0.337)			(0.167)	
z_bank_rate	0.716***			0.109	
	(0.163)			(0.116)	
z_loans	0.731***				
	(0.238)				
z_gdp	0.191				
	(0.250)				
z_m0	-0.104	0.572***			
	(0.298)	(0.084)			
Constant	0.263	-0.252***	-0.751***	0.280**	0.718***
	(0.247)	(0.058)	(0.053)	(0.120)	(0.048)
Observations	23	69	24	64	69
R2	0.966	0.545	0.411	0.914	0.719
Adjusted R2	0.953	0.531	0.385	0.910	0.714
Residual Std. Error	0.266 (df = 16)	0.200 (df = 66)	0.257 (df = 22)	0.335 (df = 60)	0.401 (df = 67)
F Statistic	75.173*** (df = 6; 16)	39.512*** (df = 2; 66)	15.378*** (df = 1; 22)	212.448*** (df = 3; 60)	171.049*** (df = 1; 67)
Note:					*p<0.1; **p<0.05; ***p<0.01

Figure 6: Table 2

The regression results are going to be presented in four tables (figure 6,7,8 and 9), each corresponding to the lagged and non-lagged version and the two different periods analysed. That way we provide a clear and structured overview. The first two tables (figure 6 and 7), lagged and non-lagged, consist of the period from 2010 to March 2020. Figures 8 and 9 present the results for the post-pandemic phase (March 2020 – 2024). The tables aggregate the key statistical measures: coefficient estimates (Estimate), standard errors (Std. Error), t-values (t-Value), p-values (p-Value) for indicating statistical significance, and R-squared (R^2) for evaluating the explanatory power of each model. Note that the variables in figure

6,7,8, and 9 are named slightly different than in our model in figure 4. For clarification here are their correspondents:

i. z_hicp corresponds to inflation
ii. z_refinancing corresponds to main refinancing operations
iii. z_reserves corresponds to excess reserves
iv. z_bank_rates corresponds to bank interest rates
v. z_loans corresponds to loans
vi. z_gdp corresponds to gdp and
vii. z_m0 corresponds to money supply (m0)

Regression Results 2010–2020 (Lagged Variables)

	Dependent variable:				
	HICP	Excess Reserves	GDP	Loans	Bank Interest Rates
lag_z_refinancing	-0.068	-0.120***	-0.237***	1.050***	0.654***
	(0.361)	(0.025)	(0.057)	(0.077)	(0.045)
lag_z_reserves	1.048**			-0.085	
	(0.439)			(0.166)	
lag_z_bank_rate	0.585**			0.019	
	(0.212)			(0.115)	
lag_z_loans	0.979***				
	(0.309)				
lag_z_gdp	0.432				
	(0.325)				
lag_z_m0	-0.174	0.642***			
	(0.388)	(0.083)			
Constant	0.217	-0.195***	-0.719***	0.218*	0.695***
	(0.321)	(0.058)	(0.056)	(0.119)	(0.045)
Observations	23	64	25	64	70
R2	0.941	0.596	0.434	0.915	0.758
Adjusted R2	0.919	0.583	0.409	0.910	0.755
Residual Std. Error	0.346 (df = 16)	0.187 (df = 61)	0.280 (df = 23)	0.333 (df = 60)	0.376 (df = 68)
F Statistic	42.463*** (df = 6; 16)	45.021*** (df = 2; 61)	17.624*** (df = 1; 23)	214.057*** (df = 3; 60)	213.147*** (df = 1; 68)
Note:					*p<0.1; **p<0.05; ***p<0.01

Figure 7: Table 3

The adjusted R^2 values remain relatively stable across most models, suggesting that the introduction of one-month-lagged variables does not significantly alter the overall model fit. While the explanatory power for excess reserves, GDP, and bank interest rates slightly increases, it marginally decreases for inflation. Specifically, the adjusted R^2 for HICP declines from 0.953 to 0.919, whereas excess reserves improve from 0.531 to 0.583. Similarly, GDP exhibits a small increase from 0.385 to 0.409, while loans remain unchanged at 0.910. The explanatory power for bank interest rates also shows a slight improvement from 0.714 to 0.755.

For the second period the F-statistic remains highly significant in the two models, indicating that both specifications remain statistically valid. However, some variations emerge.

Regression Results 2020–2024

	Dependent variable:				
	HICP	Excess Reserves	GDP	Loans	Bank Interest Rates
z_refinancing	2.616	-0.864***	0.028	-0.348	0.598***
	(2.258)	(0.177)	(0.023)	(0.222)	(0.018)
z_reserves	-0.685			-0.075	
	(0.320)			(0.069)	
z_bank_rate	-5.250			0.456	
	(3.373)			(0.373)	
z_loans	2.358				
	(1.598)				
z_gdp	2.816				
	(5.013)				
z_m0	1.083	-0.400			
	(0.671)	(0.242)			
Constant	0.464	-0.681***	0.635***	0.463	0.895***
	(2.082)	(0.110)	(0.020)	(0.317)	(0.017)
Observations	8	18	8	17	27
R2	0.997	0.707	0.199	0.257	0.979
Adjusted R2	0.977	0.668	0.066	0.085	0.978
Residual Std. Error	0.139 (df = 1)	0.421 (df = 15)	0.055 (df = 6)	0.113 (df = 13)	0.090 (df = 25)
F Statistic	51.108 (df = 6; 1)	18.134*** (df = 2; 15)	1.493 (df = 1; 6)	1.498 (df = 3; 13)	1,156.072*** (df = 1; 25)
Note:					*p<0.1; **p<0.05; ***p<0.01

Figure 8: Table 4

Regression Results 2020–2024 (Lagged Variables)

	Dependent variable:				
	HICP	Excess Reserves	GDP	Loans	Bank Interest Rates
lag_z_refinancing	0.490	-0.009***	0.028	-0.162	0.516***
	(2.057)	(0.002)	(0.018)	(0.206)	(0.025)
lag_z_reserves	-0.397			0.066	
	(0.291)			(0.064)	
lag_z_bank_rate	-2.108			0.242	
	(3.071)			(0.344)	
lag_z_loans	2.516				
	(1.455)				
lag_z_gdp	-0.671				
	(4.565)				
lag_z_m0	0.526	0.004			
	(0.611)	(0.002)			
Constant	0.032	-1.053***	0.640***	0.773**	0.954***
	(1.896)	(0.001)	(0.018)	(0.293)	(0.025)
Observations	8	8	8	17	26
R2	0.998	0.980	0.293	0.275	0.948
Adjusted R2	0.983	0.972	0.176	0.108	0.945
Residual Std. Error	0.127 (df = 1)	0.001 (df = 5)	0.052 (df = 6)	0.104 (df = 13)	0.126 (df = 24)
F Statistic	69.444* (df = 6; 1)	123.433*** (df = 2; 5)	2.492 (df = 1; 6)	1.643 (df = 3; 13)	433.206*** (df = 1; 24)
Note:					*p<0.1; **p<0.05; ***p<0.01

Figure 9: Table 5

The adjusted R^2 remains relatively stable across them, indicating that the introduction of lagged variables does not drastically alter the overall model fit. While the explanatory power for excess reserves, GDP, and bank interest rates increases, it remains stable or slightly

decreases for inflation. Specifically, the adjusted R^2 for HICP increases from 0.977 to 0.983, while excess reserves improve from 0.668 to 0.972. Similarly, GDP exhibits a moderate increase from 0.066 to 0.176, and loans improve from 0.085 to 0.108. The explanatory power for bank interest rates decreases slightly from 0.978 to 0.945.

Beside others the OLS-Regressions have shown some important changes of the regimes in the observed period.

i. Interest (Refinancing) Rate Channel and Excess Reserves

2010–2020
Refinancing Rate and Excess Reserves = -0.113* ($p<0.01$)
Lagged Refinancing Rate and Excess Reserves = -0.120* ($p<0.01$)

2020–2024:
Refinancing Rate and Excess Reserves = -0.864* ($p<0.01$)
Lagged Refinancing Rate and Excess Reserves = -0.009* ($p<0.01$)

Before and after 2020, higher refinancing rates reduced excess reserves significantly. However, the effect is much stronger in the subsequent model (2020–2024), suggesting that banks responded immediately to rate hikes by reducing reserves.

ii. Refinancing Rate and Bank Interest Rates

2010–2020
Refinancing Rate and Bank Interest Rates = 0.629* ($p<0.01$)
lagged Refinancing Rate and Bank Interest Rates = 0.654* ($p<0.01$)

2020–2024:
Refinancing Rate and Bank Interest Rates = 0.598* ($p<0.01$)
Lagged Refinancing Rate and Bank Interest Rates = 0.516* ($p<0.01$)

The pass-through from ECB rates to bank interest rates remains highly significant and positive across all periods, confirming a strong transmission of monetary policy to borrowing costs.

iii. Refinancing Rate and Loans

2010–2020

Refinancing Rate and Loans = 1.024* (p<0.01)
Lagged Refinancing Rate and Loans = 1.050* (p<0.01)

2020–2024
Refinancing Rate and Loans = -0.348 (p>0.1)
Lagged Refinancing Rate and Loans = -0.162 (p>0.1)

Before and after 2020, rising interest rates coincided with an increase in loans, possibly due to QE and credit expansion policies. After 2020, this relationship turned negative but is not statistically significant, indicating a disrupted bank lending channel.

iv. Excess Reserves and Loans

2010–2020
Reserves and Loans = 0.080 (p>0.1)
Lagged Reserves and Loans = -0.085 (p>0.1)

2020–2024
Reserves and Loans = -0.075 (p>0.1)
Lagged Reserves and Loans = 0.066 (p>0.1)

Before and after 2020, the expected inverse relationship between reserves and loan issuance is not statistically significant in any period. This suggests that banks did not systematically convert reserves into loans in a predictable manner, particularly
post-2020.

There was a statistically significant increase in the (i) negative correlation of interest rate and excess reserves and the (ii) positive correlation of refinancing rate and bank interest rate.

Interest rate hikes, which reduce lending in a normal economic environment, led to its expansion here, as the banks shifted their liquidity from the central bank to the real economy, as they were able to pass on the higher interest rate to market participants. Inflation was not curbed in this way.

In this respect, it seems obvious that the period of low interest rates undermined the European Central Bank’s ability to effectively lower inflation in the post-COVID-19 economic environment. We assume that later investigations will confirm our findings – even though there are some limitations to consider.

V. DISCUSSION

A. Pre-Pandemic Period

We now have collected everything we need to make a well-founded assessment and evaluation of what has happened. We looked at how monetary policy affects the real economy via two transmission channels, we examined the economic and liquidity-related events after 2008 and, finally, we prepared our statistical tests. What can we conclude? What do the results of these tests tell us and how can they be classified or interpreted? Did the transmission mechanisms run smoothly? How might Covid have changed those? To assess these questions, the reader should bear in mind figure 4 from section III.

Let's start by examining how the transmission mechanisms of monetary policy worked in the period from 2010 to March 2020, which was characterized by extremely low interest rates. Therefore, we are going to have a closer look on our first regression where inflation (HICP) serves as the dependent variable.

This regression catches the eye due to the positive correlation between bank interest rates (bank loans) and inflation (HICP), a counterintuitive finding in this period. The relationship is significant in both models although slightly weaker in the lagged specification (figure 6: Estimate = 0.716, $p < 0.01$; figure 7: Estimate = 0.585, $p < 0.05$). These results display that the very relationship of both variables has reversed in this period. The bank lending channel experiences a significant change:

theoretical	$i_{bank} \uparrow \rightarrow$ bank deposits $\uparrow \rightarrow$ bank loans $\uparrow$
empirical	$i_{bank} \downarrow \rightarrow$ bank deposits $\uparrow \rightarrow$ bank loans $\uparrow$

It contradicts conventional monetary theory, which expects a negative relationship (figure 4), where higher interest rates should curb inflation rather than coincide with it. When interest rates rise, borrowing becomes more expensive, leading banks to reduce lending. As a result, investments decline due to higher financing costs, and liquidity in the economy contracts. With lower spending, aggregate demand decreases, prompting companies to slow price increases or even reduce prices. Consequently, inflation falls. Additionally, second-round effects, such as weaker wage growth, further reinforce this downward pressure on prices.

> "However, the prolonged period of low inflation and low interest rates in advanced economies following the global financial crisis appears to be inconsistent with this view." (Matheson, 2022, 255)

Its cause seems to be low interest rates. What happened? As of 2008 the European Central Bank kept lowering the main refinancing operations, and consequently bank interest rates, until they reached the zero lower bound (ZLB) (see figure 11).

> "The zero lower bound arises when a government issues pieces of paper (or coins) guaranteeing a zero nominal interest rate, over all horizons, that can be obtained in unlimited quantities in exchange for money in the bank. This acts as an interest rate floor, making people unwilling to lend at significantly lower rates." (Agarwal/Kimball, 2015, 3)

The issuance of paper money by central banks effectively establishes a zero nominal interest rate and acts as a lower limit for interest rates. At the ZLB central banks are unable to stimulate consumer spending by reducing interest rates because they are already at zero and individuals would choose to hold cash instead if the central bank was to lower the rates into negatives (ibid).

> "The zero lower bound (ZLB) for nominal interest rates constrains monetary policy responses to adverse shocks. This inability to stabilize the economy is a major concern of central bankers." (Aruoba/ Schorfheide, 2016, 1)

Moreover, abolishing cash and replacing it with sight deposits would extend the central bank's room for manoeuvring into negative interest rates, which savers would no longer be able to avoid.

At the ZBL traditional macroeconomic relations recede into the background and households and business expectations play a more critical role. If market consensus suggests that monetary policy has lost its ability to control inflation effectively, long-term inflation expectations may remain stable or even increase, despite low current inflation rates. Aruoba and Schorfheide found

> "[…] that the zero-interest-rate episodes in the U.S. […] and the Euro Area are associated with low inflation […]" (Aruoba and Schorfheide, 2016, 36).

As inflation fluctuated around 2% and occasionally turned negative (figure 3), key interest rates and consequently bank interest rates were gradually lowered to zero (figures 11 and

12). This shift disrupted the conventional relationship between these variables, as reflected in our regression results, where the link between key interest rates and bank interest rates remains strong (figure 6: Estimate = 0.629, $p < 0.01$; figure 7: Estimate = 0.654, $p < 0.01$). Wullweber (2020, 56) notes that

> "The control capacity of interest rates can be lost, when they come close to the zero lower bound." (2020, 56)

A further incident in the regression is expressed by the relationship between excess reserves (bank deposits) and inflation (HICP). The results display that while excess reserves were on the rise inflation was indeed influenced positively by this movement (figure 6: Estimate = 1.297, $p < 0.01$; figure 7: 1.048, $p < 0.05$). Also, the relationship between loans and inflation remains positive and statistically significant in both models, though slightly weaker in the lagged specification (figure 6: Estimate = 1.297, $p < 0.01$; figure 7: Estimate = 1.048, $p < 0.05$). Simultaneously, the main refinancing operations (i_{CB}) did not exhibit their expected negative influence on loans but instead, as both models indicate, the relationship remained positive (figure 6: Estimate = 1.024, $p < 0.01$; figure 7: Estimate = 1.050, $p < 0.01$). Here, we found a second contradiction to theory.

theoretical	$i_{CB} \uparrow \rightarrow$ bank deposits $\uparrow \rightarrow$ bank loans $\downarrow$
empirical	$i_{CB} \uparrow \rightarrow$ bank deposits $\uparrow \rightarrow$ bank loans $\uparrow$

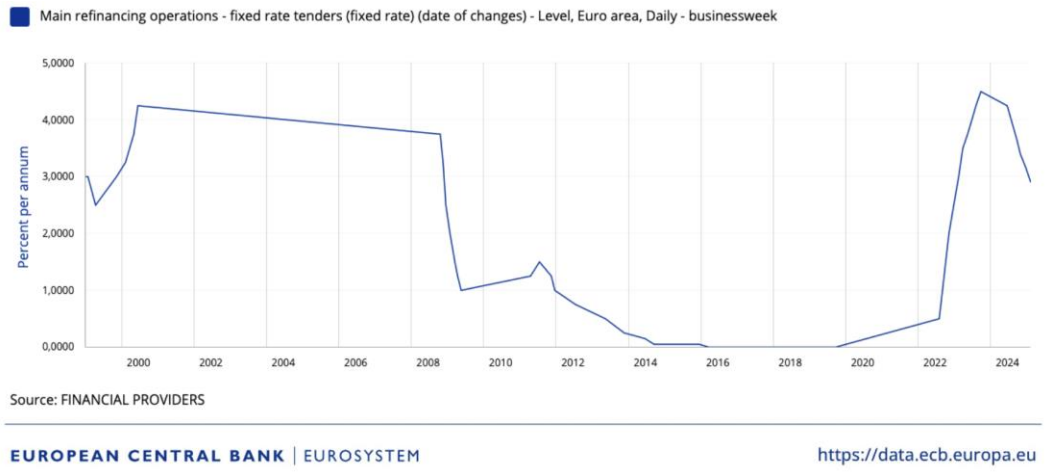

Figure 11 (ECB, n.d., g)

The loss of control capacity as Wullweber describes can be found in these results. Although, as shown in figure 4, main refinancing operations should have a negative impact on the granting of loans (red arrow), they obviously do not, at least in this period. Theoretically,

higher interest rates should reduce loan issuance by increasing borrowing costs and discouraging investment The mechanism was suspended, and loans were able to trigger a positive force on inflation (green arrow). Here we must attest a partial loss of functionality of the bank interest rate channel. We will discuss the immediate impact of credit on inflation shortly.

Apart from the findings discussed above other significant results do not violate the mode of action of their transmission mechanisms. The relationship between excess reserves and base money (M0) is positive and statistically significant in both models. In the non-lagged model, the estimate is 0.572 with a p-value of less than 0.01 (figure 6), while in the lagged model, the estimate strengthens to 0.642 with a p-value of less than 0.01 (figure 7). This result aligns with standard monetary theory, which suggests that an expansion of base money should lead to an increase in excess reserves within the banking system.

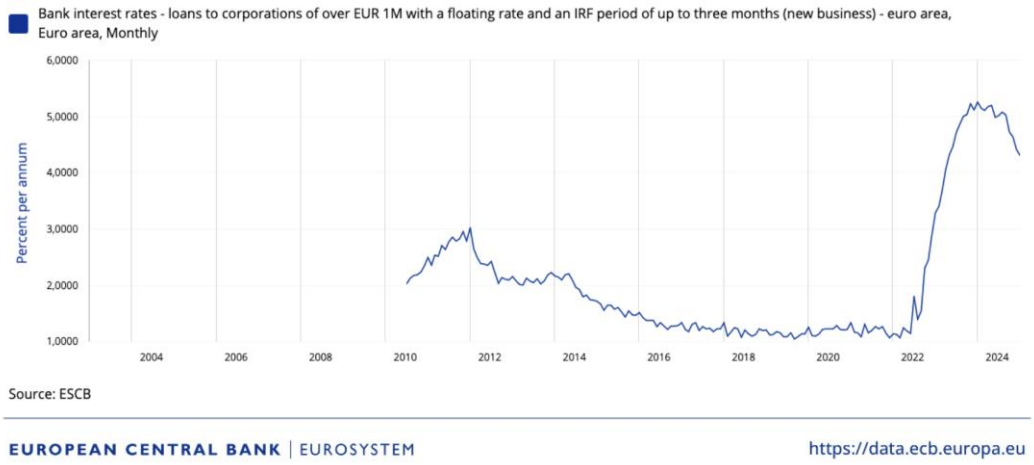

Figure 12 (ECB, n.d., j)

Similarly, the relationship between excess reserves and the main refinancing operations rate (MRO) exhibits a negative and statistically significant correlation in both models, supporting the idea that lower interest rates encourage liquidity accumulation in the banking system. In the non-lagged model, the estimate is -0.113 with a p-value of less than 0.01 (figure 6), and in the lagged model, it remains negative at -0.120 with a p-value of less than 0.01 (figure 7). This also is consistent with the conventional expectation that lower policy rates reduce the opportunity cost of holding excess reserves, leading banks to retain more liquidity.

The relationship between GDP and the refinancing rate remains in line with theoretical expectations, demonstrating a negative and statistically significant correlation in both models. The non-lagged model reports an estimate of -0.212 with a p-value of less than 0.01, while the lagged model shows a slightly stronger negative effect of -0.237 with a p-value of less than 0.01. This suggests that monetary policy still had an influence in economic activity as higher interest rates are supposed to suppress GDP.

The economic developments between 2010 and 2020 already foreshadowed the limitations of an ultra-loose monetary policy. The increasing buildup of excess reserves and the gradual weakening of transmission mechanisms resemble a coachman loosening the reins, allowing the horses to move freely without immediate consequence as Hans Werner Sinn a German economist and former president of the Ifo institute for economic research has put it. As long as the horses remain sluggish, the absence of control appears inconsequential. However, should an external shock, or even a mere shift in expectations, suddenly spur the system into motion, monetary policy, much like the coachman, may struggle to regain control.

The prolonged presence at the Zero Lower Bound (ZLB) embodies precisely this dilemma. It is not just a technical constraint but a liquidity trap, where excess reserves accumulate without immediately entering the real economy, yet remain a latent force waiting to be unleashed. As Sinn stresses his metaphor, a central bank in a liquidity trap is like a coachman holding a slack rope, it can tighten it by pulling, but it cannot push to generate inflation. This development can already be observed in the weakened effect of the key interest rate on loans as well as on the reversed effect of bank interest rates on inflation. Similarly, the ECB's extended period of low interest rates fostered an environment where inflationary pressures remained subdued for years. We will examine why the Covid-19 crisis is exactly such an external shock, which will alter economic conditions.

B. Pandemic Period

We shall now turn to the period of bolted horses so to speak. While we recorded a huge change in liquidity from 2010 to 2020, the tests we conducted, revealed quiet signs of change in the mechanisms of monetary transmission. The outbreak of the Covid-19 pandemic, the associated global lockdowns and the economic and monetary events were to cause the most

severe inflation in the Eurosystem since its inception. We want to take a closer look at what has happened since March 2020.
Therefore, we must focus on various developments that took place. As discussed in section II, A inflation began to rise in January 2021 and reached its peak with 10.1% in November 2022. What has sparked the flame of inflation?

Countering the spread of the coronavirus and preventing healthcare systems from being stretched beyond their limits, all eurozone countries sooner or later introduced national lockdowns from March 2020 onwards. Although preventing the spread of the virus, the lockdowns had far-reaching impact on the economy. In figure 4 we can observe the impact of Covid through the dashed arrows.

To check the effects of lockdowns on the economy, we must consult with the t-tests conducted for GDP. We find that there is a positive and insignificant t-statistic (2.429, 1.494 and -0.220) for GDP with p-values of 0.093, 0.176 and 0.829, respectively.

The consistent statistical insignificance for GDP suggests that any observed changes may be due to its quick recovery after the lockdowns hit rather than a lasting shift. After all, GDP growth recovered swiftly as can be seen in figure 13. Furthermore, the lack of a clear pattern in the t-statistics over time indicates that the economic impact of Covid-19 was largely short-lived. If the pandemic had caused deeper structural disruptions, we would expect the t-values to remain elevated or even increase, reflecting a protracted deviation from equilibrium. Instead, the results imply that GDP rebounded relatively quickly, showing no persistent effects from Covid-19 in the observed periods.

In any case, the GDP dip (figure 13), albeit brief, has had far-reaching consequences. That is for it can be seen as the spark that ignited inflation. Why is that one might ask. It is just a temporary dent which ultimately was balanced out rather quickly, and further growth even surpassed the level GDP had before Corona. The reason lies within the quantity theory of money and the transmission mechanism of both interest rate and bank lending channel.

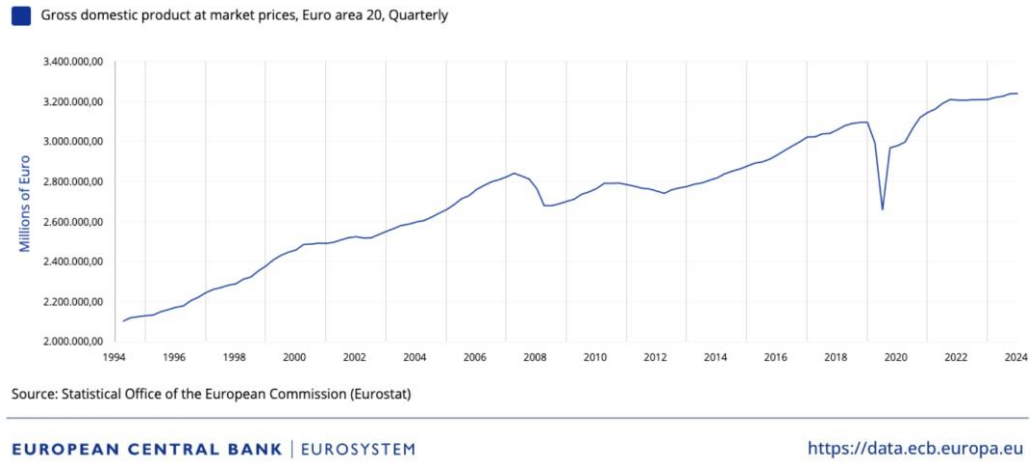

Figure 13: (ECB, n.d., k)

The quantity theory defines a long-term equilibrium between money supply and price level and describes the transition between two equilibria in such a way that the money supply determines the level prices have (Nietsch, 2005, 19). Short-term processes induce a constant adjustment process and stabilize the long-term equilibrium of money supply and price level, provided that the velocity of circulation of money is constant. It is the quotient of real output and real money supply (ibid.). What does this mean for inflation in the real economy?

The quantity theory explains inflation by comparing money and goods. If the supply of goods remains constant and the amount of money entering the economic cycle increases, the price level rises. Inflation therefore is always due to a supply of money that is higher than real economic growth (Siebke/Zumpfort, 1975, 526). More monetary units compete for the same goods in an economy. Every additional euro that comes into circulation and competes for the supply of goods exerts further pressure on prices and drives them up. The quantity equation displays the heart of the matter:

$$M \times V = P \times T$$

Money supply × Velocity of Circulation = Price Level × Transactions

With a constant velocity of money and constant transactions (quantity of goods), a growing money supply increases the price level. If the money supply remains constant and the velocity of circulation increases, the right-hand side of the equation must also rise to maintain an equilibrium. Ceteris paribus, this implies that either the price level (P) increases, leading to inflation, or the number of transactions (T) grows, indicating higher economic activity.

If you look at chart 13, you will see that the transaction (T) size did not grow but shrank during this period (dip in GDP growth). This was due to lockdowns. Since the ECB purchased large amounts of government bonds at the same time, the interest rates on sovereign debt remained artificially low. As a result, governments were able to borrow at low costs to finance economic stimulus programs and aid packages (e.g., short-time work schemes, corporate support measures).

That money thus entered the economic cycle. As long as it had stayed put on bank accounts the velocity of circulation was constant. That changed with the events discussed. The equation of the quantity theory was now distorted on both sides:

i. Money supply rose effectively as of the PEPP which enabled governments to be at debt (M ↑)

ii. The velocity of circulation rose as programs such as short time work benefits, corporate aid, and direct financial transfers to households, made liquidity available. With households and businesses spending these funds, the velocity of money circulation rose (V ↑)

iii. At the same time, transactions fell as economic output fell (T ↓).

A significantly increased money supply was now competing for a reduced supply of goods. The result can be observed when looking at inflation rates. From January 2021 onwards prices began to rise sharply (Figure 3) (ECB, n. d., a). The war in Ukraine cannot be blamed solely for this rise. As of February 2022, when war started, inflation had already been at 5.9% (ibid). The peak of inflation was going to be 10.6% in the eurozone as a whole. Before the outbreak of war, inflation had already reached more than half of its later maximum. Without a doubt, the war and issues with supply chains due to Covid-19 aggravated the further rise of inflation drastically.

When looking at figure 14, one must acknowledge that after the introduction of national lockdowns in 2020, loans initially increased until mid-2022 and have remained relatively stable since then. This observation stands in harmony to the t-test results, which indicate a statistically significant incline in loans over the post-Covid period (-17.328, -19.688, and -14.951) and p-values of 0, 0, and 0.

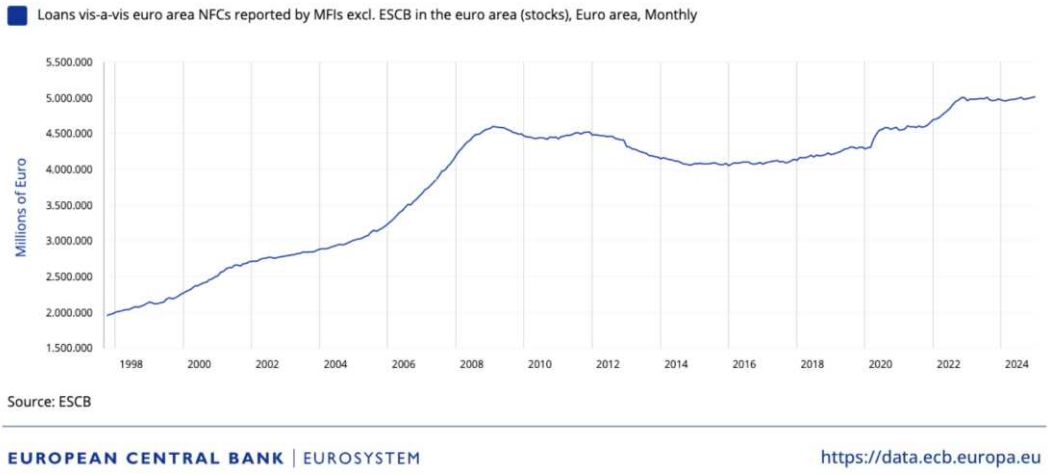

Figure 14: ECB (n.d., i)

This development is rather odd considering the increase in interest rates. As inflation was on the rise in the post-Covid environment the ECB increased its main refinancing operation to ease price pressure. Naturally, commercial banks followed and expanded their interest rates as well (bank interest rates) (figure 11, figure 12). We also find this relation in the OLS regression for the post-Covid timeframe. Here, the coefficient for main refinancing operations and bank interest rate is positive and significant (coefficient = 0.266, $p < 0{,}05$). Their rise led to a considerable rise in borrowing costs post-pandemic. As our t-tests demonstrate the development of loans is not random but certain, even though our regression does not provide a statistical relation.

theoretical	$i_{CB} \uparrow \rightarrow$ bank loans $\downarrow$
empirical	$i_{CB} \uparrow \rightarrow$ bank loans $\uparrow$

Still the absolute loan figures rose from 4,427,840 millions of euros in March 2020 to 5,024,459 millions of euros in December 2024 (ECB, n.d., i), despite the growing of interest rates. The ongoing increase in credit helped to expand money supply (M ↑), which affects the quantity equation of money as it puts upward pressure on price levels. Moreover, the continued expansion in credit indicates that the bank lending channel remained disturbed, as banks persisted in extending loans even under tightening monetary conditions. This apparent persistence in credit growth had undermined the contractionary effect of higher interest rates and, in turn, reinforce inflationary pressures on the economy. A probable explanation could be the reason these loans were issued. They were not used to expand business activities, but

rather required to cover fixed costs, as there was reduced business income during the lockdown (see figure 13).

Undeniably the accumulation of excess reserves prior to Covid-19 must be understood as an expansion in money supply. Their development can be seen in figure 1, where excess reserves (bank deposits) have been vanishing since June 2022 – from 3,888,344.50 million € in June to 4,904.64 million € in December 2024. An astonishing decrease. The large absolute t-statistics (-4.909, -8.564, and -5.964), which are significant for every period (p = 0.001, 0.000, and 0.000), indicate that the change in excess reserves is statistically robust and not due to random fluctuations. This confirms that the observed decline is a genuine structural shift, reflecting a deliberate contraction.

theoretical	bank deposits ↓ → bank loans ↑
empirical	bank deposits ↓ → bank loans ↑

The statistical findings (t-test) support empery and theory. Although our second-period regressions present hardly any significant explanation, a few important conclusions can be drawn from the t-tests. There seems to be a loose connection between excess reserves and loans. In any case, their rate of change is directly related to the corona shock, as the t-tests detected. As reserves diminished loans increased even though the central bank rose key interest rates.

It can be stated that under normal conditions, when an economy is facing inflation, central banks are well advised to raise interest rates. We witnessed, that these relationships may differ in times of abnormality. According to Fricke et al.

> "[…] the various quantitative easing (QE) policies that were implemented since the global financial crisis of 2008/09." (Fricke et al., 2024,1)

represent such a period. What influence could they have had?

In times of high excess reserves an increase in the main refinancing operation could cause the very contrary of what policymakers intended to achieve. That is because

> "[…] an increase in the reserve remuneration will boost net interest income." (ibid)

In such a scenario, banks that hold more reserves have an incentive to give out more loans. Fricke et al. found further, that

> "[…] when (i) the aggregate level of reserves is large and (ii) the interest on reserves increases materially, monetary policy transmission can vary across banks' level of excess reserves." (ibid.)

In the economic environment created by QE, a structure was reenforced that allowed banks to grant loans despite increasing interest rates. Reserve rich banks acted as a leak.

> "Based on the total outstanding pre-period credit volume of banks with reserve ratios above one standard deviation from the mean, this credit supply effect corresponds to between 0.16% and 0.28% of euro area GDP in 2022." (ibid, 3)

This is also displayed in the negative coefficient between excess reserves and the main refinancing operations (figure 8: Estimate = -0.864; figure 9: Estimate = 0.009) both positive. Banks were incentivized to redeploy these reserves rather than keep them. In other words, as interest rates rose, the opportunity cost of holding large reserves increased, pushing banks to convert these funds into loans or other assets. This structural shift suggests that the contraction in excess reserves was not random but a deliberate response to the changing monetary environment. We expected this negative correlation between excess reserves and the main refinancing operation in our model (figure 4).

Overall, what we see here is a severe damage of both the interest rate and bank lending channel. When the interest rate channel is impaired, it creates a problem for the velocity of money since this is the very mechanism that affects it. As interest rates increase, individuals are more inclined to put their money in banks instead of spending it. This process effectively extracts money from the immediate economic cycle, resulting in less money actively competing for the same quantity of goods and services and thereby putting downward pressure on prices. In this case, however, the anticipated effect is not as clearly observable as banks had an incentive to reduce reserves (relationship between reserves and main refinancing).

These findings bring us back to our coachman metaphor. The continuous accumulation of excess reserves can be likened to an increasingly loose grip on the reins. When Covid-19 struck and economic activity declined, the pressure on prices intensified, leading to a surge

in inflation. In our analogy, the horses suddenly took off. The ECB attempted to rein them in by rapidly increasing interest rates, but by then, the momentum had already built up. For a period, liquidity flowed into the real economy, amplifying inflationary pressures. The fact that excess reserves are continuously negative correlated with the key interest rate reinforces that suspicion. The money must have gone somewhere. The expected transmission effect – where tightening monetary policy would swiftly curb inflation – proved to be slower and less effective than anticipated.

The statistical results provide interesting insights but fall short of expectations in certain areas. While the conducted t-tests show strong significance, particularly regarding the changes in excess reserves and loan developments, the regressions for the 2020 – 2024 period could have revealed clearer patterns. Specifically, a more pronounced negative correlation between excess reserves and loans would have been desirable, as a decrease in reserves would typically be expected to coincide with increased lending. However, the regressions do not consistently show significant relationships in this regard. Likewise, we would have hoped for stronger confirmation of the mechanisms of the bank lending channel to more precisely illustrate the link between rising interest rates and the continued expansion of credit. This lack of clarity in the regression coefficients makes it more difficult to draw definitive conclusions.

VI. LIMITATIONS

While the findings of this study provided valuable insights into the dynamics of monetary transmission before and after the Covid-19 pandemic, several limitations must be acknowledged. They stem from various factors, including statistical constraints, structural shifts in monetary policy, and potential issues with model specification, among other influences that may have shaped the results.

A major difficulty in this analysis was differentiating between statistical significance and economic relevance. Although certain coefficients from the regression analysis do not reach conventional statistical significance thresholds ($p < 0.05$), they might still possess considerable economic relevance. In particular, coefficients that have the anticipated signs and reasonable magnitudes indicate that economic relationships may exist, even if strong statistical confirmation is hindered by the sample size or variability. This holds particular significance in monetary economics, where transmission effects frequently develop over long durations and may escape full capture complete in short-term statistical models. The absence of statistical significance therefore does not mean that an effect is non-existent. The accuracy of the estimates may have been affected by several factors, including:

i. Multicollinearity
When independent variables exhibit a high degree of correlation, it becomes challenging isolating their distinct effects.

ii. Omitted Variables
The model does not take into account some factors that can nevertheless have an impact on inflation, lending and liquidity, such as fiscal policy, supply chain disruptions or geopolitical risks.

iii. Sample Size and Variance
The post-Covid-19 period was characterized by high volatility, which may leave to greater standard errors in the estimates and complicates the detection of statistically significant relationships.

iv. Structural Breaks
The pandemic, quantitative easing and the transition from negative to positive interest rates created structural changes that may have altered the nature of economic relationships to such an extent that direct comparisons between the periods before and after the pandemic appear distorted.

The findings of this paper suggest the potential existence of an underlying economic relationship that warrants further examination, despite the small number of observations for the COVID period. Therefore, future research could:

i. broaden the time frame to include delayed impacts of monetary policy, since transmission mechanisms do not always function immediately,

ii. utilize alternative data sources for cross-validation of findings, including lending data at the firm level or patterns of household consumption and/or

iii. utilize various econometric methods, including vector autoregression (VAR) or instrumental variable (IV) approaches, to conduct a more thorough examination of causality.

One key limitation of this study is the relatively short lag structure, which considers only a one-month delay in the transmission of monetary policy effects. This choice was primarily driven by the limited sample period from 2020 to 2024, which restricts the ability to incorporate longer lags without significantly reducing the number of available observations. However, monetary transmission often unfolds over a more extended period, and the true effects of changes in excess reserves, credit supply, and liquidity conditions may become evident only after several months. Future research could expand the lag structure beyond one month to better capture the delayed effects of monetary policy adjustments, particularly in an environment of heightened uncertainty and structural shifts.

The timeframe examined in this research was characterized by extraordinary external shocks, such as the Covid-19 pandemic, extensive government interventions, and the war in Ukraine. The events have led to unique distortions that can hardly be completely isolated in a statistical model. The study considers broad monetary trends, but it does not explicitly control for fiscal stimulus programs, supply chain disruptions, or changes in inflation expectations. Consequently, certain observed relationships might be affected by these external factors instead of being influenced solely by monetary transmission mechanisms. The limitations underscore how complicated it is to evaluate the effectiveness of monetary policy in environments that are extraordinarily dynamic. Nonetheless, our results indicate significant economic trends and provide a robust basis for additional inquiry into the changing function of monetary policy in the post-pandemic era.

Furthermore, they contribute to a wider debate regarding the post-Covid-19 effectiveness of the ECB's monetary policy. Ultimately, the study underscores the need for a nuanced interpretation of statistical results, considering both their economic implications and the broader monetary policy environment. The evidence suggests that monetary transmission was not functioning as expected in the post-pandemic period, raising important questions about the ECB's policy toolkit and its ability to control inflation in future crises.

VII. CONCLUSION

This study shows that the monetary policy transmission mechanism of the European Central Bank was weakened in the periods examined. It thus joins a wider range of research studies that present similar findings. For example, Fricke et al. (2024) or Wullweber (2020) emphasize that the period of excessive liquidity provision in combination with a long period of low interest rates significantly distorted the monetary transmission mechanisms. Nevertheless, our results should be interpreted with caution. On one hand, they are subject to statistical limitations and, on the other, the results are not statistically significant. Nevertheless, they point in a clear direction:

> Yes, the period of low interest rates in the post-COVID-19 economic environment has undermined the European Central Bank's ability to effectively reduce inflation.

This is for two major reasons. First, the unusually positive correlation between inflation and the key interest rate in the pre-pandemic period is striking. It seems even without the presents of major economic disruptions, that basic mechanisms were disturbed. This is due to the closeness of interest rates to the zero lower bound and the build-up of excess reserves. The developments are reminiscent of a crossbow that has already been drawn, ready to strike.
Second, we find empirically that even though the European Central Bank increased the key interest rates to put the economy at ease, loans did not shrink putting further pressure on prices. That was, in part, because of the heterogenic distribution of reserves making it more attractive for banks to hold them. As a result, the newly created liquidity found its way into the real economy. The crossbow was fired.

Aside from the core question, this study raises concerns about the role of the ECB in facilitating cheap government debt. The ability of European governments to finance themselves with historically low interest rates has led to an expansionary fiscal policy in almost every member state. Yes, debts are an economic tool to boost investments but to this extent they raise question about fairness between generations. Debt-financed spending must not become a mechanism for shifting financial burdens onto future generations who had no say in their creation. This principle of fiscal responsibility, often referred to as the "principle of causation", suggests that those who incur debt should also bear the responsibility of repaying it, rather than passing it on indefinitely. However, the European Court of Justice

(ECJ) has ruled differently. It has decided that the ECB's Public Sector Purchase Programme (PSPP) falls within its mandate.

A look at the Federal Reserve in the United States reveals a crass contrast in the behaviour of the Americans as the Fed does not purchase state securities in the same way (Sinn, 2014, 37).

> "So, if California is bankrupt – and it is on the verge of bankruptcy – then the Fed will not buy California government bonds. The same applies to Minnesota and Illinois, which are in a similar situation." (ibid.)

The FED does not act as a backstop for its federal states when they take on debt.

The consequence of this relationships has raised concerns among top economists and former policymakers long before Covid-19. In October 2019 six highly respected central bankers, including Otmar Issing, former member of the ECB's Executive Board, and Klaus Liebscher, former governor of the Austrian National Bank, signed the *Memorandum on the ECB`s monetary policy* (Hannoun et al., 2019) expressing their deep concern over the ECB's ultra-accommodative monetary policy, which they argued was becoming increasingly problematic (ibid.). Anyone who wanted to see the inflation coming could. The heralds were unmistakable.

Looking ahead, stricter adherence to the fiscal criteria of the Maastricht Treaty is imperative. It mandates that euro area member states must not increase their annual debt by more than 3% of their GDP and total debt must be kept below 60% of it (Bundesministerium der Finanzen, n.d.). However, these limits are generously ignored. As of 2024, 16 eurozone countries exceed the Maastricht debt threshold (Statista, 2024). If these fundamental fiscal rules continue to be disregarded, the treaty itself risks becoming obsolete. Expanding government demand through central bank interventions without simultaneously ensuring that the supply side of the economy adjusts accordingly creates long-term distortions.
Finally, one has to keep in mind that the decision to raise interest rates must not be taken lightly. The entire economy is linked to the central bank's policy rates. Planning security, credit markets and investment decisions across all sectors are depended on the key interest rate. Fighting inflation comes at a significant economic cost, reducing overall prosperity and disrupting financial stability.

Nevertheless, governments in Europe are pursuing a demand policy of cheap money. If prices rise, they simply fire up the “printing press” in Frankfurt and transfer money to citizens from what is euphemistically known as an “extraordinary budget” or “special fund”. However, the freshly printed money does nothing to change the supply shortage or the war in Ukraine. Money alone does not make anyone richer – it is the availability of additional goods and services that enriches a society.

There should be a rethink towards a supply-oriented policy. If the barrel is empty, Ms. Lagarde's banknotes won't help. The barrel remains empty. Only work (in the vineyard) will fill it again.

VIII. APPENDIX

A. Codes

1. *T-Test*

```r
# Load necessary libraries
library(dplyr)
library(lubridate)
library(readxl)

# Load the data using an absolute path
df <- read_excel("/Users/clemensborn/Desktop/Master_Thesis /Excel/DatahouseII_Transposed_Format.xlsx")

# Convert the Date column to Date format
df$Date <- as.Date(df$Date)

# Define the COVID onset date
covid_start <- as.Date("2020-03-01")

# Define a function to filter and aggregate data (accumulated)
filter_and_aggregate_accumulated <- function(data, covid_start, years) {
  pre_covid <- data %>%
    filter(Date >= covid_start - years(years) & Date < covid_start)

  post_covid <- data %>%
    filter(Date >= covid_start & Date < covid_start + years(years))

  list(pre = pre_covid, post = post_covid)
}

# Variables for analysis
variables <- c("Gross Domestic Product at market prices", "loans",
               "bank_interest_rates", "excess_reserves")

# Define periods (1 year, 2 years, 3 years)
periods <- c(1, 2, 3)

# Initialize a results data frame
results <- data.frame(Period = character(),
                      Variable = character(),
                      t_stat = numeric(),
                      p_value = numeric(),
                      stringsAsFactors = FALSE)

# Loop through periods and variables to perform t-tests
for (p in periods) {
  # Get accumulated data for each period
  data_period <- filter_and_aggregate_accumulated(df, covid_start, p)

  for (var in variables) {
    if (var %in% names(data_period$pre) && var %in% names(data_period$post)) {
      pre_values <- data_period$pre[[var]]
      post_values <- data_period$post[[var]]

      if (length(pre_values) > 1 && length(post_values) > 1) {
        t_test <- t.test(pre_values, post_values, na.rm = TRUE)

        results <- rbind(results, data.frame(
          Period = paste0("Accumulated ", p, " year(s)"),
          Variable = var,
          t_stat = t_test$statistic,
          p_value = t_test$p.value
        ))
      }
    }
  }
}

# Print the results
print(results)
```

2. *Regression Models*

```r
# Load necessary libraries
library(tidyverse)
library(readxl)

# Load the dataset
data <- read_excel("Desktop/Master_Thesis /Excel/DatahouseII_Transposed_Format.xlsx")

# Convert Date to a proper date format
data$Date <- as.Date(data$Date, format = "%Y-%m-%d")

# Rename columns to avoid spaces
data <- data %>%
  rename(
    refinancing = main_refinancing_operations,
    hicp = hicp,
    reserves = excess_reserves,
    bank_rate = bank_interest_rates,
    loans = loans,
    gdp = `Gross Domestic Product at market prices`,
    m0 = m0
  )

# Replace 0s with NA in relevant columns
data <- data %>%
  mutate(across(c(refinancing, hicp, reserves, bank_rate, loans, gdp, m0), ~ replace(., . == 0, NA)))

# Filter data for the period 2010-2020
```

```r
# Perform all regression analyses

# For 2010-2020
model_2010_2020_hicp <- lm(z_hicp ~ z_refinancing + z_reserves + z_bank_rate +
                           z_loans + z_gdp + z_m0, data = data_2010_2020)
model_2010_2020_reserves <- lm(z_reserves ~ z_m0 + z_refinancing, data = data_2010_2020)
model_2010_2020_gdp <- lm(z_gdp ~ z_refinancing, data = data_2010_2020)
model_2010_2020_loans <- lm(z_loans ~ z_bank_rate + z_reserves + z_refinancing, data = data_2010_2020)

# For 2020-2024
model_2020_2024_hicp <- lm(z_hicp ~ z_refinancing + z_reserves + z_bank_rate +
                           z_loans + z_gdp + z_m0, data = data_2020_2024)
model_2020_2024_reserves <- lm(z_reserves ~ z_m0 + z_refinancing, data = data_2020_2024)
model_2020_2024_gdp <- lm(z_gdp ~ z_refinancing, data = data_2020_2024)
model_2020_2024_loans <- lm(z_loans ~ z_bank_rate + z_reserves + z_refinancing, data = data_2020_2024)

# Print summaries for all models

# 2010-2020 models
print("Regression for 2010-2020: HICP")
summary(model_2010_2020_hicp)

print("Regression for 2010-2020: Excess Reserves")
summary(model_2010_2020_reserves)

print("Regression for 2010-2020: GDP")
summary(model_2010_2020_gdp)

print("Regression for 2010-2020: Loans")
summary(model_2010_2020_loans)

# 2020-2024 models
print("Regression for 2020-2024: HICP")
summary(model_2020_2024_hicp)

print("Regression for 2020-2024: Excess Reserves")
summary(model_2020_2024_reserves)

print("Regression for 2020-2024: GDP")
summary(model_2020_2024_gdp)

print("Regression for 2020-2024: Loans")
summary(model_2020_2024_loans)
```

```r
# Install stargazer if it is not already installed
# install.packages("stargazer")

# Load the stargazer package
library(stargazer)

# Generate a table for the 2010-2020 models
stargazer(model_2010_2020_hicp,
          model_2010_2020_reserves,
          model_2010_2020_gdp,
          model_2010_2020_loans,
          model_2010_2020_bank_rate,
          title = "Regression Results 2010-2020",
          dep.var.labels = c("HICP", "Excess Reserves", "GDP", "Loans", "Bank Interest Rates"),
          model.numbers = FALSE,
          type = "text",
```

```r
# Load necessary libraries
library(tidyverse)
library(readxl)

# Load the dataset
data <- read_excel("Desktop/Master_Thesis /Excel/DatahouseII_Transposed_Format.xlsx")

# Convert Date to a proper date format
data$Date <- as.Date(data$Date, format = "%Y-%m-%d")

# Rename columns to avoid spaces
data <- data %>%
  rename(
    refinancing = main_refinancing_operations,
    hicp = hicp,
    reserves = excess_reserves,
    bank_rate = bank_interest_rates,
    loans = loans,
    gdp = `Gross Domestic Product at market prices`,
    m0 = m0
  )

# Replace 0s with NA in relevant columns
data <- data %>%
  mutate(across(c(refinancing, hicp, reserves, bank_rate, loans, gdp, m0), ~ replace(., . == 0, NA)))

# Filter data for the period 2010-2020
data_2010_2020 <- data %>%
  filter(Date >= as.Date("2010-01-01") & Date <= as.Date("2020-03-31"))

# Filter data for the period 2020-2024
data_2020_2024 <- data %>%
  filter(Date >= as.Date("2020-04-01") & Date <= as.Date("2024-12-31"))

# Normalize the data
normalize <- function(df) {
  df %>%
    mutate(across(
      c(refinancing, hicp, reserves, bank_rate, loans, gdp, m0),
      ~ (. - mean(., na.rm = TRUE)) / sd(., na.rm = TRUE),
      .names = "z_{col}"
    ))
}
```

```r
data_2010_2020 <- normalize(data_2010_2020)
data_2020_2024 <- normalize(data_2020_2024)

# Ensure data is sorted by Date (important for proper lagging)
data_2010_2020 <- data_2010_2020 %>% arrange(Date)
data_2020_2024 <- data_2020_2024 %>% arrange(Date)

# Create lagged independent variables (with a 1-month lag)
lag_vars <- c("refinancing", "reserves", "bank_rate", "loans", "gdp", "m0")
data_2010_2020 <- data_2010_2020 %>%
  mutate(across(
    all_of(paste0("z_", lag_vars)),
    ~ lag(.x, n = 1),
    .names = "lag_{col}"
  ))
data_2020_2024 <- data_2020_2024 %>%
  mutate(across(
    all_of(paste0("z_", lag_vars)),
    ~ lag(.x, n = 1),
    .names = "lag_{col}"
  ))

# Perform all regression analyses with a 1-month lag in the independent variables

# For 2010-2020
model_2010_2020_hicp <- lm(z_hicp ~ lag_z_refinancing + lag_z_reserves + lag_z_bank_rate +
                             lag_z_loans + lag_z_gdp + lag_z_m0, data = data_2010_2020)
model_2010_2020_reserves <- lm(z_reserves ~ lag_z_m0 + lag_z_refinancing, data = data_2010_2020)
model_2010_2020_gdp <- lm(z_gdp ~ lag_z_refinancing, data = data_2010_2020)
model_2010_2020_loans <- lm(z_loans ~ lag_z_bank_rate + lag_z_reserves + lag_z_refinancing, data = data_2010_2020)
model_2010_2020_bank_rate <- lm(z_bank_rate ~ lag_z_refinancing, data = data_2010_2020)

# For 2020-2024
model_2020_2024_hicp <- lm(z_hicp ~ lag_z_refinancing + lag_z_reserves + lag_z_bank_rate +
                             lag_z_loans + lag_z_gdp + lag_z_m0, data = data_2020_2024)
model_2020_2024_reserves <- lm(z_reserves ~ lag_z_m0 + lag_z_refinancing, data = data_2020_2024)
model_2020_2024_gdp <- lm(z_gdp ~ lag_z_refinancing, data = data_2020_2024)
model_2020_2024_loans <- lm(z_loans ~ lag_z_bank_rate + lag_z_reserves + lag_z_refinancing, data = data_2020_2024)
model_2020_2024_bank_rate <- lm(z_bank_rate ~ lag_z_refinancing, data = data_2020_2024)
```

```r
# Print summaries for all models

# 2010-2020 models
print("Regression for 2010-2020: HICP")
summary(model_2010_2020_hicp)

print("Regression for 2010-2020: Excess Reserves")
summary(model_2010_2020_reserves)

print("Regression for 2010-2020: GDP")
summary(model_2010_2020_gdp)

print("Regression for 2010-2020: Loans")
summary(model_2010_2020_loans)

print("Regression for 2010-2020: Bank Interest Rates")
summary(model_2010_2020_bank_rate)

# 2020-2024 models
print("Regression for 2020-2024: HICP")
summary(model_2020_2024_hicp)

print("Regression for 2020-2024: Excess Reserves")
summary(model_2020_2024_reserves)

print("Regression for 2020-2024: GDP")
summary(model_2020_2024_gdp)

print("Regression for 2020-2024: Loans")
summary(model_2020_2024_loans)

print("Regression for 2020-2024: Bank Interest Rates")
summary(model_2020_2024_bank_rate)
```

```r
# Install stargazer if it is not already installed
# install.packages("stargazer")

# Load the stargazer package
library(stargazer)

# Generate a table for the 2010-2020 models (with 1-month lag)
stargazer(model_2010_2020_hicp,
          model_2010_2020_reserves,
          model_2010_2020_gdp,
          model_2010_2020_loans,
          model_2010_2020_bank_rate,
          title = "Regression Results 2010-2020 (Lagged Variables)",
          dep.var.labels = c("HICP", "Excess Reserves", "GDP", "Loans", "Bank Interest Rates"),
          model.numbers = FALSE,
          type = "text",
          digits = 3)

# Generate a table for the 2020-2024 models (with 1-month lag)
stargazer(model_2020_2024_hicp,
          model_2020_2024_reserves,
          model_2020_2024_gdp,
          model_2020_2024_loans,
          model_2020_2024_bank_rate,
          title = "Regression Results 2020-2024 (Lagged Variables)",
          dep.var.labels = c("HICP", "Excess Reserves", "GDP", "Loans", "Bank Interest Rates"),
          model.numbers = FALSE,
          type = "text",
          digits = 3)
```

B. Literature

Agarwal, Ruchir, Miles Kimball (2015): Breaking through the Zero Lower Bound. *IMF Working Papers*. International Monetary Found. https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Breaking-Through-the-Zero-Lower-Bound-43358

Aruoba, Boragan, Frank Schorfheide (2016): Inflation During and After the Zero Lower Bound. National Bureau of Economic Research. https://www.kansascityfed.org/Jackson%20Hole/documents/7073/aruoba_schorfheide_JH 2015.pdf

https://www.bundesbank.de/de/publikationen/forschung/research-brief/2016-08-interbankenmarkt-deutschland-krise-729456

Bernanke, Ben. S., Alan S. Blinder (1992): The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review 82(4), 901-921*. https://www.jstor.org/stable/2117350

Boivin, Jean, Michael T. Kiley, Frederic C. Mishkin (2010): How has the monetary transmission mechanism evolved over time? *Finance and Economics Discussion Series No. 2010-26*. Board of Governors of the Federal Reserve System. https://www.federalreserve.gov/pubs/feds/2010/201026/201026pap.pdf

Bucher, Monika, Ulrike Neyer (2014): Der Einfluss des (negativen) Einlagesatzes der EZB auf die Kreditvergabe im Euroraum. *Ordnungspolitische Perspektiven*. Düsseldorf

Bucher, Monika, Achim Hauck, Ulrike Neyer (2020): Interbank market friction- induced holdings of precautionary liquidity: implications for bank loan supply and monetary policy implementation. *Econ Theory 70 (Juli), 165-222*. Heidelberg

Bundesfinanzministerium (n.d.): *Leitzinsen.* https://www.bundesfinanzministerium.de/Content/DE/Glossareintraege/L/leitzinsen.html?view=renderHelp

Bundesministerium der Finanzen (n.d.): *Fiskalregeln.* https://www.bundesfinanzministerium.de/Web/DE/Themen/Oeffentliche_Finanzen/Stabilitaetspolitik/Fiskalregeln/fiskalregeln.html

Constâncio, Vítor (2014): Recent challenges to monetary policy in the euro area. Speech at the Athens Symposium on Banking Union, Monetary Policy and Economic Growth, Athens, 19. June 2014.

https://www.ecb.europa.eu/press/key/date/2014/html/sp140619.en.html

Deutsche Bundesbank (n. d., a): Minimum reserves.
https://www.bundesbank.de/en/tasks/monetary-policy/minimum-reserves/minimum-reserves-625912

Deutsche Bundesbank (n. d., b): Excess reserves and excess liquidity. https://www.bundesbank.de/en/tasks/monetary-policy/excess-reserves/excess-reserves-and-excess-liquidity--889952

Deutsche Bundesbank (n.d., c): Pandemic emergency purchase programme (PEPP). https://www.bundesbank.de/en/tasks/monetary-policy/outright-transactions/pandemic-emergency-purchase-programme-pepp--831136

Deutsche Bundesbank (2014): Implications of the Eurosystem's monetary operations during the financial crisis. https://www.bundesbank.de/resource/blob/626132/7f833aa77c08128859af4b36be602bfc/mL/2014-04-monetary-operations-data.pdf

Deutsche Bundesbank (2022, a): Geld und Geldpolitik. https://www.bundesbank.de/resource/blob/606038/b481a5a4c7c3df8608802fcc212004d2/mL/geld-und-geldpolitik-data.pdf

Deutsche Bundesbank (2022, b): Das Wechselkurssystem ist wichtig für die Effekte der Bundesbank-Geldpolitik auf europäische Nachbarländer von 1974 bis 1998. *Research Brief* https://www.bundesbank.de/de/publikationen/forschung/research-brief/2022-54-wechselkurssystem-geldpolitik-662662

European Central Bank (n.d., a): HICP – overall index, Euro area (changing composition), Monthly. *ECB Data Portal.*
https://data.ecb.europa.eu/data/datasets/ICP/ICP.M.U2.N.000000.4.ANR

European Central Bank (n.d., b): Total excess reserves of credit institutions subject to minimum reserve requirements in the euro area, Euro area (changing composition), Monthly. *ECB Data Portal.* https://data.ecb.europa.eu/data/datasets/BSI/BSI.M.U2.N.R.LRE.X.1.A1.3000.Z01.E

European Central Bank (n.d., d): Open market operations. https://www.ecb.europa.eu/mopo/implement/omo/html/index.en.html

European Central Bank (n.d., e): Asset purchase programmes. https://www.ecb.europa.eu/mopo/implement/app/html/index.en.html

European Central Bank (n.d., f): Base money, Euro area (changing composition), Monthly. *ECB Data Portal.*
https://data.ecb.europa.eu/data/datasets/ILM/ILM.M.U2.C.LT00001.Z5.EUR

European Central Bank (n. d., g): Main refinancing operations – fixed rate tenders (fixed rate) (date of changes) – Level, Euro area (changing composition), Daily – businessweek. *ECB Data Portal.* https://data.ecb.europa.eu/data/datasets/FM/FM.B.U2.EUR.4F.KR.MRR_FR.LEV

European Central Bank (n.d., h): Inflation and consumer prices. https://www.ecb.europa.eu/stats/macroeconomic_and_sectoral/hicp/html/index.en.html

European Central Bank (n.d., i): Loans vis-a-vis euro area NFCs reported by MFIs excl. ESCB in the euro area (stocks), Euro area (changing composition), Monthly. *ECB Data Portal.* https://data.ecb.europa.eu/data/datasets/BSI/BSI.M.U2.N.A.A20.A.1.U2.2240.EUR.E

European Central Bank (n.d., j): Bank interest rates - loans to corporations of over EUR 1M with a floating rate and an IRF period of up to three months (new business) – euro area, Euro area (changing composition), Monthly. *ECB Data Portal.* https://data.ecb.europa.eu/data/datasets/MIR/MIR.M.U2.B.A2A.D.R.1.2240.EUR.N

European Central Bank (n.d., k): Gross domestic product at market prices, Euro area 20 (fixed composition) as of 1 January 2023, Quarterly. *ECB Data Portal.* https://data.ecb.europa.eu/data/datasets/MNA/MNA.Q.Y.I9.W2.S1.S1.B.B1GQ._Z._Z._Z. EUR.LR.N

European Central Bank (n.d., l*):* GDP, output, demand and income. *ECB Data Portal*. https://data.ecb.europa.eu/methodology/gdp-output-demand-and-income

European Central Bank (2009): Liquidity Hoarding and Interbank Market Spreads. *Financial Stability Review, B, 141-147.* https://www.ecb.europa.eu/pub/pdf/fsr/art/ecb.fsrart200906_02.en.pdf

European Central Bank (2015a): What is a central bank? https://www.ecb.europa.eu/ecb-and-you/explainers/tell-me/html/what-is-a-central-bank.en.html

European Central Bank (2015b): ECB announces Expanded Asset Purchase Programme. https://www.ecb.europa.eu/press/pr/date/2015/html/pr150122_1.en.html

European Central Bank (2017): Monetary policy decisions. https://www.ecb.europa.eu/press/pr/date/2017/html/ecb.mp171026.en.html

European Central Bank [2016a] (2023): What are minimum reserve requirements? https://www.ecb.europa.eu/ecb-and-you/explainers/tell-me/html/minimum_reserve_req.en.html

European Central Bank [2016b] (2021): How quantitative easing works. https://www.ecb.europa.eu/ecb-and-you/explainers/show-me/html/app_infographic.en.html?utm_source=chatgpt.com

European Central Bank [2018] (2024): What is the main refinancing operations rate? https://www.ecb.europa.eu/ecb-and-you/explainers/tell-me/html/mro.en.html

European Central Bank (2020): Monetary policy decisions. *Press Release.* https://www.ecb.europa.eu/press/pr/date/2020/html/ecb.mp201210~8c2778b843.en.html

European Central Bank (n.d.): The year at a glance. https://www.ecb.europa.eu/press/annual-reports-financial-statements/annual/html/ar2020~4960fb81ae.en.html

European Union (2016): Protocol (No 4) on the Statute of the European System of central Banks and of the European Central Bank. https://eur lex.europa.eu/eli/treaty/teu_2016/pro_4/oj

Evgenidis, Anastasios, Stephanos Papadamou (2020): The impact of unconventional monetary policy in the euro area. Structural and scenario analysis from a Bayesian VAR. *International Journal of Finance & Economics Vol. 26, Iss. 4, 5684-5703.* https://onlinelibrary.wiley.com/doi/full/10.1002/ijfe.2088

Fricke, Daniel, Stefan Greppmair, Karol Paludkiewicz (2024): Excess Reserves and Monetary Policy Tightening. *Discussion Paper.* Deutsche Bundesbank. https://www.bundesbank.de/en/publications/research/discussion-papers/excess-reserves-and-monetary-policy-tightening-923796

Frutos, Juan Carlos, Carlos Garcia-de-Andoain, Florian Heider, Patrick Papsdorf (2016): Stressed interbank markets: evidence from the European financial and sovereign debt crisis. *Working Paper Series, No. 1925*. European Central Bank. https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1925.sl.pdf

Greppmair Stefan, Daniel Fricke, Karol Paludkiewicz (2023): Transmission der Zinserhöhungen hängt von der Höhe der Zentralbankreserven von Banken ab. *Research Letter, 61.* Deutsche Bundesbank. https://www.bundesbank.de/de/publikationen/forschung/research-brief/2023-61-transmission-zinserhoehung-662762

Hannoun, Hervé, Otmar Issing, Klaus Liebscher, Helmut Schlesinger, Jürgen Stark, Nout Wellink (2019): Memorandum on the ECB's Monetary Policy. https://centerforfinancialstability.org/research/Memorand.pdf

Harding, Martin, Jesper Lindé, Mathias Trabandt (2023): Understanding post-COVID inflation dynamics. *Journal of Monetary Economics, Volume 140, Supplement, 101-118*. https://www.sciencedirect.com/science/article/pii/S0304393223000648

Mankiw, Nicholas Gregory (2017): Makroökonomie (7th German edition). Stuttgart

Matheson, Troy D. [2018] (2019): Interest Rates and Inflation. In: Antonio Spilimbergo and Krishna Srinivasan: Brazil: Boom, Bust and the Road to Recovery, Chap. 15. International Monetary Fund. https://www.elibrary.imf.org/display/book/9781484339749/ch015.xml

Meyer, T. (2021): Langfristig ist die Inflation immer ein monetäres Phänomen. In: Demary, Markus, Timo Wollmershäuser, Gerit Vogt, Gertud R. Traud, Stefan Mütze, Thomas Mayer, Pascal Seiler, Lukas Haffert, Nils Redeker, Tobias Rommel [Ed.]: Konsumstau, höhere Energiepreise, lockere Geldpolitik: Droht nach Corona die große Inflation? *Ifo Schnelldienst*, *Vol. 74, Iss. 09, 17-20*. https://www.ifo.de/DocDL/sd-2021-09-demary-etal-inflationx.pdf

Mishkin, Frederic S. (1996): The channels of monetary transmission: Lessons for monetary policy. *Working paper 5464*. National Bureau of Economic Research. Cambridge, MA. https://www.nber.org/system/files/working_papers/w5464/w5464.pdf

Nietsch, Harald (2005): Quantitätstheoretische Geldpolitik. Berlin

Österreichische Nationalbank (n.d., a): Minimum reserves. https://www.oenb.at/en/Monetary-Policy/monetary-policy-implementation/minimum-reserves.html

Samuelson, Paul A., William D. Nordhaus (1998): Volkswirtschaftslehre. Wien

Siebke, Jürgen, Wolf-Dieter Zumpfort (1975): *Weltinflation und Inflationstheorien*. Wirtschaftsdienst, Vol. 55, Iss. 10, pp. 524-528. Hamburg. https://www.econstor.eu/bitstream/10419/134874/1/wd_v55_i10_pp524-528.pdf

Sinn, Hans Werner (2014): Alle in der Falle. Interview. *Focus Money, Ed. 43, p. 37.* https://www.hanswernersinn.de/de/medienecho_ifointerview-focusmoney-15-10-2014

Statista (2024): Europäische Union: Staatsverschuldung in den Mitgliedstaaten im 2. Quartal 2024 in Relation zum Bruttoinlandsprodukt (BIP). https://de.statista.com/statistik/daten/studie/163692/umfrage/staatsverschuldung-in-der-eu-in-prozent-des-bruttoinlandsprodukts/

Wullweber, J. (2020): The COVID-19 financial crisis, global financial instabilities and transformations in the financial system. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3688453

Wullweber, J. (2024): Central Bank Capitalism: Monetary Policy in Times of Crisis. Stanford