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"THE EFFECTS OF ECB'S MONETARY POLICY ON BANKS' INVESTMENT DECISIONS"

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Firma dello studente

Margherita Ferrari

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1. INTRODUCTION

Since the crash of Lehman Brothers in 2008, from which started a global financial crisis for which banks have suffered a hard period of turmoil, and which, in particular in Europe, was prolonged by the subsequent sovereign debt crisis that affected some countries like Portugal, Irelands, Italy, Greece and Spain, monetary policy has played an important role trying to stabilize the situation and achieve its announced objectives.

In this context, numerous economic and monetary maneuvers have been undertaken to counteract the malfunctioning of the money market.

Nevertheless, these frictions have caused a change in the monetary policy transmission mechanisms: the traditional ones no longer fulfilled their function. From this, the need for European Central Bank to implement unconventional (or non-standard) monetary policies to restore the functioning of the transmission channels.

This work focuses on the role of ECB and aims at understanding how different monetary policy actions have influenced banks' behaviors in terms of loans, investment portfolio, risk bearing.

We will work on a sample of 50 banks: 25 Italian and 25 German. This choice is made with the aim to compare different reactions of vulnerable and less vulnerable countries (respectively, Italy and Germany) generated by the implementation of ECB's monetary policy. Our analysis is focused on the portfolio rebalancing channel: we will demonstrate its existence considering changes of the lending activity of banks towards customers, both firms and households, in relation to the introduction of unconventional monetary policies. In detail, we explore the relation between loans and the investment in securities, expanding the investigation to reinvestment decisions guided by the desire to maintain the portfolio at a certain risk and duration threshold. The equation will be calculated using a panel regression model, since, as we will learn in the respective chapter, it is suitable for our study. We will consider a time span that goes from 2011 to 2019.

In detail, in Chapter 2 we will introduce the European Central Bank, its role and its objectives. Firstly, conventional monetary policies will be analyzed focusing on the instruments at the disposal of the ECB for its purposes; secondly, we will treat the unconventional ones used to face the turbulence situations from 2008 on. General consequences due to the adoption of them will be considered.

In Chapter 3, the attention will be shifted to the transmission mechanism of the monetary policy.

Traditional channels, which include the interest rate c., the asset price c. and the credit c., and other new channels that have emerged as a result of the unconventional monetary policies, like direct pass-through c., portfolio rebalancing c., and signaling c. will be described.

Emphasis will be given to the portfolio rebalancing channel, that will be analyzed in detail in Chapter 4. It has effects on the financial market, since the yields on a broad range of assets are lowered. This will make the lending activity of banks becoming more attractive. In addition, we will make a literature review of previous works that considered the portfolio rebalancing channel to measure the effects of European Central Bank's monetary policies.

Dynamics and consequences of its transmission of the monetary policy will be analyzed.

In Chapter 5 we will introduce the quantitative analysis that we want to consider. The approach will be described, as well as the sample chosen. Variables will also be explicated one at a time and will be discussed expected results.

The model will be run in Chapter 6, considering firstly the Italian and then the German case, and obtained results will be argued and compared to the expected ones. To determine the best estimation method for our purpose, we will conduct some robustness checks. We will consider other variables that may impact on the tendency to rebalance the investment portfolios, allowing us to exclude them from the relation of causality considered.

In the last chapter we will draw conclusions on what we have obtained.

2. ECB'S MONETARY POLICY

The European Central Bank was founded in 1998 in Frankfurt am Main, Germany. The ECB and the National Central Banks of the Member States (nowadays they are 19) constitute the Eurosystem, which formulates the Single Monetary Union.

The process for the institution of the European Central Bank went through three stages. The first was aimed to prepare conditions for the subsequent stages; to this purpose, the Treaty of Rome – establishing the European Economic community- needed to be revised. Negotiations during the Intergovernmental Conference on EMU led to the creation of the Treaty of European Union in 1992. The second stage started in 1994 with the establishment of the European Monetary Institute (EMI), which has the tasks of strengthen the central bank's cooperation and monetary policy coordination and to prepare the environment for the establishment of the European System of Central Banks (ESCB). Finally, on 1 January 1999 the third stage took place constituting the fixed exchange rate of the currencies of the 11 Member States initially taking part in the Monetary Union.

Based on the Statute of the ESCB (Article 127), Eurosystem is responsible for: defining and implementing monetary policy, conducting foreign exchange operations, holding and managing the euro area's foreign currency reserves and promoting the smooth operation of payment systems.

Main objective of the ECB is to maintain price stability, which is fundamental for economic growth and job creation (Article 127 Treaty of the functioning of the EU). Moreover, the ECB aims to keep the inflation rate below, but close to, 2% over the medium term (Figure 1).

Inflation refers to a general increase in consumer prices, it is measured with the Harmonised Index of Consumer Prices (HICP)[1].

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[1] Index with which the Governing Council defines and assesses the price stability in the Euro area.

Inflation in the euro area (annual percentage changes, non-seasonally adjusted)

Start of Stage Three of EMU

1.69%

Source: Eurostat. Data prior to 1996 are estimated on the basis of non-harmonised national Consumer Price Indices (CPIs). Average inflation since 1999.
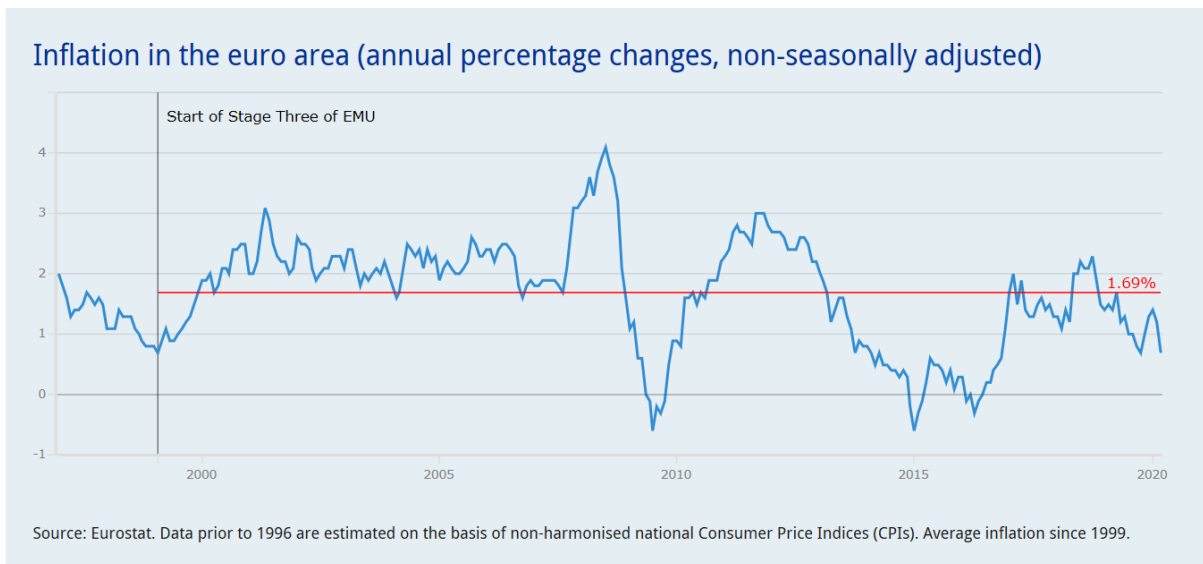
FIGURE 1. SOURCE: ECB WEBSITE

Other tasks carried out by ECB concern areas of *Banknotes*: since it has the exclusive right to authorize the issuance of banknotes in the euro area, thus controlling the quantity of money in circulation (money supply); *Statistics*: relates to the collection (in cooperation with National Central Banks) of statistical information necessary to the Eurosystem to perform its tasks; *Financial stability and supervision*: it is based on the Council Regulation (EU) No 1024/2013 of 15 October 2013, conferring specific tasks on the European Central Bank which is responsible for the prudential supervision of credit institutions of the Euro area and participating non-Euro area Member States, within the Single Supervisory Mechanism, which comprises also the NCAs (National Competent Authorities), thus creating the conditions for the financial system stability and making the banking system safe and sound. Moreover, the *International and European cooperation*: ECB maintains relations with relevant institutions both inside and outside the EU; finally, *Macroprudential policy*: the main goal of macroprudential policy is to preserve financial stability. It aims to prevent excessive build-up of risk, resulting from external factors and market failures, to smoothen the financial cycle, to make the financial sector more resilient and limit contagion effects and to encourage a systemic-wide perspective in financial regulation to create the right incentives for market participants.

The European Central Bank have legal personality and it works independently in the exercise of its powers and in the management of its finances.

The decision-making bodies of the ECB are the Governing Council and the Executive Board (Article 129 of Treaty of the functioning of the EU). The Governing Council comprises all the members of the Executive Board and the Governors of the National Central Banks. Responsibilities of the first body are to take the decisions necessary to enable the ECB to

conduct its tasks and to formulate the monetary policy of the Euro area, meaning that it decides for interest rates, supply of reserves in the Eurosystem, monetary objectives and it defines how to implement these decisions. Governing Council takes monetary policy decisions every six weeks.

The Executive Board, instead, is made up of the President of ECB, the Vice President and four other members. It operates according to the guidelines given and the decisions taken by the Governing Council to implement the monetary policy and gives the necessary instructions to the National Central Banks. Moreover, the Executive Board prepares the meetings of the GC and manages the day-to-day businesses of the ECB with the support of the Chief Services Officer. There is a third body – the General Council – that can be treated as a transitory body. The President, the Vice President and the Governors of all the Member States of the European Union take part of it. The General Council will exist as long as there are States that do not adopt the single currency. It performs tasks of the EMI that the ECB is required to conduct in Stage Three of Economic and Monetary Union since not all European Member States have adopted euro currency. Moreover, it helps to the ECB's advisory functions, the collection of statistical information, preparation of ECB's annual report, the necessary preparation for irrevocably fixing exchange rates of currencies of EU Member States against euro and other activities.

Primary objective of ECB's monetary policy is to maintain price stability over the medium term. It steers short-term interest rates exploiting its monopoly on the supply of monetary base, thus contributing to the economic growth and development and job creation.

Price stability has been defined as a "year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%". Reason behind the choice of a 2% inflation rates is, mainly, because this threshold is low enough to allow the economy to gather all the benefits deriving from the stability of prices.

Such benefits are, for example, the assurance of price transparency since individuals will know that changes in prices will be caused exclusively by relative scarcity of resources. This will also improve the allocation of resources. Another example is the reduction of inflation risk premia in interest rate since individuals will not ask them to compensate for risks deriving from holding nominal assets over the longer term. Finally, price stability helps to keep financial stability avoiding sudden changes in the value of the assets in the banks' balance sheets.

In order to pursue the primary objective, the Governing Council adopts the so-called two-pillars approach, namely an economic and monetary analysis of all the relevant information necessary to implement the monetary policy decisions. The economic analysis focuses its attention on real activities and financial conditions. It is centered on the short to medium-term variables that

shape price developments. It considers shocks affecting the Euro area and the consequences that those have on the setting of costs and prices and the transmission of them in the economy. The monetary analysis, on the other hand, is focused on a longer-term horizon with respect to the economic one. It refers to the monetary aggregate allowing to an insight on the determinants of monetary and credit developments considering their implications for future inflation. From these two analyses, the Governing Council makes a cross-checking in order to determine the relevant information necessary to implement the monetary policy strategy.

A successful monetary policy can be distinguished for some characteristics. Firstly, a functioning money market is fundamental for the correct transmission[2] of the monetary policy, and it depends on the behavior of banks and on their intention to entertain exchanges of liquidity in the interbank market[3]. Dysfunctional money markets can weaken the ability of monetary policy to influence price stability. Secondly, considering that monetary policy can affect the economy only after some quarters or years, due to some lags in the transmission process, it has to be forward-looking and pre-emptive, meaning that it must decide today what policy measures will be needed in the future. Thirdly, due to these transmission lags, some short-term inflation is unavoidable. It is impossible to counteract sudden changes in prices. For this reason, monetary policy should have a medium-term orientation in order to avoid excessive activism and unnecessary volatility in the economy. Moreover, it is paramount that the central bank – in general – acquires credibility, communicating clearly and openly and fixing inflation expectations, in order to influence those of economic actors. Lastly, the ECB must rely on a broad base of information so to keep all the determinants of the economic developments.

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[2] The transmission mechanisms of the monetary policy will be analyzed in further detail in Chapter 3.
[3] The interbank market can disappear during the crisis.

2.1. Conventional monetary policy

The operational framework of the Eurosystem, which is a set of instruments that can be used to steer interest rates, manage liquidity and illustrate monetary policy intentions, provides the link between the ECB's monetary policy and the money market.

The instruments at the disposal of the ECB are three:

- open market operations
- standing facilities
- minimum reserves requirements.

In order to grant to a broad range of counterparties to participate in these procedures, banks have to fulfill some eligible criteria which allow them, in different Member States, to receive an equal treatment.

To be an eligible counterparty, a bank must be financially sound, subject to minimum reserve system and at least under an accepted supervisory regime (like harmonized EU/EEA supervision by the national authorities). These criteria are requested for open market operations and standing facilities. Moreover, in order to participate to credit operations, institutions should hold assets, which can be both marketable and non-marketable, that are eligible as collateral for such operations. Eligible assets are debt instruments that fulfill specific criteria (e.g. Debt instruments issued by Central Governments, asset-backed securities, covered bank bonds ecc.).

2.1.1. Open Market Operations

Open Market Operations can be distinguished in four categories, according to aims, regularity and procedures.

Main Refinancing Operations (MROs) are the most important open market operations, used by the ECB to manage the liquidity situation in the money market. They are conducted regularly on a weekly basis, with a weekly maturity, thus providing liquidity on a short-term period and controlling better the quantity and quality of money. This type of operations is used to steer short-term interest rates enabling to display the monetary policy stance.

MROs are executed through a standard tender. In the context of operational framework, the term "standard" refers to a tender operation that is conducted in accordance with a pre-announced schedule, which is completed in a time span of 24-hours running from the moment of announcement of the tender to the communication of the results. In this tender, the ECB specifies the amount of liquidity that wants to auction (the allotment amount) and requires banks to express the interest. The tender can be both fixed or variable: in a fixed tender ECB specifies

also the interest rate at which it will lend to other banks; on the other hand, in a variable tender, ECB specifies a minimum bid rate and banks bid against each other in order to obtain the liquidity available.

From June 2000 MROs were conducted as a variable rate tenders with a minimum bid rate using a multiple rate procedure. Starting from the operation settled on 2008, the MROs were conducted as fixed rate tender with full allotment, meaning that, considering the period of turmoil, ECB, once specified the rate, accepted all the bids in full, while before tenders provided an allocation to banks proportional to the ratio between total bids and total liquidity to be allotted.

Longer-Term Refinancing Operations are longer-term liquidity providing operations. In this case, the Eurosystem acts as rate taker. They are executed as standard tenders (generally pure variable tenders) on a monthly basis and have a maturity of three months. They are useful in order to prevent all the liquidity in the money market to be rolled over each week and to give counterparties access to longer-term refinancing. ECB may conduct additional non-standard LTROs which can have different maturities, e.g. a maintenance period (calculated on the level of liabilities), six months or twelve months.

Fine-Tuning Operations are carried out on an ad hoc basis. Since they can either provide or absorb liquidity, FTOs manage the liquidity situation in the money market and are aimed at steering interest rates, smoothing the effects of interest rates due to unexpected liquidity fluctuations.

Their frequency and maturity are both non-standardized, thus allowing to a better grade of flexibility.

They may be conducted on the last day of a reserve maintenance period to counter liquidity imbalance which may have accumulated since the allotment of the last MROs. FTOs are primarily executed as reverse transactions, but also as foreign exchange swaps or collection of fixed-term deposits, depending on the kind of operation. They are normally conducted by the Eurosystem as a quick tenders[4], which are executed in 90 minutes after the announcement, or bilateral procedures.

Finally, **Structural Operations**. They are executed by the ECB whenever there is the need to adjust the position of the Eurosystem vis-à-vis the financial sector. This means that they can be both liquidity-absorbing or liquidity-providing operations whose frequency and maturity can be regular or non-regular. They can be performed using reverse transactions or issuance of ECB

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[4] Since they have to be performed quickly, only a limited number of counterparties can participate.

debt certificates, and in these cases they are executed as standard tenders, or outright transactions, using bilateral procedures.

At this point, the ECB has five instruments at its disposal in order to conduct Open Market Operations.

- Reverse transactions: are the main open market instruments of the ECB and can be used for all type of liquidity-providing operations. They refer to operations in which the ECB buys or sells eligible assets under repurchase agreements (Repo) or conducts credit operations against eligible assets or collateral. When the transaction takes the form of a repo, the difference between the purchase price and the repurchase price corresponds to the interest due on the amount of money borrowed or lent over the maturity of the operation. Reverse transactions can be used also for Fine-Tuning Operations and Structural Operations.

- Outright transactions: with this instrument the Eurosystem buys or sells eligible assets outright on the market. They are executed only for fine-tuning or structural purposes and only considering marketable assets as underlying assets. They imply fully transfer of ownership from the seller to the buyer. They are used both in conventional and unconventional monetary policy.

- Issuance of ECB debt certificates: the ECB can issue debt certificates in order to adjust structural position of the Eurosystem towards the financial sector, creating (or enlarging) a liquidity shortage in the market. ECB does not limit in any way the transferability of the obligations. They are issued at below the nominal amount and are redeemed at maturity at the nominal amount: the difference equals the interest accrued on the issue amount, at the agreed interest rate, over the maturity of the certificate.

- Collection of fixed-term deposits: ECB may invite counterparties to place remunerated fixed-term deposits with the NCB in the Member State in which the counterparty is established. It is envisaged only for Fine-Tuning Operations to absorb liquidity in the money market. NCB will not release any collateral against the remunerated deposit.

- Foreign exchange swaps: are spot and forward transactions in euro against a foreign currency. They can be used for Fine-Tuning Operations, mainly aimed at managing the liquidity position and steering interest rates.

2.1.2. Standing Facilities

Standing facilities provide or absorb liquidity in the money market with an overnight maturity, signal monetary policy stance and define overnight interest rates, on the initiative of the eligible counterparties (i.e. credit institutions).

There are two types of standing facilities:

- marginal lending facilities
- deposit facilities.

Marginal lending facilities are used by the counterparties to obtain liquidity from the National Central Bank, in order to cover temporary specific shortfalls. The facility has an overnight maturity and is accessible to counterparties against eligible assets as collateral. The interest rate of this instrument is pre-specified and it is important because it is normally higher than the money market rate, thus representing the ceiling of the overnight interest rate. The NCBs may provide liquidity either in form of repurchase agreements or in form of collateralized loan, and there is no limit on the amount of liquidity that can be provided. Finally, the sporadic use of this facility is not seen as a raising problem for the creditworthiness of the counterparty.

Deposit facilities allow counterparties to deposit excess liquidity in NCBs at a pre-specified interest rate and with an overnight maturity. In this case no collateral is required to the NCB against the deposit. In normal circumstances the interest rate provides the floor for the overnight money market interest rate. If the interest rate applied is negative, the counterparty has a payment obligation towards the NCB, which, in addition, has the possibility to debt the account of the deposit holder accordingly.

Generally, overnight interest rates on deposit and lending facilities are set in order to reduce the incentive of credit institutions to rely on these instruments (i.e. they are unfavorable with respect to the money market interest rates). By setting the rates, the ECB determines the "corridor" or "band" where the overnight money market rate can fluctuate.

In figure 2 we can observe the trend of the three most important rates through which the ECB can influence the money market: deposit rate, marginal lending rate and main refinancing rate, which is the rate at which banks can borrow from the central bank with a maturity of one week. We also consider the EONIA rate, which is calculated as the weighted average of overnight rates applied to all the overnight unsecured lending transactions.
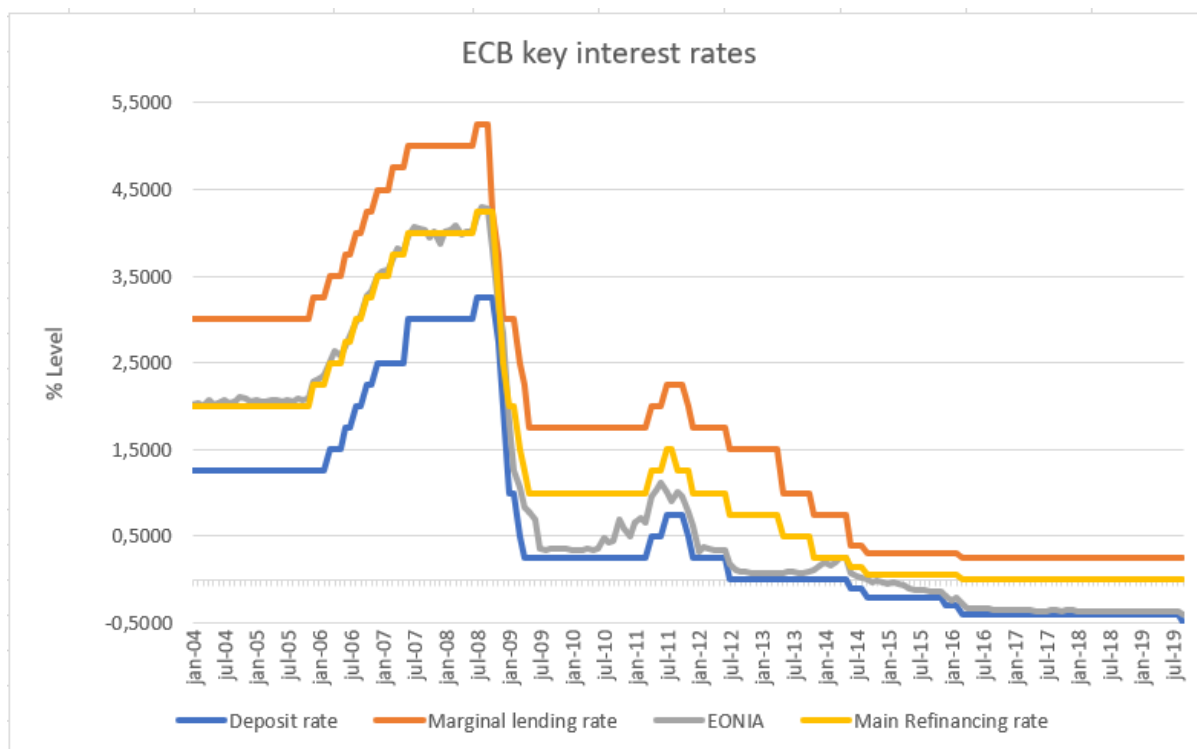
FIGURE 2: ECB KEY INTEREST RATES; PERSONAL ELABORATION OF DATA TAKEN FROM EUROPEAN
CENTRAL BANK STATISTICAL DATA WAREHOUSE

The chart clearly shows that in normal circumstances the EONIA rate has generally remained very close to the rate applied to the MROs, highlighting the importance of these operations for the Eurosystem in conducting monetary policy. This trend changed in October 2008, when non-standard monetary policy was introduced to counteract the effects of the crisis. The difference between the rates on lending facilities and MRO rate, for the period from 1999 to 2008, remained unchanged at ±1 p.p., was then temporarily narrowed to ±0,5 and again widened to ±0,75 p.p. in 2009, when the Governing Council set the rate for MRO at 1,0%.

At the present, the width of the corridor is narrowed to -0,5 and 0,25 percentage points.

In 2012 the deposit rate reached the 0% and the main refinancing rate progressively drop in the following period until it reached 0,25% in 2014. Subsequently, the deposit rate went negative, whilst the main refinancing rate reached the 0. This reduction in interest rates was contained in a package undertaken by the Eurosystem; however, nowadays, negative rates are widely used by central banks all around the world.

This negative environment might involve several issues for the functioning of money market as well as the structure and profitability of financial institutions. However, this environment is expected to have overall positive effects, since it helps reducing the cost of funding the real economy and providing incentives for banks to lend on their liquidity.

The resulting low yields, however, imply one-off capital gain on a bank's fixed-income portfolio. In the short period low interest rates can increase the net interest income by reducing the cost of funding, whilst the rate on loans may take a while to re-price. On the other hand, on the long term, low interest rates decrease net interest income.

Moreover, in the following chart it is possible to observe how the volume of open market operations has changed during the period considered.
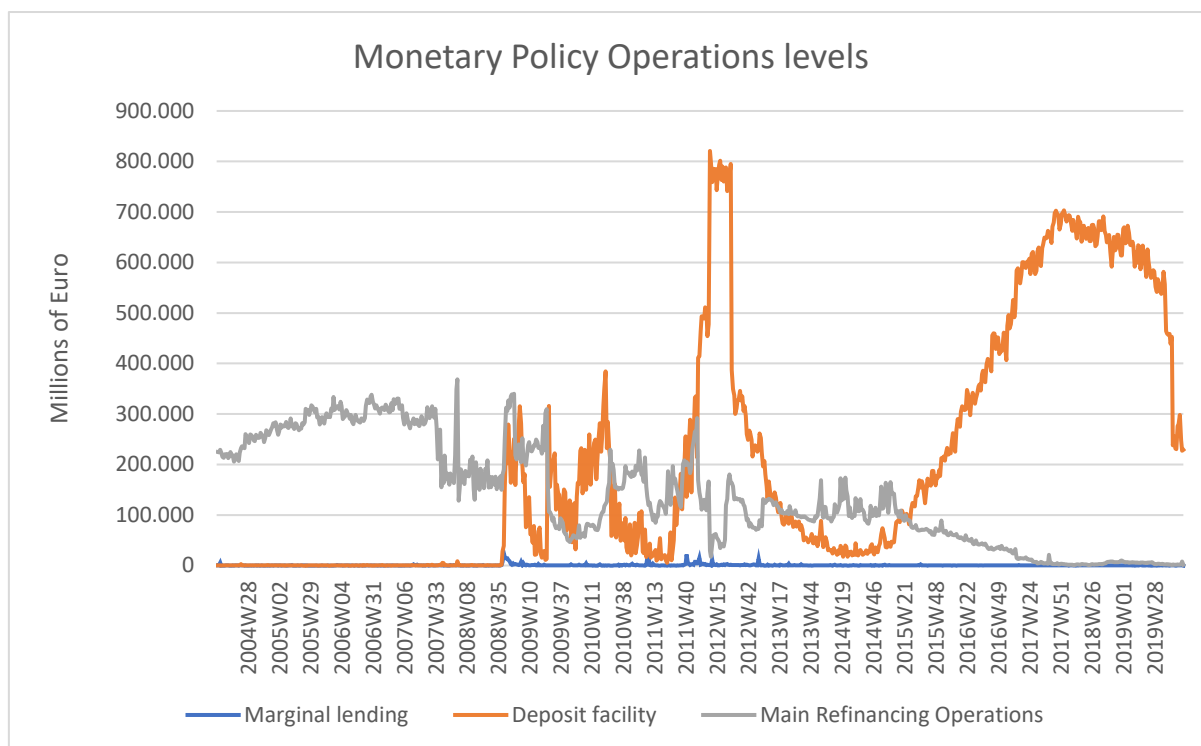
FIGURE 3. MONETARY POLICY OPERATIONS LEVELS; PERSONAL ELABORATION OF DATA TAKEN FROM EUROPEAN CENTRAL BANK STATISTICAL DATA WAREHOUSE

We can notice that in normal circumstances (before 2008) credit institutions tended to use standing facilities in very small volumes, this because of the unfavorable interest rates set by the ECB. However, as the time passed and economic and financial conditions changed, counterparties make more use of these instruments, particularly of deposit facility. In fact, it is possible to observe a spike of the orange line in 2008 due to the incredible increasing of deposits with ECB, since the turbulent conditions of the economic environment and the lack of confidence in the interbank market (for these reasons, even the amount of reserve holdings increased). Another huge amount of deposit facility was used in 2012, resulting as a consequence of the three-year LTRO that injected a large volume of liquidity in the money market.

2.1.3. Minimum Reserve Requirements

Minimum reserve requirements are the last instrument that ECB can use to conduct monetary policy. With this tool, the ECB requires banks in the Member States to hold compulsory deposits (required or minimum reserves) on account with the ECB and NCB in pursuance of two main objectives:

- stabilization of money market interest rates
- creation (or enlargement) of structural liquidity shortage of the banking system.

The **stabilization of the money market interest rates** is conducted giving the possibility to the institutions to perform the averaging provision. It allows banks to smooth out daily liquidity fluctuations, since daily reserves imbalances can be contrasted by opposite imbalances generated within the same maintenance period, which starts on the settlement day of MROs after the Governing Council meeting (where the monetary policy stance is discussed and scheduled) and ends on the day preceding the corresponding settlement day in the following month. To better explain, averaging provision enables credit institutions to lend in the market (when the shortest interest rates are higher than the one expected to prevail for the remainder of the maintenance period), thus running a reserve deficit, or to borrow in the market (when the interest rates drop), thus running a reserve surplus. All these operations, which are free from interest and have to be executed during the maintenance period, are expected to stabilize the level of interest rates between the money market one and that expected to prevail at the end of the maintenance period.

Through this mechanism, central bank can avoid intervening frequently to adjust rates in the money market.

However, at the end of this period, reserves requirements have to be satisfied, all the operations have to cease and compliance will be valuated considering the average of the daily balances during the maintenance period.

Creation (or enlargement) of structural liquidity shortage of the banking system, instead, exploits the amount of reserve deposits in order to reduce or enlarge the quantity of money in the system. The need for credit institutions to hold reserves with the NCBs contributes to increase the demand for credit by central banks. This need gives the possibility to ECB to steer money market interest rates through the open market operations allocating liquidity to the banks at a price that encounter its policy intentions, thus influencing the interest rates.

Regulations referred to how to calculate the required reserves are defined by the Governing Council and they provide that the amount to be held has to be determined in relation to the reserve base, which in turn relies on some specific items of the banks' balance sheets (generally liabilities such as deposits or debt securities issued). Then, reserve base is multiplied by the reserve ratio which is uniform and positive (it was lowered from 2% to 1% in 2012 by the Governing Council to support bank lending and liquidity in the euro area).

Required reserves held by banks are remunerated with the average, over the maintenance period, of the "marginal rate of allotment" of the MROs, paid by the NCB on the second business day after the end of the maintenance period in which the remuneration was earned.

Excess reserve holdings, however, in an environment of negative interest rates on deposits, are remunerated at 0% or at the rate on the deposit facility, whichever is lower.

Finally, there is the possibility that the credit institution is non-compliance with the requirement. In such cases, the ECB is entitled, in accordance with the Council Regulation (EC), to collect penalty interest and to impose sanctions to the bank, like a payment up to 5% above the marginal lending rate, applied to the amount of required reserves that the institution failed to provide, or a payment up to two times the marginal lending rate calculated on the amount failed to provide, or the establishment of non-interest-bearing deposits with the NCB or ECB of up to three times the amount of reserve requirement failed to provide.

2.2. Unconventional monetary policy

Using the tools described above, ECB should be able to reach its main objective of price stability. However, as the chart below shows, this was not so after 2007, when we can see that standard measures were no longer sufficient and for this reason were introduced the non-standard measures.

FIGURE 4. EVOLUTION OF INFLATION. SOURCE: ECB DATA WAREHOUSE

The crash in U.S. mortgage market in 2007 and the subsequent failure of Lehman Brothers in 2008 (first phase of the crisis), caused turbulences in the global financial market with strongly negative consequences on the behaviors of all the economic actors, e.g. investment decisions and consumption. In particular, after the breakdown of Lehman Brothers the spread between three-month Euribor rate and overnight interest rate (EONIA) sharply increased to around 150 basis point, while in normal circumstances it was about 10 basis point. As a consequence of this event, market liquidity dried up and it triggered loss of confidence among market participants and interbank market, banks started to increase the amount of reserves in order to create capital buffers to face risks and uncertainty, and to reduce the amount of lending both to firms and private sector, thus rendering more difficult the access to credit.

In order to face this situation and restore the price stability in the Euro area, the Governing Council undertook a series of non-standard monetary policies, with exceptional and temporary nature, complement to the already discussed standard measures, aimed at providing liquidity to banks, as well as supporting the financial conditions and credit flows.

Such measures, adopted in 2008 and 2009, were subsequently referred to as the Enhanced Credit Support and provided actions directed to banks, since firms in the Euro area are strictly dependent on banks' funding, rather than funding in capital markets. Unconventional measures taken in this phase were, in particular, the extension of the maturity of liquidity provision, since LTROs maturity was prolonged to 12 months, keeping money-market interest rates at a low level and providing longer liquidity horizons to banks; fixed rate full allotment tender procedures, conferring unlimited access to liquidity to eligible counterparties in the Euro area at a fixed rate since they could no longer rely on borrowing from each other; extension of the list of eligible assets accepted by the Eurosystem for main refinancing operations, providing an effective help against the liquidity shortage caused by the halt and lack of trust in the interbank market; covered bond purchase programme, thus reviving the correspondent market which is an important financial market and primary source of financing given the crucial role of government bonds as benchmark for the rates applied to loans in the private sector. Fortunately, all these actions gave signs of amelioration, leading ECB to stop some of them. In particular, Italy endured better than other countries to the first phase of crisis because of the firmly reliance on the traditional business model and the sound supervision. However, in 2010 the environment worse again with the risen of the sovereign debt crisis (second phase of the crisis), which affected mainly Portugal, Ireland, Italy, Greece and Spain, showing their inability to repay debts. Again, focusing on the Italian situation, in order to have a better insight on the consequences on our country, the spread between Italian BTP and German Bund reached the threshold of 500 basis points, while before it was around 200 b.p. after a gradual increase. Furthermore, the transmission of the tensions between the difficulties in repaying sovereign debts and the banking sector were more substantial in Italy, due to its large exposure to domestic sovereign bonds and the high level of public debt.

To face these problems, Governing Council intervened again introducing a series of non-standard measures to tackle the malfunctioning of the market and to reduce the heterogeneous financing conditions in different Euro area countries. In particular, these were the Securities Market Programme, extraordinary LTRO (called also Very Long-Term Refinancing Operations), with an extended maturity of three years and Outright Monetary Transactions (OMT), with the purpose of restoring the functioning of money market transmission mechanism and ensuring depth and liquidity to the affected sector, by purchasing government bonds in the secondary market (in line with the provisions of the Treaty of Functioning of the European Union).

Moreover, in the following year (2012), a persistent negative situation in financial markets contributed to augment the level of stress of them (third phase of the crisis). The increase in the

spread between government bonds and German bund reflected into fear of irreversibility of Euro. In addition, due to the nexus between sovereign and bank's credit rating, which is modified shortly after the modification of the sovereign one, the crisis affected the banks' access to interbank market, thus reducing its disposal of liquidity and leading to a credit crunch. The ECB's non-standard measures adopted to counter this environment were aimed at influence all the interest rates relevant for the financing condition. In detail, these maneuvers, known as "credit easing" package, comprised negative interest rates on deposits, were introduced the Targeted Longer-Term Refinancing Operations (TLTROs) - in order to sustain bank lending -, the Asset Purchase Programme (APP) and finally the forward guidance, consisting in communicating how the European Central Bank expects that its monetary policy will evolve in the next periods.

2.2.1. Measures of the second phase of crisis: SMP, VLTROs and OMT

With the decision of 14 May 2010, the ECB introduced the Securities Market Program, faced to restore the correct functioning of financial markets after the turbulent period and the tensions in some market segments that caused problems in the monetary policy transmission mechanism and compromised the possibility to reach the goal of price stability, in the medium term, of the ECB. This intervention permits to National Central Banks of the Eurosystem to purchase on the secondary market eligible marketable debt instruments issued by central governments or public entities of the Member States of the Monetary Union, and on the primary or secondary market eligible marketable debt instruments issued by private sector in countries which adopt the euro currency. National Central Banks can operate in this way according to their percentage shares in the subscription of the capital of ECB[5]. Must be considered eligible debt instruments all those liabilities denominated in euro and either those issued by central government or public entities in the Euro area.

It is important to remark that the SMP did not affect the monetary policy stance, hence the medium-long term achievement of price stability, since one of the main features of this program is the sterilization (namely, the removal of money from the money market in order to not increase the monetary base after the intervention) intended to not modify the amount of liquidity of central bank held by banks.

The Securities Market Programme contributed to control the trend of sovereign debt yields.

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[5] Decision of the European Central Bank of 14 May 2010 establishing a securities markets programme (ECB/2010/5), OJ L124/8, 20.5.2010.

However, it was not enough. The situation of financial market continued to get worse, downgrades of sovereign government bonds led to a consequent downgrading of banks' rating and a reduction of banks' balance sheets, since they held sovereign government debts which suffered reductions in their values. CDS spreads exceeded the peak reached after the crash of Lehman Brothers and banks' equity dropped of almost 70%, leading to a reduction in lending activity.

For these reasons, in 2011 the Governing Council introduced another program consisting of two LTROs, conducted as fixed-rate with full allotment procedures at the average rate of main refinancing operations, with an exceptional maturity of 36 months each (also called Very Long-Term Refinancing Operations), granting banks with a sufficient amount of liquidity over the medium term allowing them to not reduce credit lines. Characteristic of these instruments was, of course, the duration, which replaced the ones with maturity of 12 months, but also the possibility given to the beneficiaries of them to repay after the end of the first year on any day coinciding with the settlement day of MROs any part of the allotment. The liquidity provided to banks with both operations was around one trillion and participated even small and very small banks.

Moreover, in this period ECB reduced the reserve ratio, used to calculate minimum reserve requirements, from 2% to 1%, since the full allotment granted for MROs has weaken the utility of reserves to steer money market interest rates, in order to incentivize banks with excess liquidity to exchange it with other banks, and widened the span of collaterals in order to allow counterparties to have better access to credit operations by diminishing the rating threshold of certain Asset-Backed Securities (at least a single A) and including, temporarily, NCBs' bank loans satisfying eligible criteria.

Notwithstanding the numerous monetary actions taken by the ECB, financial markets continued to be very stressed, and the transmission of monetary policy was heterogeneous among countries in the Euro area since the different development of the government bond markets. The costs of funding continued to increase leading banks to reduce credit activities both towards firms and households. In addition, some countries (in particular PIIGS countries) faced higher government bond yields, which were incorporating the "redenomination risk premia", namely premia for the risk that those countries were no longer adopting the euro currency.

To counteract this persistent negative background, the Governing Council decided to introduce another non-standard measure: the Outright Monetary Transactions (OMT). The President of ECB Mario Draghi, in September 2012, during a speech said that the ECB was ready to do "whatever it takes" in order to repristinate the correct functioning of monetary policy transmission mechanisms and homogenize the funding conditions of the real economy with the

ECB key interest rates, thus defined these operations aimed at facing the deterioration of the monetary policy stance by intervening in the secondary market. Engaging itself in this maneuvers, the European Central Banks launched strong signals of its being at disposal to restore the sovereign bond market reducing the risk which contributed to push sovereign bond yields up, in particular announcing no ex-ante limitations to purchasable quantity.

OMT programme had the purpose of buying in the secondary market sovereign bonds issued by Member States of the Euro area. More specifications have to be given for the secondary market: in fact, in the Article 123 of the Treaty of Functioning of the European Union it is clearly explained that the purchase of such type of bonds must not be made by ECB or NCB in the primary market, but in the secondary one and without the intention to circumvent the objectives of the prohibition on monetary financing.

A necessary condition for Outright Monetary Policy is the "strict and effective" conditionality to a proper financial stability program (ESFS/ESM) and a commitment towards country's structural reforms. In addition, the ECB could decide when to start, stop or suspend transactions, in accordance to its monetary policy mandate, and whenever they were not anymore warranted from monetary policy perspective, or the objectives were achieved, the Governing Council could decide to stop them.

Outright Monetary Transactions and Securities Market Programme were different in some ways: first of all, the ECB clarified that it would accept to be treated in the same way of other public institutions and private sector creditors with respect to the bond issued by countries in the Euro area and purchased by the Eurosystem, while the context was different under SMP in which ECB had a preferential treatment; then, OMT were focused on short-term maturities of bonds, in particular those from one to three years, since they appeared to be more affected by the numerous tensions in financial markets, while under SMP operations were concerned on 10-years maturity; finally there was a principle of transparency under OMT for which OMT holding and their market values had to be made public.

With the introduction of the OMT the SMP was terminated.

2.2.2. Targeted Longer-Term Refinancing Operations

Another measure adopted by the ECB were the Targeted Longer-Term Refinancing Operations TLTRO-I), announced in June 2014 with the purpose of increasing the quality of the transmission mechanism, but also, and mainly, boosting the lending activity of banks both towards households and non-financial firms, by introducing the possibility for counterparties to borrow at favorable conditions. These operations were intended to be liquidity-providing open market operations with three-months maturity (i.e. they were conducted on a quarterly basis), within an operational period of four years, executed by the NCBs with standard fixed rate tender procedures with a fixed maturity date defined in the ECB website. The rate of the operations was, in 2014, equal to the rate applied to MROs at the time of subscription plus 10 b.p. of spread, while already in 2015 it changed eliminating the spread.

What characterizes these measures is firstly the longer maturity of four years, with respect to the "normal" LTROs, but also the aim for which they were conducted. In fact, while LTROs were intended to recover the monetary policy transmission mechanism, TLTROs, in addition, tried to accommodate monetary policy stance, which was affected by a continuative low inflation, by incentivizing the lending activity towards Member States within the Euro area. Secondly, they were targeted measures since eligible banks were limited in the amount they could borrow, which was calculated on the basis of their total outstanding amount of loans towards non-financial corporations and households (i.e. eligible loans) for the first borrowing allowance (September or December 2014), and also net eligible net lending, for the following allowances which cannot exceed the amount of the first.

The participation to TLTROs was granted both in an individual basis, satisfying the eligible criteria for the open market operations, and in a group basis, through a lead institution, excluding the possibility to take part in them in the two ways simultaneously.

To participants was given the option of an early repayment, starting after the first two years from the announcement of this measure, with a frequency of six months on days that coincide with the settlement of main refinancing operations, in order to reduce or stop, on a voluntary basis, the operations before the maturity. Moreover, if after two years from the initial time, institutions, either on individual or group basis, failed to fulfill the target for eligibility, were subject to a mandatory repayment, fully or in part, of their initial and additional borrowings.

In 2016 another tranche of TLTRO was announced in order to continue to support the credit activity towards the non-financial private sector, maintaining the same features as regard as the

way in which to conduct them: four targeted longer-term refinancing operations, with a maturity of four years, conducted on a quarterly basis.

Despite the membership to the same monetary policy program, the two TLTRO presented several differences. In detail, while under TLTRO-I all the operations matured at the same time, under TLTRO-II each operation had a maturity of 4 years, in order to make tempting in the same measure the four operations.

Besides, considering the TLTRO-II, all the institutions that outperformed the benchmark in terms of net lending would be awarded with a lower interest rate, related to the deposit rate even in circumstances in which it was set to be negative (as the case in question since it was - 0.4%). Such an incentive was considered in order to replace the mandatory repayment under TLTRO-I. Moreover, voluntary repayment was possible under TLTRO-II but with a maturity of three and no more six months, as in the first case, and, in addition, participants had the possibility to early repay, on the date coinciding with the settlement of the second series of the program, funds deriving from the first tranche of operations in order to switch them with those of the second one, thus extending the maturity of lending and reducing the cost of funding (since the average cost of TLTRO-I was around 10 basis points, while for TLTRO-II was 0[6]).

Total outstanding TLTROs (both I and II) at the end of March 2017 were 761 billion of euro. In the following chart it is possible to observe how the participation to them was evolved during the years, and in particular we can notice that it was prominently directed towards the second series, after the introduction of TLTRO-II. Such differences in preferences of institutions could be explained, probably, considering the expectations of lower interest rate charged in the future, thus pushing institutions to wait until the final operation, as well as more attractive prices of those instruments with respect to other banks' funding alternatives.

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[6] ECB, (2017). The TLTRO: an overview of the take-up and their impact on bank intermediation", Economic Bulletin, Issue 3, pp. 42-46
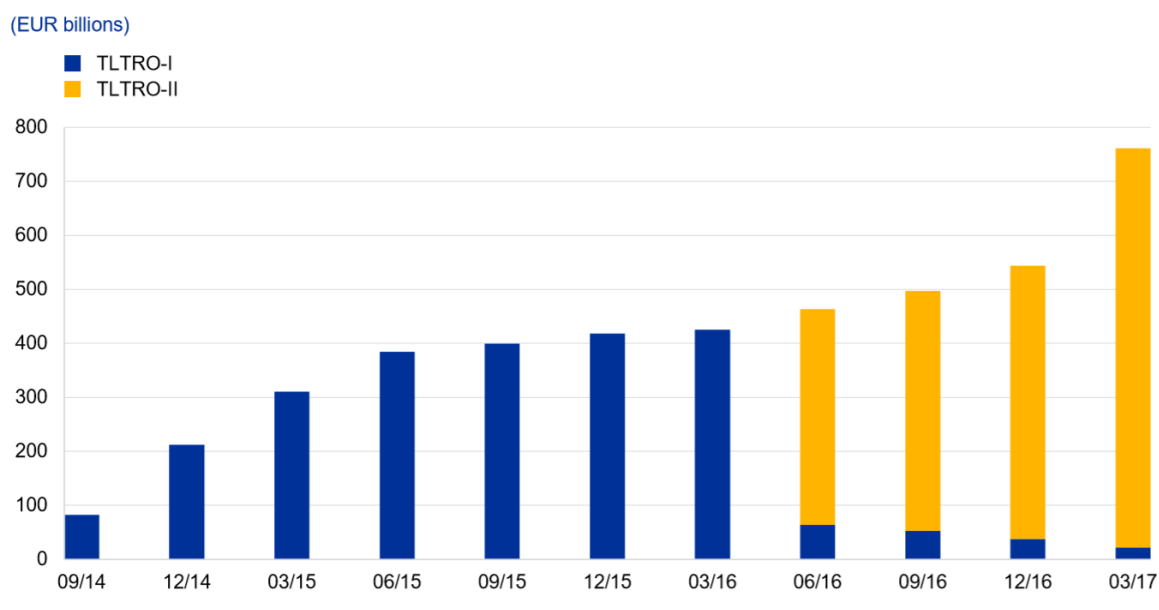
FIGURE 5. EVOLUTION OF BANKS' GROSS TLTRO BORROWINGS, DATA FROM ECB, ECONOMIC BULLETIN, ISSUE 3 /2017, P.43

The new measures, introduced from 2014 on, contributed to reduce the cost of bank funding, deriving from a reduction in the issuance of bank bonds, thus loosening the funding conditions and favoring the credit conditions for banks, in addition boosting the borrowing and the expenditures for investment and consumptions.

Considering all the non-standard measures adopted since 2014, they successfully worked in order to restore the effective monetary policy transmission of lower interest rates and better borrowing conditions. Once that these TLTROs were announced, the interest rates on loans started to decline.

In 2019 the Governing Council introduced a third series of TLTRO (TLTRO-III) to be conducted between September 2019 to March 2021, consisting of seven operations, each with maturity of two years, always at quarterly frequency. In this case, the interest rate applied to the operations undertaken by counterparties which outperformed the benchmark of net lending in the second reference period of the operation (from March 2020 to the end of March 2021) should be set lower than the rate applied in normal circumstances (i.e. main refinancing rate plus a fixed spread), up to 10 basis points above the rate applied to deposit facility, depending on the deviation from the benchmark[7]. This reduction was incremented to 50 basis point with

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[7] Decision (EU) 2019/1311 of the European Central Bank of 22 July 2019 on a third series of targeted longer-term refinancing operations (ECB/2019/21).

the amendment of 30 April 2020, measure undertaken during the Coronavirus pandemic event. Another divergence with respect to the two first stages of operations regards the option given to counterparties: since in this case the maturity is shorter (only two years against four), institutions, both on individual or group basis, cannot decide to early repay the borrowed funds. In September 2019, the Governing Council modified some conditions of this third series. In particular, the maturity was prolonged for one year, so they will mature after three years from their respective settlement date and for this reason the possibility of early repayment was reintroduced: commencing from 24 months after the settlement of each operation, counterparties may decide to stop or reduce the amount of TLTRO-III before the maturity.

2.2.3. Asset Purchase Programme

To react to the crisis triggered with the collapse of Lehman Brothers, ECB adopted in 2015 after the reduction of key interest rates even at negative levels, in addition to all the tools explained until now, the expanded Asset Purchase Programme (APP), already used in other countries like Japan or UK. It was a measure aimed at creating new money to purchase both private and public sector securities so to bring inflation at levels coherent with its objectives, to boost investments and to provide better borrowing conditions through the creation of monetary policy stimulus. All National Central Banks and ECB participated in the purchases, which were conducted on the secondary market considering the NCBs' shares in the ECB's capital.

APP was composed by several purchase programs, including:

- corporate sector purchase programme (CSPP),
- public sector purchase programme (PSPP),
- asset-backed securities purchase programme (ABSPP),
- covered bond purchase programme (CBPP),

but it is important to understand that these tools were used in the same period and not subsequently, as we can notice from the following chart. We can ascertain that the most used program was the public sector purchase one, while the size of CBPP3 and CSPP can be easily compared since the volumes were similar.
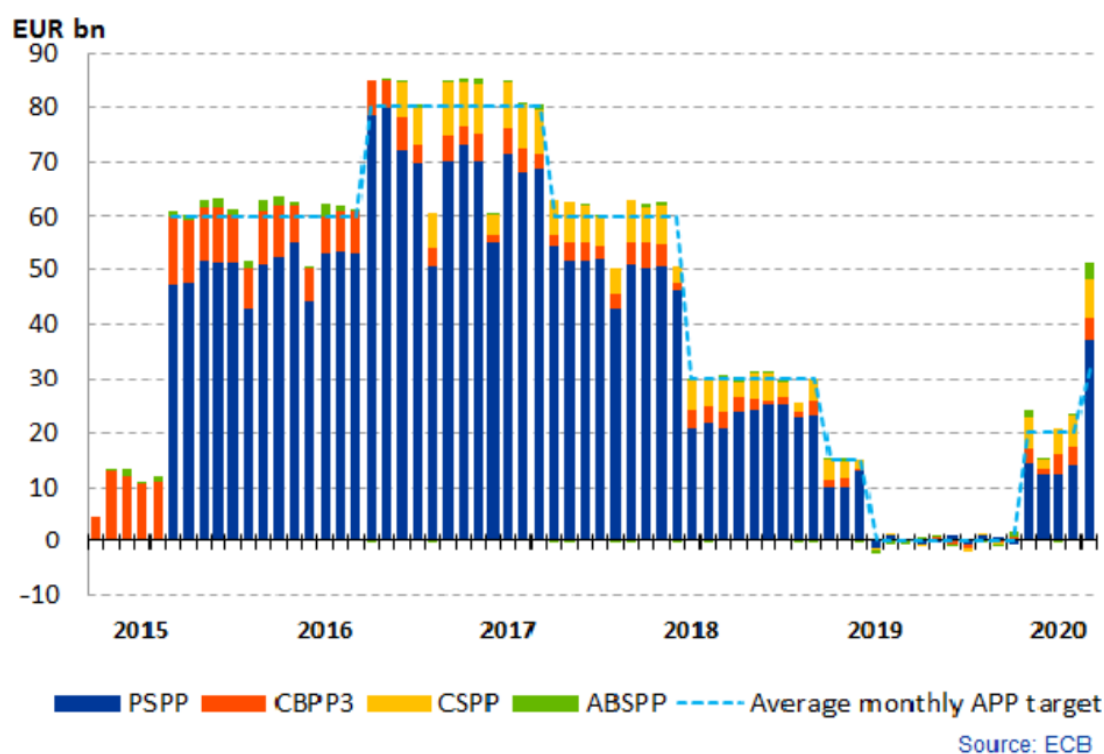
FIGURE 6. VOLUME OF ECB EXTENDED APP.
SOURCE: ECB WEBSITE

Moreover, we can observe the blue dotted line, which represents the average monthly APP target, namely the amount of net APP sustained during the years with the different purchase programmes. From 2015 to the end of 2017 the average volume was 60 billion of euro, except for the period from April 2016 to March 2017 when the ECB increased the amount purchased to €80 billion. In 2018, instead, the ECB reduced the volume to €30 billion, while for the last months (from October to December) it was reduced even more to €15 billion. In 2019 the average monthly APP was zero, meaning that the Eurosystem decided to reinvest principal payments deriving from maturing securities held in APP portfolios and this operation continued even after the Governing Council started to increase the ECB key interest rates. Finally, we can notice that from September 2019 the net purchases restarted, using all the above-mentioned tools, with an average monthly volume of €20 billion.

These purchases will be conducted as long as they are effective in restoring the accommodative impact of interest rates of monetary policy and in adjusting the inflation in order to achieve the ECB main objectives[8].

With the outbreak of Covid-19 virus, and all the health consequences, monetary policy transmission mechanism faced a period of serious risks; for this reason ECB implemented in

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[8] ECB website

28

March 2020 the PEPP: Pandemic Emergency Purchase Programme. It is a temporary asset purchase program of both private and public sector securities. All eligible requirements for assets effective for the APP continue to be active for PEPP, with exceptions for the Greek government, for which will be granted a waiver of them.

This maneuver will be effective until the Governing Council will assess that the crisis created by the virus is over, and, however, not before June 2021. Originally, the amount to grant was €750 billion, but in June 2020 the Governing Council decided to increase by €600 billion the total amount, thus reaching €1359 billion.

2.2.3.1. Corporate Sector Purchase Programme

The Corporate Sector Purchase Programme was established in March 2016, when the amount of APP was increased to €80 billion, with the aim of creating the basis for a better access to credit, boosting investments and creating job, thus bringing inflation at suited levels in order to permit to ECB to achieve its primary objective of maintaining it below, but close to, 2% over the medium term. The Eurosystem exploited the instrument function in order to purchase eligible corporate bonds of non-banks corporations (like insurance companies or non-financial corporations) established in the Euro area, both in primary and secondary markets, while only on secondary market the public sector corporate bonds.

In order to be eligible a security must satisfy the eligibility criteria for the Eurosystem credit operations, it must be denominated in euro and should be issued by a counterparty incorporated in a Member States of the Euro area. Moreover, it should mature in minimum 6 months or maximum 30 years and have at least an investment grade of BBB- rating or equivalent. Purchases of securities with negative yield to maturity equal to the deposit facility rate, or above, were permitted. The eligibility criteria were voluntary broad in order to include in the program as much counterparties as possible.

This typology of tools (CSPP) were used, in a decentralized manner, but still coordinated by the ECB, by six National Central Banks of Euro area Member States (Belgium, Germany, Spain, France, Italy and Finland).

In addition, the Eurosystem applied an issue share limit of 70% per security, on the basis of the outstanding amount.

Allowing the purchase of such broad investment grades (from AA to BBB-) implied a great diversification of bonds in terms of yield (moving in a range between -0.3% to 3%), but also in terms of issuers, countries and economic sectors (12% infrastructure and transportations, 16% utilities, 15% industrials, 9% communications, 6% real estates, 6% technology, 6% energy and

30%% others; data for Q3 2019). The spectrum of bonds purchased was wittingly so broad, in order to manage the risk and ensure the effectiveness of monetary policy.

These operations had a significant impact on financial markets, affecting the spread of corporate bonds. The idea was that by lowering the bond yields it would generate an increase in the demand of riskier assets, thus leading to a shift in the portfolios of counterparties towards other assets with similar risk characteristics but that are expected to provide higher returns.

In the following figure, it is possible to observe how spreads have moved in the years before the announcement of CSPP and how they have reacted immediately after it.

**FIGURE 7. INVESTMENT-GRADE CORPORATE BOND SPREADS.
SOURCE ECB ECONOMIC BULLETIN, ISSUE NO 5/2016, (AUGUST 2016), P. 22.**

We can notice that during the years antecedents, the spread between corporate bonds and a risk-free rate increased markedly. In March 2016 (the first dotted line), the Governing Council introduced the CSPP and, as it is possible to observe, spreads sharply declined during that day and continued to decrease even in the following periods. We can notice another decline immediately after the second vertical line, in particular for the insurance corporations due to the acceptance of them as eligible issuer of securities. Subsequent volatility was due to the English referendum establishing the membership or not into the European Union[9].

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[9] The corporate bond market and the ECB's corporate sector purchase programme. ECB Economic Bulletin issue No 5/2016 (August 2016).

Moreover, after the introduction of CSPP the issuance of bonds rose up suggesting a slight shift from bank-based to market-base funding by some firms, permitting also to them to have access to capital markets in order to get financed (in particular small and medium enterprises), since the positive environment created in the bond market was reflected even in bank lending sector. The program gave the possibility to companies to enhance their ability to issue bonds in order to acquire liquidity, in this way increasing the amount of money that banks could use to finance smaller enterprises[10]. In addition, the shift in the method of financing consisted in a reduction in the demand for loans, but on the aggregate level that market was not affected.

Nowadays (March 2020) the CSPP holdings stay at around 207 million of €, divided into €36 million in primary market, corresponding to the 18%, and €165 million in the secondary market, corresponding to the 82%[11].
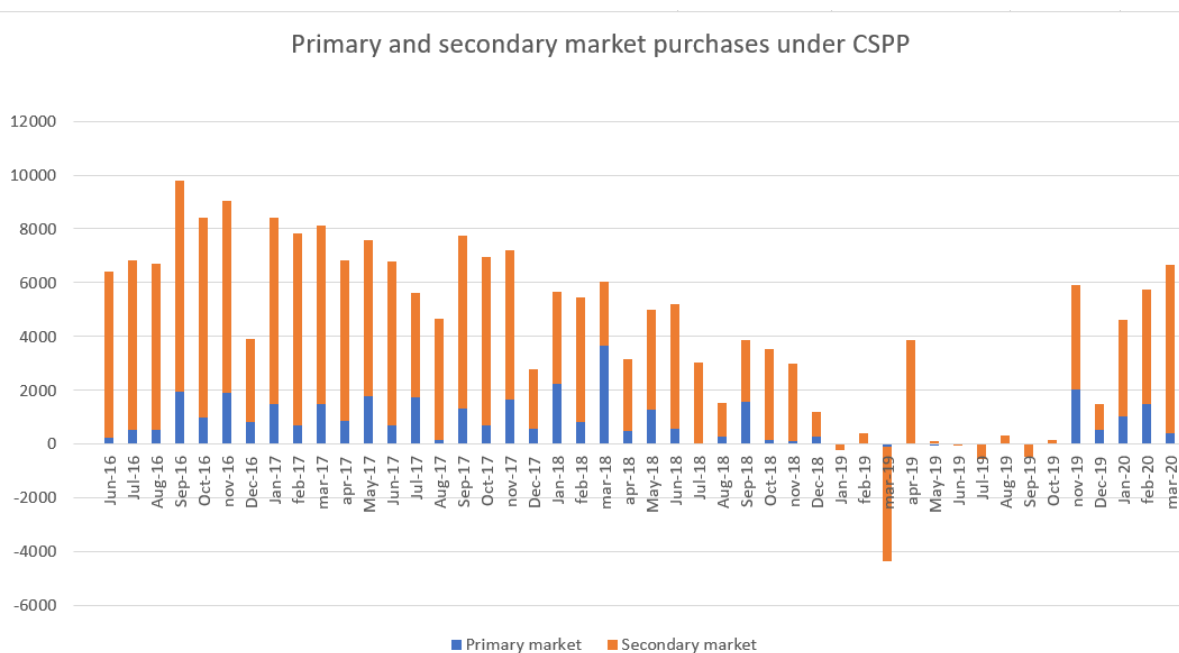
FIGURE 8. PRIMARY AND SECONDARY MARKET NET PURCHASES UNDER CSPP. PERSONAL ELABORATION OF DATA TAKEN FROM ECB WEBSITE

It is possible to observe how the secondary market worked, and still works, more than the primary one, probably even due to the restrictions imposed to the primary market regarding the consideration of debt instruments issued by public undertakings.

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[10] "The ECB's corporate sector purchase programme: its implementation and impact" ECB Economic Bulletin Issue 4/2017, p. 40-45
[11] ECB website

The flexibility in the allocation between primary and secondary market permits to adjust purchases considering the liquidity conditions, which are unpredictable.

During the 2019 the purchase activity was null or negative in most of the months due to the reinvestment activity undertaken by the Eurosystem.

2.2.3.2. Public Sector Purchase Programme

Again, in an environment where key interest rates were already at their lower bounds and the achievement of the ECB's objectives was compromised, in order to restore inflation to reach acceptable levels and guarantee market neutrality, the Governing Council announced in January 2015 the introduction of another program under the already undertaken Asset Purchase Programme.

The Public Sector Purchase Programme (PSPP) allowed the NCBs, according to the capital share invested into the ECB, and ECB to purchase eligible marketable debt instruments on the secondary market from eligible counterparties.

In this case was considered only the secondary market, in respect of the Article 123 of the Treaty of Functioning of the European Union. This permitted to avoid interferences with the private sector purchase program conducted in the primary market: for this reason in order to let proceed the formation of market price in the primary market, it was not allowed to purchase newly issued securities over a period determined by the Governing Council, the so-called "blackout period".

Marketable securities which took part to the purchase program were issued by international and supranational entities located in the Euro area, such as central, regional and local governments, recognized agencies, international organizations and multilateral development banks (since December 2018 their bonds make up around 90% of the total Eurosystem portfolio [12]). Moreover, marketable debt instruments should satisfy the eligibility criteria for Eurosystem monetary policy credit operations and should be issued or guaranteed by institutions classified at least with a Credit Quality Step 3; if there was not compliance with the last condition, in particular circumstances marketable securities were included in PSPP only if they were issued or fully guaranteed by Member States of the Euro area under a specific financial assistance program.

Finally, were included securities whose remaining maturity was between a minimum threshold of two years, subsequently reduced to 1 year with the Decision (EU) 2017/100 of the European

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[12] ECB website

Central Bank of 11 January 2017 in order to smooth the implementation of the APP, and a maximum of 30 years. After several revisions, even debt securities with negative yield to maturity above or below the deposit facility rate were purchased.

When the Governing Council introduced the PSPP established an allocation of purchases distributed between international organizations and multilateral development banks and central, regional or local governments and recognized agencies, respectively at 12% and 88%. Subsequently these percentage were changed to 10% and 90% respectively, with the aim to support the enforcement of Public Sector Purchase Programme. Furthermore, the total amount detained by NCBs was 90%, while the remaining 10% was held by the ECB. In general, the issue share limit per securities was set to 33% of an issuer's outstanding securities. In addition, the ECB clarified that it would accept to be treated in the same manner (*pari passu*) of the other private investors with regard to the purchase of marketable debt securities.

The size of net purchases under PSPP during the years was sizeable. Nowadays (April 2020), the PSPP holdings amount to €2,190 billion, divided in several different countries, as it is possible to note in figure 9.
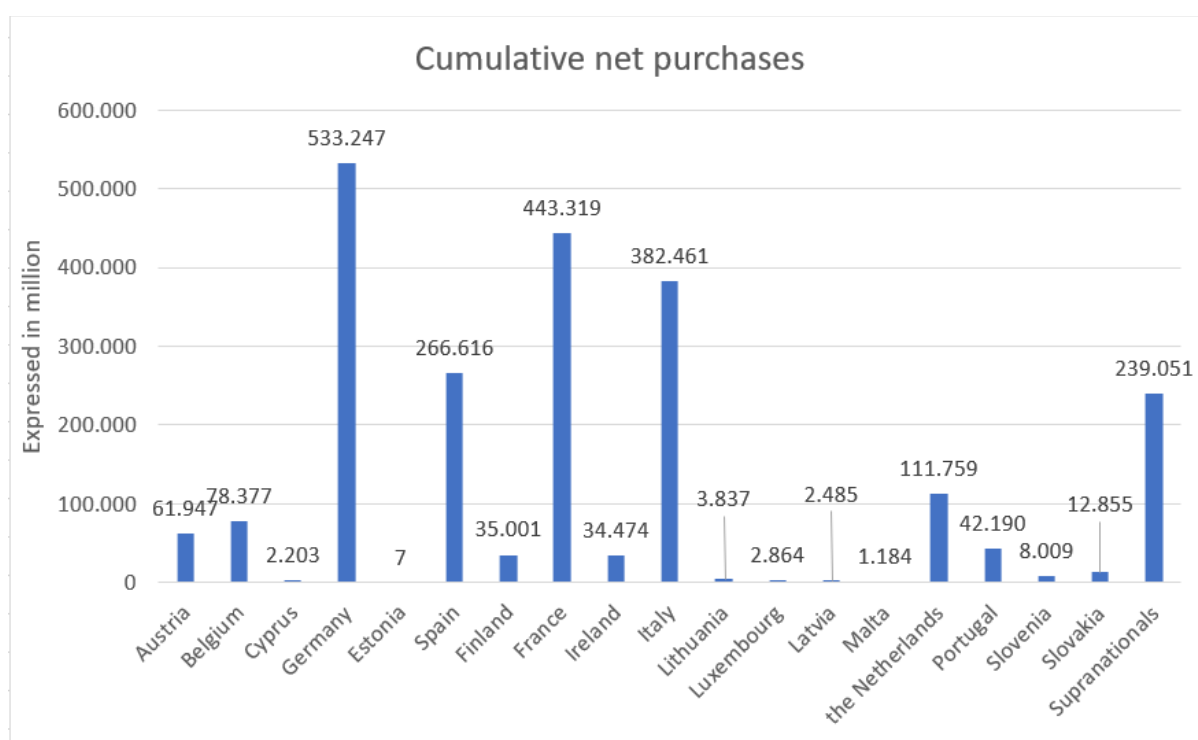

FIGURE 9. CUMULATIVE NET PURCHASES UNDER PSPP. SOURCE OF DATA: ECB WEBSITE.

We can see that Germany, France and Italy purchased huge amounts, in million, of securities, while other countries like Estonia, Malta, Cyprus, Latvia and Luxembourg purchased the

smallest amount of debts, since their shares of ECB's capital key are very low. Nevertheless, there is space for flexibility because the share of capital is not strictly checked any month, thus permitting to correctly activate the program.

PSPP was active from 2015 to December 2018, then the Eurosystem decided for 2019 to reinvest maturing securities and restart with purchasing in November 2019.

2.2.3.3. Asset-Backed Securities Purchase Programme

In November 2014 the Governing Council introduced the Asset-Backed Securities Purchase Programme (ASBPP), which was aimed to support financial conditions of the market, to create better conditions for the lending activity of banks to real economy and, in general, promote the generation of positive effects even on the other markets, enhancing the achievement of monetary policy's objectives. Specifically, in performing its role of providing credit to real economy, ABSPP was intended to operate through loans securitization and the resale of them in order to create the necessary liquidity to provide to banks, thus easing credit conditions.

The implementation of the outright purchase of eligible ABS was different with respect to the other programs because, exceptionally for the initial phase, it was conducted centrally by the ECB, whilst for the subsequent phases it was performed in a decentralized manner by the NCBs of the Member States of the Euro area. The ECB could purchase ABS from both primary and secondary markets by means of its previously educated agents.

In order to be eligible for the program, Asset-Backed Securities should satisfy several criteria: they had to be, in general, eligible as collateral for monetary policy credit operations; they must be classified with a second-best credit assessment of at least Credit Quality Step 3; they should be issued in euro by Euro area Member States. In addition, they should be secured by claims in non-financial private sector entities or natural persons, in which a minimum share of 95% is euro-area dominated and of which a minimum share of 95% are resident in the Euro area[13].

With the amendment published in 2015, the Governing Council decided that even mezzanine tranches of ABS could be purchased, if they were appropriately guaranteed, as well as ABS with yield to maturity at the same level, or above, of deposit rate, while lower rates are considered only to extent necessity. However, before the assessment of the respect of these criteria, a due diligence analysis had to be made by the ECB.

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[13] ECB, Decision of the European Central Bank of 19 November 2014 on the implementation of the asset-backed securities pruchase programme (ECB/2014/45)

Furthermore, some limits have been set: a threshold of 70% of the outstanding amount of ABS can be held, except for ABS with underlying claims against entities resident in Cyprus or Greece for which the purchase limit was 30%.

In April 2020, the total amount of ABS purchased was €31,203 million, approximately equally divided between the primary (52%) and the secondary market (48%).

2.2.3.4. Covered Bond Purchase Programme

Since July 2009 the Governing Council announced the introduction of a new monetary policy instrument, the Corporate Bond Purchase Programme (CBPP1), to create better conditions for the lending activity, thus improving the credit that banks offered to their clients, but also to provide liquidity to important sectors of debt market.

It ended in June 2010, after having purchased covered bonds for a nominal amount of €60 billion. This program created positive effects also for other markets even outside the Euro area, encouraging financial institutions to shift to the issuance of covered bonds as new form of funding. At the end, in 2010, the average remaining maturity of the securities purchased was around 4 years.

In November 2011, another similar program was announced (CBPP2), under similar conditions of the first one and with the same purpose. It ended at the end of October 2012. Originally, the total amount supposed to be purchased was €40 billion, but only a total volume of €16,4 billion was reached. In this case, when purchased, covered bonds should have a maximum residual maturity of around 10 years.

Finally, on 20 October 2014 the Governing Council instituted a new Covered Bond Purchase Programme (CBPP3), but, differently from the other programmes, this one was included in the envelope of the general APP. The goals were largely the same of the two previous tools, with the only distinction provided by the fact that CBPP3 should achieve also the objectives set by the APP, such as providing the smooth functioning of monetary policy transmission mechanism, generating general positive effects to other markets and boosting credit provision. The activity of the program should be conducted in a decentralized manner, both in primary and secondary markets.

The eligibility requirements for participating in the operation had changed between the first two programs and the third. Specifically, securities should be issued and held by institutions resident in the Euro area, whose currency is the euro; they should be eligible for monetary policy credit operations; should be classified with a minimum credit rating of BBB- or equivalent, corresponding to a Credit Quality Step 3; have an underlying asset with an exposure to private

and/or public entities. Moreover, unlike the two previous programs, CBPP3 did not require specific limitations to maturity or issuance size (before was €500 million in CBPP1 and €300 million in CBPP2). Since a subsequent amendment in 2017, it was admitted the purchase of covered bonds with yield to maturity at the level, or above, the deposit facility rate, while considering the purchase of bonds with lower interest rates only at extent necessity.

Furthermore, the Eurosystem set some limits on the issue share of 70% per securities, again with the exception for covered bonds issued by institutions in Greece or Cyprus, for whom the limit was set to 30%.

The third programme ended in December 2018. The Eurosystem reinvested maturing assets during 2019 and on 1 November 2019 the purchase activity restarted.

In contrast with CBPP1 and CBPP2, the CBPP3 did not establish a total amount that should be purchase at the end of the period. In 2020 the volume accounts to around €278 million, divided between primary (39%) and secondary (61%) markets[14].

Summing up, the adoption of Asset Purchase Programme, with all the programs enveloped within it, and all the non-standard measures adopted have permitted to largely improve the financial conditions and the activity of bank lending towards the real economy, contributing in the reduction of spreads.
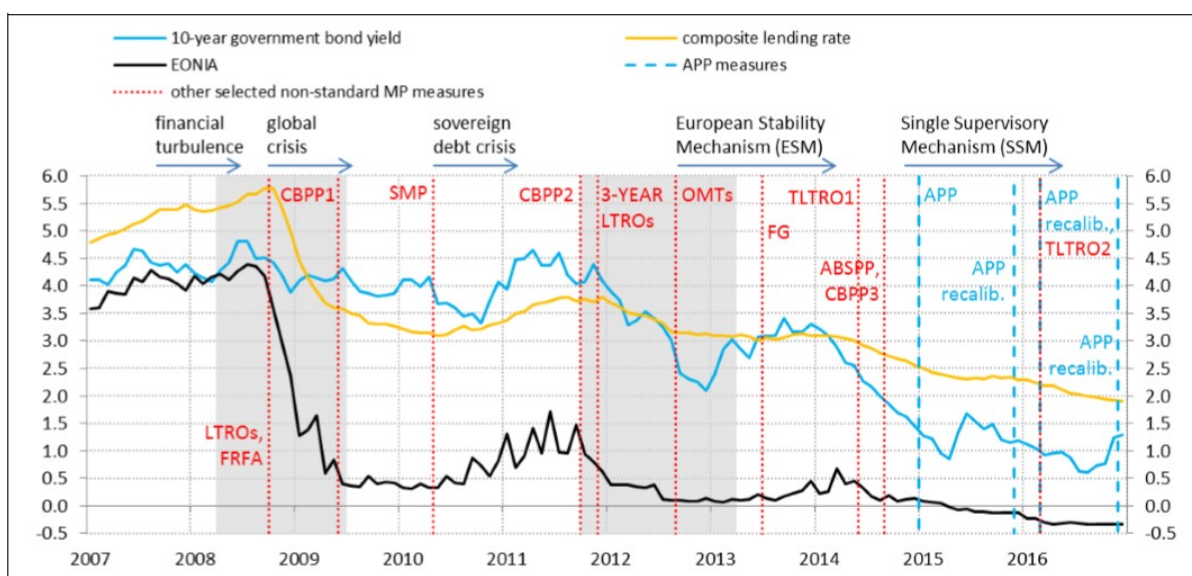
FIGURE 10. SELECTED MARKET INTEREST RATES, JANUARY 2007 TO DECEMBER 2016. SOURCE: THE MACROECONOMIC IMPACT OF THE ECB'S EXPANDED ASSET PURCHASE PROGRAMME (APP), P.25

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[14] ECB website

2.2.4. Forward Guidance

The last unconventional measure that we introduce is forward guidance, which is an anticipation of the future monetary policy that Central Banks, in general, will undertake, on the basis of their predictions of future inflation.

The Governing Council started to use forward guidance in 2013, affirming that it expected a persistent low level of interest rates.

The mechanism of forward guidance is simple: it starts with Central Banks affirming that it expects a certain level of interest rates for a long period, suppose low interest rates. Then, banks will feel comfortable in setting a lower level of interest rates for long-term loans, since they know that, in case of necessity, they will be able to borrow from central banks at a lower cost. According to this strategy, access to credit for households and firms will be cheaper, thus boosting the lending activity and investments, stimulating the economic growth.

3. MONETARY POLICY TRANSMISSION MECHANISM

To achieve its objectives, ECB has at its disposal a set of instruments. One of the main features needed to affect prices is a functional money market which would permit to correctly transfer the Governing Council monetary policy: the way in which it affects the market is important to decide how to intervene, which variables modify, and at what time, considering the lag between the announcement and the effects.

In this chapter we will analyze the different channels through which monetary policy can reach the market: firstly, we introduce the traditional ones and, subsequently, the new channels arose with the introduction of unconventional monetary policy measures. All mechanisms imply the involvement of economic actors and macroeconomic variables which will react to the measures undertaken. We know that the effects of monetary policy on market price and environment in general depend on a set of relevant factors, like the banks' business model and economic developments.

The ECB, through these maneuvers is required to secure an adequate level of liquidity to the banking sector, as well as to firms and households: in doing this, it will modify key interest rates, making the related channel the starting point of transmission mechanism.

3.1. Traditional Channels

3.1.1. Interest Rate Channel

The channels through which the monetary policy can be transmitted are numerous and they can be divided into traditional and new ones.

Considering the former, the interest rate channel is the main form of transmission. The European Central Bank, thanks to its monopoly on the issuance of new money in the market, can influence interest rates both on short- and long-period, thus affecting the allocation of resources between consumption and investment of economic actors. Expectations will also have effects on asset prices and inflation.

This channel operates modifying nominal interest rates, which in turn will affect real interest rates, thus permitting the monetary policy to influence money market even if nominal rates are at their lower bound; this is possible if we assume inflexible prices and sticky nominal wages in the short run. With this starting point, an expansionary monetary policy will reduce nominal rates and, at the same time, also real rates. This reduction will decrease the costs of funding,

thus leading to an increase in investment spending and, therefore, an increase in the aggregate demand and final output.

The impact of monetary policy, however, depends on the speed of adjustment of rates on loans and deposit after the change in key interest rates. In turn, a series of factors influences the way in which rates adjust: the situation of banks' balance sheets, their financial conditions and developments, the competition in the market of financial intermediaries.

3.1.2. Asset Price Channel

Asset price channel is strictly intertwined with the interest rate one, since it involves variables, others than interest rate, that can define the price of assets: the stock-market price, the real estate price and exchange rate.

Considering firstly the stock-market price, it influences the money market through investment decisions and through households' wealth and liquidity. To study these effects, it is appropriate to distinguish two sub-channels: the Tobin's q theory and the wealth effect.

The Tobin's q is the ratio between a firm's market value and its replacement cost of capital.

If q is greater than 1 means that the market is considering the value of intangible assets of the company, which are not listed in the firm's balance sheet: a signal of the positive perception of the firm's capacity of producing value. On the opposite side, if q is smaller than 1 reflects a negative perception of the ability of the firm to produce added value. To give an idea of how this channel could work, considering the Tobin's q theory, suppose a monetary tightening: it will lead to an increase in interest rates and in the cost of funding, which, in turn, will result in a reduction of investment spending, negatively influencing the stock market price due to the contraction of demand. In addition, higher interest rates will reduce the profitability ratio between stocks and bonds. All these factors, will affect the value of the variable q, diminishing the investments[15]. Alternatively, an expansionary monetary policy decreases the interest rates and consequently increases the investment spending, making stocks more attractive and thus increasing the investment and the stock price.

The wealth effect, instead, can be used to describe how asset price channel works through stock market price, considering households' wealth and liquidity.

Wealth effect was introduced by F. Modigliani in his lifecycle consumption model and is based on the fact that consumers spending depends on their resources, which are composed by human capital, real capital and financial wealth. Starting from this assumption, changes due to monetary policy regulations will affect interest rates and, consequently, the capital component

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[15] Dan Horatiu, "The asset price channel and its role in monetary policy transmission", p. 445-454

through the increase in asset prices. Higher wealth of consumers means higher level of investment and consumption.

Besides, real estate is another asset important to consider for the asset price transmission channel. To this, can be simply applied both the Tobin's q and the wealth effect: an increase in house price leads to an increase in the value of the variable q, thus stimulating the production, whilst real estates and lands are a big component of households' wealth. Thus, an increase in their prices leads to an increase in wealth and therefore to an increase in consumption, with an overall final effect on the aggregate demand and output.

Finally, with the development of the economy, even exchange rates contributed to transmit the monetary policy to the market. This channel is strictly related to the interest rate one since, when it changes, for example decreasing, the domestic currency deposits become less attractive with respect to deposits denominated in other currencies, thus leading to a depreciation of the domestic currency (in this case the euro). This lower value, in turn, makes domestic goods cheaper relative to those of foreign currency, hence increases the net exports and, consequently, increases the aggregate demand and the final output.

3.1.3. Credit Channel

Another mechanism used to control the flow of regulations from the Governing Council to the money market is the credit channel. In most of the existent literature, this channel is considered as complement to the already seen interest rate channel since it is looked at as a system which amplifies the effects caused by the latter.

The credit channel is classified as a non-neoclassical transmission mechanism (differently from the neoclassical interest rate and asset price channels [16]), since it arises from market imperfections deriving from market segmentation or information asymmetries in financial markets. Such frictions result in higher cost of monitoring and enforcement of contracts due to the adverse selection problem arising when evaluating the creditworthiness of a borrower.

The credit channel is characterized by the so-called "external finance premium" and the demand for collateral (Ramey, 1993; Bernanke and Gertler, 1995; Dajcman and Tica, 2017); the size of the first element depends on the level of imperfections in the market and it consists on the difference between the cost of external funding, by issuing equity or raising debt, and the cost of internal funding, by retained earnings. Furthermore, it contributes to enhance the effect of the propagation of monetary policy through the interest rate channel, since a monetary policy

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[16] Boivin, Kyley, Mishkin, 2010, "How Has the Monetary Transmission Mechanism Evolved Over Time?", NBER Working Paper No. 15879

which results in an increase or reduction of the market interest rates will have the same effects on the cost of external financing.

Because of these conditions, this channel may affect the demand for investments and the supply of loans.

The credit channel operates with two distinguished channels: the broad credit, or balance sheet, which refers to the borrower's balance sheet and income statement, and the impact of monetary policy on them, and the narrow credit, or bank lending, which focuses on the banks' balance sheets, channels.

The **balance sheet channel** is based on the assumption that the costs of external funds are linked to the health of the borrower's net worth, namely the sum of liquid assets and marketable collateral: specifically, the higher the borrower's net worth, hence the stronger his financial position, the less he would rely on the lender to finance his projects of investments or consumption, but rather he would be able either to self-finance or to guarantee more collateral against loans. Starting from this hypothesis, it is clear how changes in the balance sheet of borrowers will affect the amount of investments and consumptions (Bernanke and Gertler, 1995). Contrarily, the lower the net worth of the borrower, the higher will be the moral hazard and adverse selection problems in the evaluation of his creditworthiness, leading the lender to ask more collaterals or reduce the amount lent because of the lack of trust derived from the increase in risk-taking. In this scenario the overall aggregate demand will decrease since the investment spending is reduced. This situation is also called the "financial accelerator theory", discussed by Bernanke and Gertler in 1995, which is based on the assumption that in a market without imperfections and frictions, borrowers do not face additional costs in external financing since they can trust in an efficient capital market to raise funds without any premium. Instead, in an environment like the one considered to describe the credit channel, there is a link between the real economy and financial markets, because the investment spending decisions depend on the net worth of the borrower, which is affected by monetary policy regulations, thus producing a big effect from a small change in interest rates.

On the other hand, **bank lending channel** is focused on the financial health of banks. The underlying assumption is that changes in monetary policy will affect the ability of banks to supply loans, thus producing credit rationing and a reduction of the aggregate demand: in fact, such changes modify the interest rates on loans and increment the effects produced by the interest rate channel. Banks play an important role in trying to calm down problems deriving from informational asymmetries between them and borrowers. Since the Euro area is characterized by a high recourse to bank funds, especially by small and medium firms, changes in the lending conditions may have an important impact on the investment spending.

In addition, this channel is based on the fact that loans and bonds are not perfect substitutes, thus meaning that banks cannot completely absorb deposit losses by reducing securities holdings (Bernanke and Gertler, 1995); this will result in a reduction of retail deposits and a consequent decrease in loans. Moreover, monetary policy can affect the supply of loans through reserve, which is a necessary condition for this channel to be operative (Van den Heuvel, 2007). Considering, for example, a monetary tightening, this will drain reserves held by banks and the amount of deposits, thus limiting the bank lending activity.

Nevertheless, in contrast with the theory of the imperfect substitutability of loans and other forms of funds, discussed by Bernanke and Blinder in 1988, it is interesting to consider the development provided by Gambacorta and Marques-Ibanez in 2011, after the financial crisis in 2008. In fact, there was evidence of the fact that non-financial firms, especially those very large, recurred to an alternative source of funding different from the banking system. This is the corporate bond market, from which companies rely on to get funds, thus avoiding supply constraints in the banking sector. In addition, recent literature has highlighted the development of securitization as an instrument for the institutions to get access more easily to credit in the money market, bypassing the capacity of banks in providing funds. As a consequence, monetary policy shocks are less responsible for changes in the demand of credit, the effectiveness of which becomes more difficult to assess.

For the reasons discussed above, it appears that the bank lending channel has evolved over time and has reduced its impact on the transmission of monetary policy.

In general, the importance of this channel will depend on the change in lending activity due to changes in monetary policy. The more interest elastic is the demand for money, the higher the variation of deposits and loans to monetary policy shocks[17].

3.1.3.1. Bank Capital Channel

Another monetary policy transmission channel that is worth analyzing is the much-debated bank capital channel. There is a lot of literature relative to it, sometimes controversial.

This channel can be considered as a continuum to the bank lending one, since it contributes to affect the lending behavior of banks and it shares the same assumption that frictions in the market may impact the transmission of monetary policy.

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[17] Bean C., Larsen J. And Nikolov K., "Financial frictions and the monetary transmission mechanism: theory, evidence and policy implications", ECB Working Paper No. 113 (2002)

As affirmed by Van den Heuvel in 2002, bank lending and bank capital channels are both deriving from deviations of the Modigliani-Miller theorem, which implies that banks, as well as non-financial firms, do not depend on their financial structure when making, respectively, lending or investment decisions. Van den Heuvel considers the bank capital channel as an intensification of the interest rate channel. In particular, the model developed in his paper is based on three important characteristics: banks are subject to risk-based capital requirements according to the Basel Accord; the bank equity market is imperfect; finally, banks perform maturity transformation, meaning that loans have a shorter maturity relative to liabilities, exposing them to the interest rate risk since peaks in short-term interest rates affect negatively banks' profit and further the willingness to increase the lending activity. Moreover, the author discusses that for banks with a level of equity at or below the binding capital requirements, lending channel will be less strong, because of the bank's inability to increase the amount of loans without raising new capital. This first result, however, is completely static. At the same time, in fact, the author proposes a contradictory conclusion affirming that monetary policy will have, even if delayed, a stronger effect on bank lending when these institutions hold lower capital with respect to the level required, because when monetary policy measures have effects on bank profits, these will also have an impact on bank capital, and any change in that affects the lending behavior (dynamic effect).

In the analysis performed by Kishan and Opiela (2006), authors try to respond to some questions referred to the behavior of banks to changes in monetary policy, distinguishing between low-capitalized and high-capitalized credit institutions. It arises an asymmetric reaction to different monetary policy operations, for both types of banks. In particular, lower capitalized banks react diminishing the loan growth in a contraction of monetary policy, while they are not particularly affected by an expansionary policy; contrarily, well capitalized banks are not significantly affected in the supply of loans in the former case, while they tend to increase the loan growth in the latter. Following the reasoning of the authors, this last result is particularly important since it means that an expansion in monetary policy can be considered to restore the proper functioning of the market in situations of recession in an environment of higher capitalized banks.

Continuing to analyze the existing literature relative to the bank capital channel, we can consider the work provided by Gambacorta and Mistrulli in 2003, in which is assumed an environment similar to that treated by Van den Heuvel: frictions in the market of bank equity, banks performing maturity transformation and a mandatory capital requirement to be fulfilled by banks which will influence the supply of credit. They highlight the importance of capitalization, defined as the excess capital relative to the minimum capital requirement, which

acts as a cushion with the role of absorbing losses deriving from monetary policy shocks. Authors describe a possible scenario in order to emphasize the role of bank capital. Specifically, they rely on the fact that since banks perform maturity transformation, interest rate on bank's assets adjusts slower relative to liabilities and, for this reason, changes in interest rates lead banks to reduce profits and capital to avoid non-compliance to capital requirements. Results of this model show that better capitalized banks are less affected by changes in monetary policy since they can skillfully rise funds in alternative ways. In addition, authors find that this type of banks are less pro-cyclical, meaning that in bad scenarios they are risk-averse and thus they suffer less with respect to lower capitalized banks.

Also Dajcman and Tica addressed the topic in 2017, trying to find a possible interrelation between bank capital and borrowers' financial conditions. Specifically, they conducted the analysis in core and peripheral Euro area countries: they discovered that the two channels are actually interrelated, particularly in the peripheral ones, whilst in core countries the credit channel is more active, highlighting the importance for the Eurosystem to correctly analyze and evaluate which monetary policy to introduce considering the channels at work.

Moreover, as for bank lending channel, the development of other forms of funds, like securitization, changes the regulation for minimum requirements of capital, thus making the capital-to-asset ratio a bad approximation of the capital constraints of banks (Altunbas, Gambacorta, Marques-Ibanez, 2009).

3.1.3.2. Risk-Taking Channel

In addition to all the channels discussed until now, a new one focuses on the impact of changes in short-term interest rates on risk perception and risk tolerance of banks in building their asset portfolios: the risk-taking channel.

It works through different dimensions, like the value of collateral and the asset prices.

In an environment with low interest rates, for example, the value of collaterals increases, leading banks to move towards riskier investments. Specifically, by modifying asset values, low interest rates may create a wedge between the actual return and the target return of some financial institutions: since riskier assets become more attractive, economic agents shift their investments towards higher yields. This gives them the possibility to increase the supply of loans due to an easing in credit standards.

In their work, Borio and Zhu (2008) argue that the accounting rules implied take an important role in determining the strength of the risk-taking channel. In addition, economic agents have different reactions to the risk, hence they are not affected in the same measure to monetary

policy shocks: for this reason it is of utmost importance to understand how the risk is distributed in the economy.

In conclusion, all the traditional channels analyzed up to now contribute to enhance the transmission of changes in interest rates and especially their effects on economic behaviors.
It is not easy to determine the functioning of the above mentioned channels, but it is extremely important to measure and assess them correctly, to make the best decisions in terms of how to intervene, to adjust the equilibrium of the markets and to achieve the objectives of the European Central Bank. In the figure below, it is represented a summary of what has been just discussed.
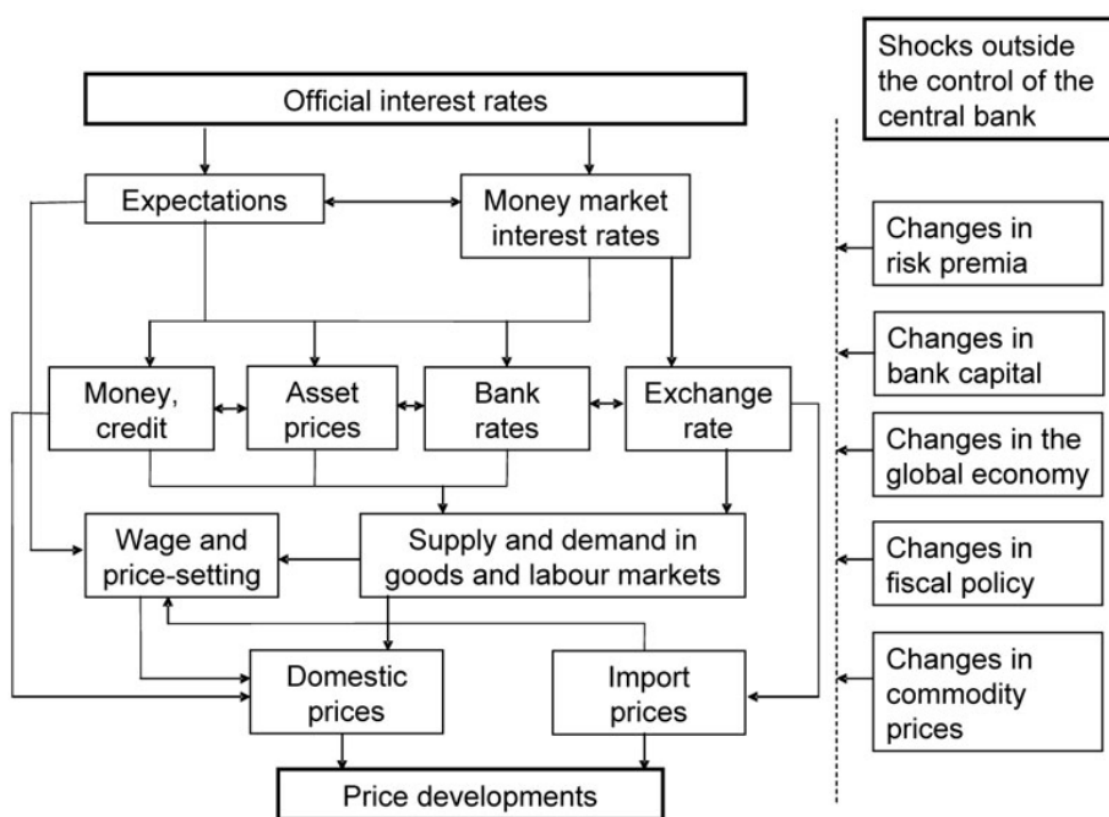
FIGURE 11. MONETARY POLICY TRANSMISSION CHANNELS. SOURCE ECB WEBSITE

3.2. Transmission channels of Quantitative Easing

The recent financial crisis experienced have affected the effectiveness of the traditional transmission channels, impairing the pass-through from the key interest rates of monetary policy to the money market rate. Particularly, with the introduction of the unconventional policies, new channels developed, similar to each other but involved in different ways by the

various maneuvers: the direct pass-through, the signalling and the portfolio rebalancing channels[18].

A substantial amount of literature has been produced to study the new mechanisms of transmission, in particular focusing on the Asset Purchase Programme (or Quantitative Easing). First, the **direct pass-through channel** works allowing unconventional measures to improve conditions for banks' refinancing by incentivizing consumption and investments. It is mostly used for TLTROs, which are designed to decrease the cost of funding for banks, thus encouraging the supply of loans to the real economy.

Second, the **signalling channel** is strictly related to the expectations of economic agents: through it, central banks show their commitment to keep interest rates low in the future, especially with measures affecting banks' balance sheet. This can have mainly two effects: it can lead to a downward revision of market expectations of short-term interest rates, or it can increase (or anchor) the expectations of inflation. Using the signalling channel, central banks provide information about the likely path of future monetary policy (Hausken and Ncube, 2014). However, some studies have found that this channel is uncertain since the difficulty to measure its contribution to the real economy.

Third, the **portfolio rebalancing channel**. Considering the APP conducted by the ECB, the purchase of assets increases the liquidity held by the sellers, which, however, cannot be considered as a perfect substitute of the assets sold. In such cases, economic agents may decide to rebalance their portfolios towards other assets, similar to those sold, thus increasing the price of them and reducing the yields and the cost of external financing.

In the next chapter we will analyze in depth the portfolio rebalancing channel, considering the literature both for a theoretical overview and for considerations on the existing models used to study its contribution in the transmission of monetary policy.

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[18] ECB, The transmission of the ECB's recent non-standard monetary policy measures, Economic Bulletin Issue 7, 201

4. FOCUS ON PORTFOLIO REBALANCING CHANNEL

With the introduction of the unconventional monetary policy, credit institutions increased their liquidity holdings. However, the assets sold cannot be considered as perfect substitutes of the received liquidity, hence banks attempt to reinvest in other assets to rebalance their portfolio. This channel is based on the Expanded Asset Purchase Programme undertaken by central banks, which modifies the available securities in the market by increasing prices and lowering yields of both the purchased assets and the similar ones. In an environment of lower returns on the remaining holdings of assets, investors are incentivized to shift their investments towards assets with higher returns with respect to central bank reserves, thus creating a new equilibrium in terms of prices and returns. The lower yields and higher prices can generate positive wealth effect to individual investors by reducing the borrowing costs (Lloyd, 2018). Under these assumptions, banks are more inclined to offer credit.

This mechanism induces investors to change their investments towards riskier assets and longer maturities, thus modifying also the duration of their portfolio. The large-scale asset purchases conducted in the Euro area affected the banks' lending behavior in different ways. According to Tischer (2018) the increase in asset prices leads to a consequent increase in banks' equity; incremental reserve holdings push credit institutions to rebalance their portfolio towards less liquid assets like longer-term assets, such as loans, to restore the amount of duration risk. Finally, changes in price of bonds and loans make loans more attractive, thus leading to a rebalancing from bonds to loans.

Paludkievwicz (2018), instead, studies banks' choice between securities and loans, considering the issue of the "yield-induced portfolio rebalancing channel". The yields' decline of securities held by banks, consequent to the purchase programs, leads to an increase in lending decisions. In detail, he found that banks make their investment decisions considering a specific target yield level, shifting their investments from bonds to loans to the real sector, which are expected to yield higher returns.

In synthesis, the key element defining the portfolio rebalancing channel is the different price of the assets held by banks during the purchase programs (Jouvanceau, 2016).

In some recent literature (Blattner et al., 2016; Chakraborty, Goldstein, MacKinlay, 2019) we can find the discussion of two main channels linked to the portfolio rebalancing: the balance sheet and the origination channels. The former relates to the fact that the increase in prices due to the purchase activity, leads to an increase in the value of the balance sheet of the bank that holds the assets in its portfolio, thus improving its liquidity and capital position. In addition,

credit institutions have the possibility to sell securities to central bank in exchange for risk-free cash: in this way banks can increase their profits and rebalance their portfolio.

The origination channel, instead, is particularly important to shape the portfolio rebalancing in the context of ABS and covered bonds purchase. Banks are strongly incentivized to issue ABS, MBS and covered bonds due to the higher liquidity in the market and the increased prices. According to Chakraborty, Goldstein, MacKinlay (2019), banks issuing these types of products could sell them directly to the Federal Reserve. This origination activity of covered bonds allows banks to reduce the maturity mismatch between assets and liabilities, since they are an important source of long-term funding for banks, thus improving the ability to take on longer maturity assets, such as loans.

This topic is discussed by several authors under different aspects. An interest one is analyzed by Goldstein, Witmer and Yang in 2018, which is different from the majority of the existing literature because they chose to focus on mutual funds rather than on banks, in order to discover whether also mutual funds play a crucial role in the transmission of monetary policy. They investigate whether these institutions sell assets to Federal Reserve and towards which classes of securities rebalance their portfolio under the Fed quantitative easing. Findings show that funds reinvested in other government securities, particularly newly issued government bonds, thus reducing the yields on them, rather than in riskier assets, like corporate bonds. This means that, by purchasing in the secondary market existing government debt, Quantitative Easing helped US Treasury to finance.

Moreover, Peydrò, Polo and Sette in their work (2017) decided to consider also the demand side of credit, in addition to the supply, in order to widen the perspective on the issue. They argue that a portfolio rebalance towards securities can occur because of a credit demand problem, with few lending opportunities and highly leveraged borrowers.

The portfolio rebalancing channel has been studied by several authors who wanted to demonstrate its existence. In the next paragraph, we will analyze in detail some of the previous literature, considered as the starting point of the present work, which aim is to study how this channel affects the banks' investment decisions, thus assuming the functioning of it.

4.1. Literature review

The purpose of this paragraph is to study the strand of literature which examines the portfolio rebalancing channel, one of the many transmission channels of the monetary policy, implied to boost the lending activity of banks and, generally, the growth of the real economy. All the financial turmoil occurred, from the financial crisis in 2008 on, have led to the introduction of non-standard monetary policies and the subsequent development of new transmission channels, which authors have tried to discuss considering their impact on the economic environment.

Now we will summarize some works that form the basis on which we construct our analysis. Specifically, in this literature, three drivers can affect the activity of the portfolio rebalancing channel: firstly, macroeconomic variables, such as GDP, unemployment growth rate, inflation; secondly, microeconomic variables or bank-specific features, such as profitability ratios, liquidity ratios, governance, size, credit risk measures; thirdly, monetary policy variables, like interest rates (Euribor, EONIA), yields on bonds and so on.

We will consider even studies which are not strictly related to our issue, but they can help us to better explain the portfolio rebalancing channel, particularly the relation between loans and other securities, under different perspectives. Nevertheless, given the vastness of the argument and the different facets which characterize it, we will not be able to fully explain this phenomenon, thus limiting our analysis.

The work of Tischer (2018) "*Quantitative Easing, portfolio rebalancing and credit growth: micro evidence from Germany*" studies the relation between bonds and loans in banks' portfolio after the introduction of the Quantitative Easing policy. It results that banks decide to rebalance their portfolios from securities towards loans as a consequence of the higher amount of liquidity injected in the system by the purchase activity, which led to a reinvestment decision.

To conduct this analysis, Tischer uses a new strategy consisting in considering the maturity structure of securities held in the portfolio. He wants to answer to the question whether there is a link between the maturity structure and the investment in loans during the period of QE. The final aim is to verify to what direction, effectively, banks decided to rebalance their portfolio, taking into account the research for higher-yielding assets.

The sample considered includes data from German banks at monthly frequency, in a time window of two years, spanning from 2014 to 2016, mainly related to security-specific redemption volumes in banks' portfolio, on the basis of data from the Deutsche Bundesbank's Securities Holdings Statistics matched with those of the ECB's Centralised Securities Database.

As anticipated before, the study is conducted with a new strategy, focused on the amount of maturing assets held in banks' portfolio during the QE. This is the identification variable of the model, and it represents the maturity structure of the asset portfolio: according to the author this specific variable is involved in increasing banks' reinvestment decisions. The reasoning which has led to this type of approach is the following: whenever an asset matures, banks face a reinvestment decision which can be summarized in an investment in bonds or in granting loans. In addition, redemptions increase the risk-bearing capacity of banks, since they consist of an exchange of risky assets and riskless cash: since rebalancing is hindered by capital constraints, the higher risk-bearing permits banks to rebalance more. The basic regression used for the analysis is the following:

$$\frac{\Delta \text{Lending}_{it}}{\text{TA}_{i,t-1}} = \alpha_i + \alpha_t + \beta_1 * \text{Redemptions}_{it} + \boldsymbol{\gamma}' * \mathbf{A}_{it} + \boldsymbol{\delta}' * \mathbf{B}_{i,t-1} + u_{it}$$

The dependent variable is the change of volume of lending to non-banks, normalized by total assets in t-1; $\alpha_{i/t}$ represents bank and time fixed effects; Redemption is the variable of interest, which represents the volume of maturing assets in the bank's portfolio. Vector A_{it} considers the net purchases and net sales of assets, in order to control for trading behavior of banks, since it could affect portfolio rebalancing; whereas vector $B_{i,t-1}$ contains other determinants of credit growth, often used in the related literature: e.g. lagged balance sheet share of deposits, wholesale funding and equity to control for capital position, lagged shares of interbank claims and central bank liquidity to control for liquidity, lagged natural logarithm of total assets and the growth rate of total assets to control for trends of bank size and assets growth.

First results demonstrate the existence of a portfolio rebalancing behavior: QE increases the yield spread between bonds and loans, thus the relation between redemptions and credit growth is stronger during this monetary policy intervention. Banks face the need of reinvestment after the maturity of their assets and, in doing so, they consider the higher yield of loans with respect to bonds. To convey further evidence to his findings, Tischer conducts additional analysis and some robustness tests: focusing on the borrower type, he checks whether maturing assets of a particular category, like government bonds, lead to increasing investments to the security issuer, in this example the government. Results are negative, meaning that there is evidence neither across borrowing types nor for a replacement of government securities with loans to government. In addition, another issue considered refers to the maturity structure of new loans: in fact, if the portfolio rebalance is made towards longer-term assets, then banks are more

exposed to interest rate risk. This type of check can also explain the evidence that the spread between bonds and loans informs banks' investment decision. Running the regression, it results that lending activity is more turned to loans with longer maturities, because, without considering the risk, the most important feature is the maturity of the substitute investment. In addition, mainly two robustness check are made: firstly, the analysis is run using the risk-adjusted spread, in order to avoid the influence of banks' risk-taking behavior on the spread between bonds and loans; secondly, it is conducted in order to study whether the results obtained are driven by security-specific effects, such as the probability of default or central bank eligibility.

Going on, Albertazzi, Becker and Boucinha (2016) analyze in their paper the effectiveness of the portfolio rebalancing channel and the related search-for-yield behavior of investors, namely the research of assets with higher expected returns as a consequence of the reduction of yields of long-term securities.

The study relies on the portfolio compositions of different sectors, including banks, in order to examine whether the assumption of search for higher yield is confirmed. Specifically, institutions holding assets whose yields have diminished little should not be incentivized to shift their investments to increase returns of their portfolio. For this reason, the key variable of the model is the asset price, defining the value of the portfolio.

The sample used to conduct the analysis includes the granular information on security holdings of the largest twenty-five Euro area bank, both of vulnerable and less vulnerable countries, matched with bank-level information on stocks and flows of loans granted to the non-financial sector. The period considered is quite limited, since it comprises only the first quartile of 2014 and the second one of 2015, in order to cover the Asset Purchase Programme.

The baseline regression is the following:

$$h_{i,h,t} = \left(\beta_0 m_i + \beta'_0 r_{it} + \beta_0'' m_h r_{i,t} \right) + \left(\beta_1 m_h T_t + \beta_1' T_t r_{i,t} + \beta_1'' m_h T_t r_{i,t} \right) +$$

$$+ \gamma T_t + a_{i,t} + b_{h,t} + \varepsilon_{i,h,t}$$

where the dependent variable $h_{i,h,t}$ is the log amount of holdings security, the variable of interest is m_h, which is the intensity of monetary policy shocks, T_t is a dummy variable that equals 1 if the period under consideration is 2015 Q2, $r_{i,t}$ is the yield-to-maturity of security i at time t. So, a positive coefficient of β_1'' would indicate that between the two periods considered (2014 Q1 and 2015 Q2) investors more exposed to monetary policy shock rebalanced their portfolio towards riskier assets more than investors in other sectors.

Authors find rebalancing only in more vulnerable countries, namely those more involved in the sovereign debt crisis, interpreting this result in terms of low levels reached by long-term yields, which may constrain investors in rebalancing towards riskier portfolio since this would mean investing in other countries. On the contrary, for what concerns less vulnerable countries, evidence shows a positive relationship between monetary policy and credit growth.

Karol Paludkiewciz in his work "*Unconventional Monetary Policy, Bank Lending, and Security Holdings: The Yield-Induced Portfolio Rebalancing Channel*" proposes a different perspective, considering a yield-induced portfolio rebalancing channel. It works due to the yield reduction deriving from the introduction of unconventional expansionary monetary policy which lead investors to rebalance their portfolio towards real sector lending in order to maintain a specific targeted yield level. The analysis is conducted on a sample of 204 German banks, after merging loans data with data from German securities register and statistics on financial statements compiled by the Deutsche Bundesbank, for a baseline period going from January 2013 to December 2015. Purpose of this work is to study how changes in asset yields (or prices) have influenced the reinvestment decisions of investors after the introduction of unconventional monetary policy, particularly considering the increase in credit activity.

The approach used by Padulkiewciz to study this relation is a difference-in-differences regression, based on the following equation:

$$\Delta Log(loans)_i = \beta_0 + \beta_1 * MP_i + X_i' \beta_2 + Banktype\ FE + u_i$$

The dependent variable represents the change in logarithm of newly issued loans in response to the yield decline of bank i. The variable of interest, instead, is MP_i, which is calculated focusing on fixed-income securities, since they account for more than 95% of the all securities holdings of German banks, and considering by how much the average yield of the securities portfolio dropped, due to monetary policies. Then each security is weighted by its nominal amount. The coefficient β_1 measures the treatment effect of the monetary policy induced yield decline. The variable X_i includes monthly bank-level information like: the logarithm of total assets, which represents the size of the bank; the equity to assets ratio, allowing to test for different reactions of low-capitalized and well-capitalized banks; central bank reserves, to control for any potential sales of securities by the bank to the central bank in the context of the APP; ROA; deposits, to check for another liquidity driven transmission channel; net interest margin to control for profitability; and the interbank lending, to study the funding situation of the bank. In addition, also banktype fixed effects are included in the regression.

The author operates firstly running the above specification, then he introduces a dummy variable *POST_t*, which takes value 1 when observations refer to the year 2015, to study the differences in the behavior of banks in case of low or high yield decline.

Studies considering the relation between maturing assets and the rebalancing of the portfolio, as well as between the amount of equity held and the rebalancing behavior have been made.

Results are statistically significant and show a positive sign, meaning that banks experiencing a higher average yield decline of their securities portfolio, induced by expansionary unconventional monetary policy, increase their lending activity towards the real sector. This behavior is accented in concomitance of maturing assets and consequently reinvestment decisions. Finally, after some robustness tests, the author can affirm that banks actively rebalance their investments from securities portfolio to credit provision.

In addition, the paper provided by Rodnyansky and Darmouni, "*The Effects of Quantitative Easing on Bank Lending Behavior*" studies the impact of the three tranches of QE on commercial bank lending in the U.S. Authors explore different channels that may contribute to affect the lending behavior of banks, focusing on the relevant net worth and liquidity channels. The former relies on the fact that changes on security prices increases the value of security holdings thus raising the bank net worth; the latter, instead, is based on the possibility for banks to swap Mortgage Backed Securities for reserves and, consequently, expand their lending behavior.

The approach used is a difference-in-differences estimation using individual bank data from 2008 to 2014. It contributes to provide evidence on LSAPs stimulating bank lending behavior when financial institutions hold a considerable amount of MBS on their balance sheets. Each institution's sensitivity towards Quantitative Easing is measured using the MBS-to-assets ratio. Rodnyansky and Darmouni, in addition, try to identify whether there is a different response by banks with larger holdings of MBS and by those with a smaller amount. Their work is based on two main sources: the Consolidated Reports of Condition and Income (Call Reports), including quarterly data of insured deposits and detailed information on banks' income statement, balance sheet and off-balance sheet items, and the DealScan syndicated loan database, providing information on the borrowing history of both public and private firms.

To measure the causal effects of QE, authors use a pooled estimation model (in an earlier version of the paper, they used separate DiD model for each QE round and results was even stronger than the ones using the pooled method) represented by the following specification:

$$\log(Y_{i,t}) = \alpha_i + \gamma' \mathbf{QE}_t + \delta' (Treat_i \mathbf{QE}_t) + \theta' X_{i,t} + \lambda' X_{i,t} \mathbf{QE}_t + v_{i,t}$$

The dependent variable is the level of total real estate or commercial and industrial loans granted by bank i at time t; α_i is a bank fixed effect; $Treat_i$ is a dummy variable taking the value 1 if the bank belongs to the treatment group, that is defined by a MBS-to-assets distribution above the upper quartile, and 0 otherwise. QE_t is an indicator variable which includes QE_{1t}, QE_{2t}, QE_{3t} and takes value 1 after the introduction of each QE round. The variable $Treat_iQE_t$ is the interaction term between the QE dummies and the bank's treatment status. The related coefficient δ is the key parameter of interest since it measures the difference in lending outcomes between banks with relatively high and low MBS portfolios when passing from periods in which there are not monetary policy shocks and periods of QE introduction. It measures the treatment effect of each QE wave. In addition, the regression takes into account control variables, such as bank size, equity normalized to total assets, ROA as benchmark for profitability. To run some robustness checks, the control variable X is interacted with the QE indicators to allow for possible heterogeneous responses.

Results from this analysis show that banks with a relatively large fraction of MBS on their balance sheets aggressively expanded their lending after QE1 and QE3, when the Fed targeted those particular types of securities. This means that QE has different impact depending on what types of assets are considered: for this reason, is more important to understand the specific asset to target during monetary policy actions, rather than focusing on the quantity during any LSAP.

The following papers that we are going to introduce all refer to the security perspective.

Firstly, the paper by Abbassi et al. aims at investigating the implications of the recent financial crisis on securities trading by banks and the related consequences on the supply of credit to the real sector. The sample used to conduct this analysis is constituted by a proprietary data set at security-level from the Bundesbank on German banks (517), from a time period that spans from 2005 to 2012, matched with some credit register information on the individual loans made by banks. The main testable hypothesis is whether banks with higher trading expertise will increase their holdings of securities during the crisis period, instead of investing in the lending activity, and profit from their trading opportunities.

Authors run two different models in their work, a security and a credit analysis. Since we are interested in the lending behavior of banks, we will focus only on the latter.

The regression is:

$$\Delta Log(loan\ credit)_{jbt} = \beta Trading expertise_b + \gamma_{jt} + Controls_{bt-1} + \varepsilon_{jbt}$$

The dependent variable is the change in log of credit granted by bank b to non-financial firm j during quarter t. γ_{jt} includes borrower*time fixed effects in order to control for unobserved heterogeneity in borrower risk and growth opportunities across time. The variable of interest is *Tradingexpertise*, which is a proxy that takes value 1 if the bank has membership to the largest fixed-income trading platform in Germany, which is the Eurex Exchange: the underlying idea that led to this type of study is that banks with higher level of expertise are thought to be more inclined in investing in securities rather than in loans, relative to other banks. Within the control variables are considered the securities holdings-to-total assets, which increased during the crisis period, in contrast with the loan-to-total assets ratio which, instead, declined. Also the capital ratio is taken into account, which contributes to define the lending behavior of banks and acts as a proxy for risk-bearing capacity. In addition, to control for the fragility of the liability side of banks' balance sheet authors include interbank borrowing and deposits as a fraction of total assets.

What results from the above analysis is that, contrarily to the behavior in securities market, the liquidity introduced by the central banks is used to trade securities, rather than stimulating lending activity towards real sector: in fact, banks with higher trading expertise reduce their overall supply of credit in crisis time, especially investing in securities that experienced a large drop in price.

Another important contribution to this field of literature is the paper provided by Peydró, Polo and Sette, titled "*Monetary Policy at Work: Security and Credit Application Registers Evidence*". They aim at studying the potency of the bank lending channel of monetary policy in relation to the tendency to rebalance the portfolio towards credit supply and risk-taking: they sustain that less-capitalized banks are more likely to increase their holdings of securities rather than lend to the real sector. The analysis carried out in this paper study the impact of the unconventional monetary policy via banks during the Euro area crisis and, contrarily to the existing literature, it arrives to a different conclusion with, consequently, different implications in terms of theory and policy.

Even this work considers the relation between loans and security holdings, since they contribute to define the monetary policy transmission mechanism in different ways depending on which one prevails while rebalancing the portfolio.

The study is focused on Italian banking sector: data are taken from several sources, such as the Security Register, managed by the Bank of Italy; Datastream, to obtain monthly time series of prices and yields; FactSet, to get information regarding the issuer, the residual maturity and the time series of rating; the Italian Supervisory Reports to obtain data on individual and

consolidated balance sheets for banks of Italy. The period under consideration spans from 1999 to 2013. In order to compare differential reach-for-yield in class of similar securities, authors decide to reduce the securities considered to only debt securities with the notional amount above the €10 million, and also exclude banks with value of total assets above €1 million, thus resulting in a final sample of 104-120 banks and 1388-815 securities respectively in the crisis period and in the pre-crisis period. The main empirical specification is:

$$\text{Trading}_{sbt} = \beta_1 \text{Capital Ratio}_{bt-1} * \text{SofterMP}_{t-1} + \beta_2 \text{Capital Ratio}_{bt-1} * \text{SofterMP}_{t-1} * \text{Yield}_{st-1} +$$

$$+\text{Controls}_{sbt-1} + \gamma \text{Capital Ratio}_{bt-1} * \text{Yield}_{st-1} + \alpha_{st} + \alpha_b + \varepsilon_{sbt}$$

where *Trading*$_{sbt}$ is the dependent variable and is determined by the increase in holdings of security *s*, by bank *b* during the month *t* and it is symmetric around 0. On the other side of the equation, instead, there are the variables affecting the trend of Trading: the lagged measure of monetary policy, which is calculated using as a proxy the size of the balance sheet of the ECB deflated by the nominal Italian GDP during the crisis period, while using the regression of EONIA on Italian GDP growth and inflation during normal times; the lagged measure of capital ratio, calculated using the ratio of equity divided by the total assets, which is a key driver of risk-taking and bank lending channels; the lagged measure of the yield, as a measure of the risk of a security, and it is defined as the Yield-to-Redemption minus the overnight interest rate for the Euro area. *Control* includes macro variables like the variation of the consumer price index and of the unemployment, as well as bank variables, such as the size, the liquidity ratio and the ratio of bad loans to total assets.

In parallel another similar analysis is performed to determine how much monetary policy decisions affect the tendency of banks to grant new loans.

Results show that the triple interaction between monetary policy, capital ratio and yield is statistically significant and positive, meaning that when monetary policy conditions are softer, less capitalized banks buy more securities, but with lower yield in comparison to the high capitalized ones, meaning a different reaction in relation to the risk-taking behavior.

Another more recent work that is worth to consider is the one provided by Bubeck, Maddaloni and Peydró, which studies the effect of negative monetary policy rates on the search-for-yield behavior of banks. Differently from the other existing literature, which analyses the change in the supply of credit in response to monetary policy shocks, this paper focuses on the amount of securities holdings; one of the reasons of this choice is that banks take risk through securities holding in addition to their lending portfolio. Banks under consideration are both those with a

high level of retail deposits and a low level of the same. Due to the maturity transformation performed by banks, since they hold long-term assets and short-term liabilities, changes in policy rates will increase the net worth of them because, while long-term assets remain mostly unchanged, banks can fund themselves at lower costs: this increment in banks' financial wealth, in turn, supports the increase in lending and investing in securities. However, the transmission of negative policy rates does not work properly in this way. Evidences will show that banks that rely more on customer deposits are more affected by negative rates since they do not pass negative rates to their customers, because of several reasons such as the willing to maintain solid relationships with long-term customers; this implies that high retail deposit banks, which have less wholesales deposits than low ones, are less able to pass the negative rates to their liabilities.

The analysis is conducted considering a time period going from Q4 2013 to Q1 2014, defined as the pre-NPR (negative policy rates), and from Q2 2014 to Q4 2014, defined as the post-NPR period, studying how the holdings of debt securities (both short- and long-term) change in response to the introduction of the negative policy and exploiting data at security-bank quarter level. In order to compare investments in financial assets with different yields, the authors decided to use the yield adjusted measure, calculated as

$$\text{Yield} = 100 \cdot \frac{\text{Coupon}[\% \text{ ann.}]}{\text{Price}} + \frac{100 - \text{Price}}{\text{Residual Maturity}/365}$$

including in the sample the securities with a yield adjusted measure comprised between the 5th and the 95th percentile of the overall distribution.

The dependent variable of the model is the holdings of security by a certain bank in each quarter, considered at the log-level.

To identify the link between negative policy rates and the reach-for-yield behavior, the authors use a difference-in-differences model, comparing banks that rely more on retail deposits with other banks, assuming that these ones are less affected.

From this analysis effectively emerges that banks with higher retail deposits hold more securities after the introduction of the negative policy rates (given by the positive interaction between the two variables Deposit Ratio and Post[19]). Moreover, interacting these two terms with Yield they still have a positive coefficient, meaning that the impact of an increase in the adjusted current yield in the post-NPR period is significantly different for banks with higher retail deposit ratio. For these reasons, in general the post-NPR portfolio of such banks becomes

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[19] *Deposit Ratio* is calculated as Customer Deposits over Total Assets, while *Post* is the coefficient of a dummy variable that equals one from Q2 2014 onwards.

riskier compared to the one of low deposit ratio banks, suggesting that the reach-for-yield behavior is a consequence of the introduction of the abovementioned monetary policy shock. As initially supposed, banks that rely more on retail deposits are more affected by this negative rate, thus they increase the risk-taking in order to reach higher yields.

Finally, this study is conducted dividing securities in four groups, depending on their issuer: this permits to identify which class of securities is more affected by the negative rates. It results that the reach-for-yield behavior is strongest for private debt securities issued by both financial and non-financial corporations.

Evidence on the overall lending is weak, using the sample analyzed for the security holdings.

Another work that stands in opposition with the one just seen is titled "*Negative monetary policy rates and portfolio rebalancing: evidence from credit register data*", focused on the impact of negative interest rates policy on the lending behavior of Italian banks, questioning, in addition, whether there are different responses to either conventional or unconventional monetary policy. Bottero et al. contribute to provide evidence of the elasticity on credit to balance sheet variables that proxy for different transmission channels of NIRP. According to the authors, negative policy rates can affect the banking system through two main channels: the "retail deposit channel" and the portfolio rebalancing channel. While the former is particularly accentuated for banks more reliant on retail deposits, since negative rates may reduce their capital, leading them to reduce the amount of credit supply, the latter works starting from the fact that liquid assets are characterized by low or negative interest rates, thus incentivizing banks to shift their investments from them towards higher-yield assets, like corporate loans, to preserve profitability.

To conduct the study, the data are collected on a monthly basis (with exception of firm balance sheets, which are annually, and bank balance sheets, which are quarterly or semiannually) in a period of two years between 2013 and 2015 and are taken from the credit register of Italian banks, where it is possible to obtain detailed information on the features of the loans granted; then, they are matched with information relative to banks' and firms' balance sheets.

To measure the effectiveness of the portfolio rebalancing channel, two elements are considered: firstly, the *net interbank position*, given by the interbank loans minus the interbank deposits, divided by the total assets, including interbank transactions with a maturity up to one week. The reason of this choice regards the fact that interbank rates are the most affected by negative rates. Secondly, the *banks' liquid balance sheet position*, which is defined as the ratio of securities over total assets: it is chosen because it is a broader measure of the negative interest rate policy,

in terms of maturity and assets, and because the change of the yield curve induced by that affected all maturities and not only the very short ones.

To identify the effect of negative interest rates on the portfolio rebalancing, authors compare banks with different exposures to the policy, considering three and six months before the announcement and the same time interval after that. The regression used is the following:

$$\Delta Loan_{ib} = \alpha \; Net \; interbank \; position_b + \beta \; Liquidity_b + \gamma' \mathbf{X}_b + \phi_i + \epsilon_{ib},$$

where the dependent variable is the log variation in loans granted by bank b to firm i between the post- and pre- negative policy rates; the net interbank position and the liquidity are the two key explanation variables and, as already said, measure the bank exposure to negative interest rates. In addition, it is included a variable of control, X, which includes bank size, regulatory capital, non-performing loans and bank fixed effects. A similar regression is used to measure the impact of NRP on the real economy, using as dependent variable a range of firm-level outcomes. Evidence shows that banks with greater net interbank positions in the period pre-policy experienced a higher increase in credit supply in the period post-policy. Moreover, banks with more liquid assets held in the period before the introduction of the negative policy rates reduce more the holdings of them in the period immediately after the introduction of the policy. These results contribute to demonstrate the effectively existence of a portfolio rebalancing channel in an environment with negative interest rates. After the introduction NIRP, it was recorded a growth in the credit supplied and the announcement of this policy moved the entire curve of yields downward, particularly affecting the yield of safer assets, thus expanding the spread between safer and riskier assets in favor of the last.

All the papers introduced in this chapter contribute to form the consistent literature on the portfolio rebalancing channel. We have tried to choose them considering the direction of our analysis, in order to have an ample base from which start to make some reasoning, and to cover as much as possible the vast topic under consideration. Of course, they represent only a small fraction of all the literature produced, but we think that it could be the starting point of our model finalized to study the existence of the portfolio rebalancing channel, focusing on the aspect of different yields and maturities. We will explain our intended analysis better and in more detail in the next chapter.

5. THE QUANTITATIVE ANALYSIS

As discussed above, the lending activity of banks is particularly affected by monetary policy decisions since they modify the equilibrium created between banks and the real sector. The topic has been largely discussed; however, it is very difficult to capture all the determinants of the phenomenon. They can be distinguished between macroeconomic variables, such as GDP, unemployment rate, inflation rate, interest rates, as well as bank-features variables, like liquidity conditions and capitalization, agency problem, profitability and performance measures, risks exposure and others.

Our work is intended to contribute to the attempt to describe the portfolio rebalancing channel, in particular assessing in what measure it participates in the transmission of the monetary policy and in increasing of the credit supply.

5.1. The framework

The **Italian framework** can be discussed considering the Bank of Italy annual bulletin, released every year on the 29th May and referring to the preceding year. In our case, we will consider the 2020 edition, in which we can observe the trend of the main features of the Italian economy. In detail, it is recorded a reduction in the increasing trend of GDP in all the main economies, due to the drop in the German industrial sector activity.

As regard as credit, in 2019 loans to Italian banks have diminished by 0.5%, due to a lower demand for funds: this negative result has interrupted the positive trend started in 2016. On the other hand, loans to households is still in line with the one observed in the period from 2016 to 2018, while loans to non-financial firms have experienced a drop of 1.8%. This decline has intensified during the year and it is of greater dimension for construction companies, services and riskier firms. However, in general, loans to small firms have decreased, while those to the bigger ones slightly increased.

All loans are financed with deposits.

In the following graph we can observe the trend of loans to non-financial private sector and to non-financial firms: we can notice that in both cases from the end of 2013 there is an upward trend until the end of 2017 and some months of 2018, and then the curve slightly declines to the end of 2019. As regard as the non-financial firms, three sectors are considered and they show different path, in particular the manufacturing sector started to increase the lending activity from 2012 and reached the highest value, while, on the other hand, the construction

sector did not really benefit from the expansionary monetary policy, since we can observe that the line moves on the negative side of the graph, reaching low levels.

Prestiti bancari (1)
(dati mensili; variazioni percentuali)

(a) al settore privato non finanziario

(b) alle società non finanziarie
per comparto di attività economica (3)

— sui 12 mesi   — sui 3 mesi in ragione d'anno (2)

— manifattura   — costruzioni   — servizi   — totale
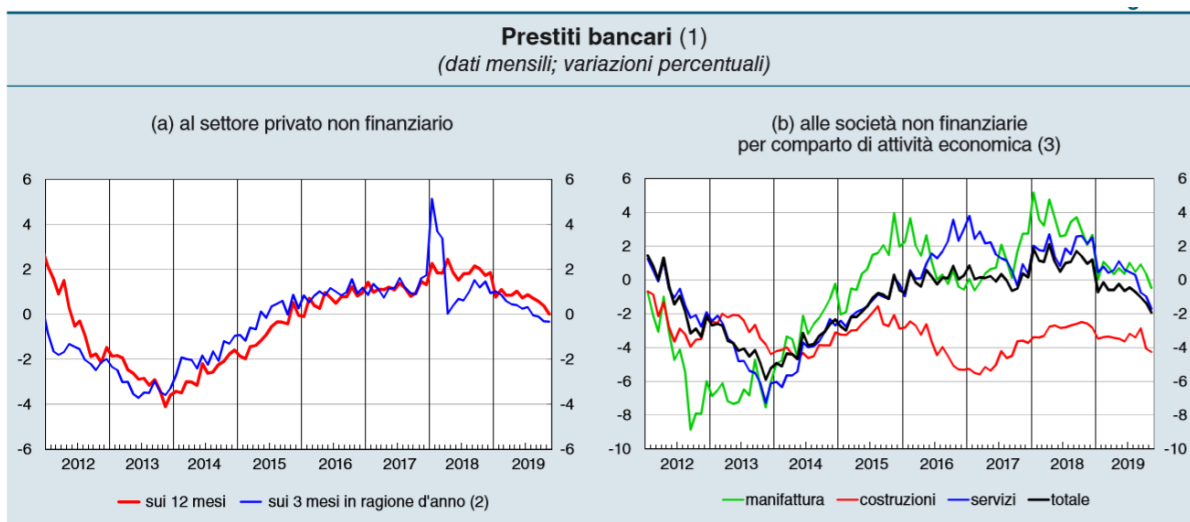
Fonte: segnalazioni di vigilanza.
(1) I prestiti includono le sofferenze e i pronti contro termine, nonché la componente di quelli non rilevati nei bilanci bancari in quanto cartolarizzati. Le variazioni percentuali sono calcolate al netto di riclassificazioni, variazioni del cambio, aggiustamenti di valore e altre variazioni non derivanti da transazioni. – (2) I dati sono depurati dalla componente stagionale secondo una metodologia conforme alle linee guida del sistema statistico europeo. – (3) Variazioni sui 12 mesi; fino a dicembre 2013 le serie per i comparti non sono corrette per gli aggiustamenti di valore.

FIGURE 12. BANKS' LOANS TO DIFFERENT SECTORS. SOURCE: BANK OF ITALY ECONOMIC BULLETIN, 1, 2020, P. 34.

Moreover, looking at the NPL, in 2019, after a strengthening of banks' balance sheets, there has been a reduction in non-performing loans. The incidence of them is reduced by two third since the peak in 2015. Considering the NPL in relation to the total of credits, the ratio fell to 1.2%, which was a very low level in comparison with the historical one and lower by almost one percentage point with respect to the end of 2007 (before both the financial and the sovereign debt crisis).

In order to measure the performance of banks in the Italian environment, we find, in the annual report, data for the return on equity (ROE). In 2019 the profitability of banks is slightly diminished relative to the preceding year due to the reduction of the interest margin and to the higher taxes. ROE reached a value of 5% in 2019, while in 2018 it was 5.7%. In particular, it is possible to observe different values: for more significative banks, the value of ROE has diminished by more than one percentage point, to 4.9%, while for less significative ones ROE has increased to 6.5%, thanks to commissions and earnings linked to the sales of financial assets. In addition, there is heterogeneity within the less significative banks, which is originated by different business models: those engaged in household and firm financing activities have experienced low levels of ROE, while for those banks specialized in investment services, like leasing, factoring, consumer credit and NPL management, ROE was measured to higher levels.

For what concern banks' capital, in December 2019 the ratio between the core equity tier 1 and the risk-weighted assets is 13.9%, 60 basis points more than the end of 2018. The ameliorating is due to the increase in CET1, which has benefited from the positive result of the economic year. At the end of the year the spread between the average CET1 of the significative European banks and that of the corresponding Italian banks was 0.8 percentage points, while it was 1.7 p.p in 2018.

On the other hand, we introduce the **German environment** by considering the Annual Report of the Deutsche Bundesbank, drafted in 2020 but related to 2019.

The downturn, due to the high uncertainty caused by the trade conflicts in the German industry persist in 2019. On the other hand, the economic sector with a more domestic focus continued to grow. As regard as the construction sector, it experienced an increase against the last year, thanks to the robust domestic demand which could exploit cheaper loans, higher government spending and the good labor market situation.

The GDP in 2019 settled at 0.6%, breaking the positive trend of the past five years, when on average it was around 2% (1.5% in 2018).

In addition, the persistent environment characterized by low interest rates has implications for the financial stability of the German economy. The lower rates could imply the research, by banks, of higher risks in order to get higher returns: this can be noticed from the tendency to boost the credit supply, in particular versus firms which are less financial sound. However, in recent years, lending activity has been reduced due to the long period of favorable economic development.

The banking system in Germany is characterized by three pillars: the private commercial banks, the public sector banks and the cooperative banks.

The first group is the bigger one, accounting for 40% of the total assets of the system. They are mainly active in the German export economy, considering that they manage the 88% of the country's exports and hold three quarters of the foreign network.

The second pillar, the public sector banks, includes saving banks, such as Sparkassen, Landesbank and DekaBank, which act as the central asset manager of Saving Banks Finance Group, and it accounts for 26% of total assets. They perform the same activities of the private banks, but they do not compete against each other since they work only in their competence region. Initially, Landesbanks were thought to act as the central bank for this group. However, recently they increase their presence in the wholesales funding and investment banking sector, and this fact led them to compete with other commercial banks.

Finally, cooperative banks include Volks- and RaffeisenBanken and one central cooperative bank: DZ Bank AG. They account for 18% of total assets. Owners of the cooperative banks are the same members (since they are institutionally organized as clubs), who are also depositors and borrowers of this type of banks. In performing their activity, which consists in offering banking services to the public, cooperative banks do not compete with each other, since they are subject to the regional principle for which each bank operates in its area under the government of the local owner.

However, these three pillars do not correspond to the totality of banks' assets: in fact, there are other residual banks grouped together (mortgage banks, building and loan associations, and the special purpose banks) which include the KfW (Kreditanstalt für Wiederaufbau) banking group, which is the equivalent of the Italian *Cassa Depositi e Prestiti*.

We have decided to consider both Italian and German banks in order to study two different scenarios: one given by Italy, which suffered more from the sovereign debt crisis and it is considered a vulnerable country, the other given by Germany which, instead, was not affected so much by the same crisis and it is less vulnerable. We want to focus on the reactions, in terms of portfolio rebalancing channel, to the implementation of monetary policies, starting from different economic situations.

5.2. The model

5.2.1. Description of the procedure

The purpose of this analysis is to study the relation between monetary policies, particularly the unconventional ones, and the investment decisions of banks.

The portfolio rebalancing behavior, as we have learnt from the recent literature, is originated by the presence of an increasing amount of liquidity in the banks' balance sheets, which involves a reinvestment decision, merely guided by a liquidity reason, or by the intention to restore the original duration and yield of the portfolio, directing reinvestments towards specific assets.

In the next chapters we will go through several steps to conduct the study: firstly we will describe the sample choices, illustrating, generally, the main characteristics of the banks considered; secondly, we will explicit the research question that we want to investigate; thirdly, we will define the variables that best fit our purposes, then collect the values and finally compute the ratios and indexes. After the first part, we will construct the panel regression

model, through which we will understand whether our analysis is significant and exhaustive, or if it is biased for problems of inconsistency or other. We will use the software Stata13 to conduct the study.

Finally, after all the calculations, we will comment the results obtained, checking for the reliability of the model.

When choosing the best instrument to conduct the analysis we considered the cross-sectional data, which focus on a sample of individuals, households and firms at a given point in time. The key feature of this tool is that data have been obtained by random sampling of the population: for this reason, if we want to compare phenomena in two distinct periods, we would analyze different samples, since they are taken randomly. For our purpose, this method is not the best, because to correctly study economic behavior of banks we consider the same sample and variables across period.

Another tool we considered is the time series data, which consist of observations on several variables over time. The main characteristic of time series data is that past events can influence future events, meaning that the chronological order is important and conveys relevant information.

In order to overcome the shortcomings of the two instruments and, at the same time, exploit the benefits related to both cross-sectional and time series data, we decide to use a panel data, or longitudinal data, which is characterized by a time series for each cross-sectional member in the dataset (Wooldridge, 2012). In this way, the same cross-sectional units are considered over a given time period, giving multiple benefits: firstly, having a consistent number of observations on the same sample allows to control for unobserved characteristics of the group under analysis; secondly, we can observe the effect of lags in behavior or the results of economic decisions.

The aim of this work is to study the effects that changes in monetary policies have on banks behavior, exploiting the portfolio rebalancing channel as transmission mechanism.

As we have already explained and discussed, this channel is characterized by the reinvestment decisions of banks, due to the increase in the amount of liquidity injected by central banks after the introduction of unconventional monetary policies.

To the best of our knowledge, most of the existing literature focuses its attention on the liquidity channel of the portfolio rebalancing channel. On the contrary, we try to divert by the previous works by focusing on the so-called "yield-induced portfolio" (Paludkiewicz, 2018), studying the way in which unconventional monetary policies contribute to the portfolio rebalancing,

altering indirectly the returns of the original portfolio and widening the spread between the yield of long-term securities and loans.

The research question we investigate relies on the assumption of the existence of the portfolio rebalancing channel and considers the "search-for-yield" behavior due to changes in the maturity structure of the original portfolio. We want to test the existence of a positive relationship linking the spread between loans and long-term securities and the issuance of new loans. In addition, we search a negative relation, in the long period, between negative interest rates and the lending activity, thus demonstrating the efficacy of monetary policies in inducing reinvestment activities. The main assumption that we need to make is the perfect substitutability between loans and securities, which allows us to better understand the mechanism behind the reinvestment decision to restore the duration of the portfolio.

In the next paragraphs we will introduce the sample chosen and the main characteristics of that.

5.2.2. The sample

To create our sample, we have selected a group of banks from two different countries, 25 for Italy and 25 for Germany. We have made this choice because we want to study whether monetary policies impacted in the same way countries with different circumstances in terms of financial wealth: Italy was mostly affected by the sovereign debt crisis after the financial crisis in 2008, so it was in need of a stronger restoration by the ECB to avoid unpleasant economic developments, whilst Germany was less affected by the crisis in 2010-2012, thus it exploited in different ways the expansionary monetary policy. We will conduct two separated analyses using a panel data regression model for the two countries, and then we will compare results considering the same periods to discover discrepancies between vulnerable and less vulnerable countries.

Criteria according to which we have selected banks relies on the country ranking, sorted in a descending order considering the amount of total assets and the availability of data.

Data are collected with annual frequency in a period spanning from 2011 to 2019, due to the scarce availability of value for the previous years, and they are provided by annual reports of each bank. In addition, we collected data from Eikon Thomson Reuters dataset, Bank of Italy and other statistical databases, over the same period.

The samples chosen for Italy and Germany are a good proxy for the countries' banking sector, because the sum of the total assets of each bank considered represents the 78% and the 70%, of the total assets of, respectively, the Italian and the German banking sectors.

From here we begin to illustrate the main statistics for the variables considered. The total number of observation is 225, given by the 9 yearly observations for each of the 25 banks in the two samples: there are three exceptions, spread, GDP and the government net debt, which do not vary across cross-sectional observations but only across time.

5.2.3. Variables and expected results

To perform the abovementioned analysis, we construct the following regression:

$$LOANS_{i,t} = \beta_1 Yield_{t-1} + \beta_2 Interbank_{i,t} + \beta_3 Securities_{i,t} + \beta_4 NPL_{i,t-1} + \beta_5 Dep_{i,t} + \beta_6 ROA_{i,t} + \beta_7 Tier1_{i,t-1} + \beta_8 Size_{i,t} + \beta_9 GDP_t + \beta_{10} D_t + \varepsilon_{i,t}$$

where $\varepsilon_{i,t}$ is the composite error term, made up by $a_i + u_{i,t}$. a_i captures the unobserved factors affecting the dependent variable; it is time-invariant and for this reason it is also called fixed effect. On the other hand, the term $u_{i,t}$ is called the idiosyncratic error, or time-varying error, because it includes the unobserved factors which affect the dependent variable and vary with time.

The dependent variable we chose is **$LOANS_{i,t}$**, defined as the ratio between the amount of loans on total assets at time t. The reason why we decided to consider the ratio with total assets is to control the percentage of loans kept by banks after the reinvestment decision, thus demonstrating, generally, the existence of the portfolio rebalancing channel towards credit.
We now consider the variables which influence the amount of loans granted.

The first key explanatory variable is **$Yield_{t-1}$**, which is determined by the spread between yields of long-term securities and loans. Due to the complexity in finding data, we use as proxy for the yield of long-term securities the 10-year yield of government bonds[20] (both for Italy and Germany), whilst for loans the cost-of-borrowing for long-term newly issued loans[21].
As we can notice from the figure 12, during the sovereign debt crisis, between 2011 and the end of 2012, the government bond yields of the PIIGS countries, the more vulnerable ones, increased abruptly with respect to that of Germany, which, instead, remained more financial stable during the crisis.

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[20] Data taken from Eikon Thomson Reuters dataset.
[21] Data taken from the Bank of Italy Statistics.
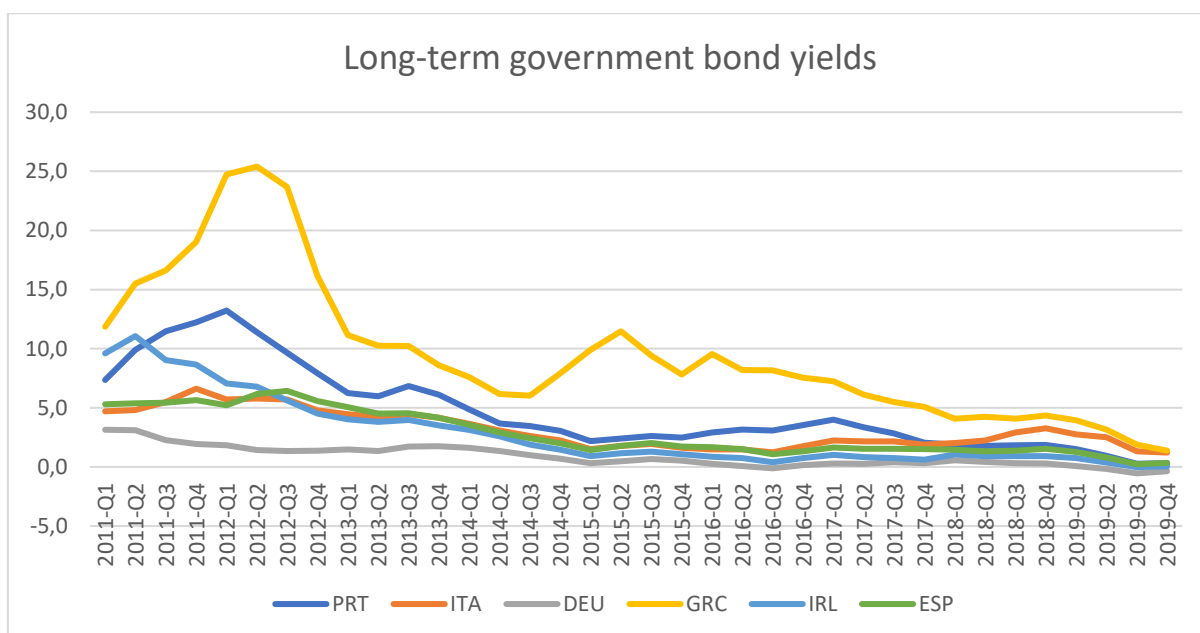
FIGURE 13. LONG-TERM GOVERNMENT BOND YIELDS. ELABORATION OF DATA FROM OECD WEBSITE.

We take into consideration this variable to study how changes in yields due to the introduction of unconventional monetary policies has influenced the supply of loans, since we want to research the yield-induced portfolio rebalancing. We focus only on the first lag of the variable taking into account the delay in the transmission of the monetary policy to the economy.

This variable is directly influenced by monetary policy shocks. As argued by Paludkiewicz, the asset purchase conducted by ECB under the APP causes a drop in the yield of fixed-income securities, favoring the supply of credit rather than the reinvestment in securities. Simultaneously, the interest rate charged on newly issued loans decreases, but since the speed at which the two yields change is not the same, the spread increases making the rebalancing channel work.

According to the literature, we expect a positive coefficient, reflecting the positive relationship between the lending activity and the spread considered: the greater the latter, the greater the tendency to issue new loans.

The second explanatory variable is $\boldsymbol{Interbank_{i,t}}$, namely the bank's interbank ratio at time t, given by interbank loans minus interbank deposits over total assets.

Since we want to capture the behavior of banks after the introduction of unconventional monetary policies, we consider this ratio in order to capture reactions to the negative interest rates policy, considering that this rates were the most affected by this policy. According to the work by Bottero et al., we expect that banks which have ex-ante larger net interbank positions, thus those more affected by the negative interest rate policy, cut their interbank loans and

increase the amount of loans supplied to customers. Moreover, as results from the analysis conducted in the paper named before, banks more affected by this policy reduce their investment in lower yield assets, such as short-term interbank claims, and rebalance their portfolio towards higher yield assets, like corporate loans in general.

The third key explanatory variable is $\boldsymbol{Securities_{i,t}}$, given by the amount of long-term securities held by banks divided by the total assets. It is considered to value the liquidity position of banks. Since at the beginning of our analysis we have assumed that loans and securities are perfect substitutes, we want to investigate how the investment in securities has changed consequently to the introduction of unconventional monetary policies, and we expect a negative relation with respect to the supply of credit. We decided to consider long-term securities because, as we have learnt from the existent literature, a consequence of the Asset Purchase Programme conducted by the ECB is the change in the duration of the original banks' portfolio: for this reason, financial intermediaries, in order to restore this parameter, need to take a reinvestment decision between long-term securities or newly issued long-term loans.
In the following figures we can have an overview of the allocation of loans and securities in banks portfolio, considering the whole sample of banks for each year under consideration, both for the Italian and German case.
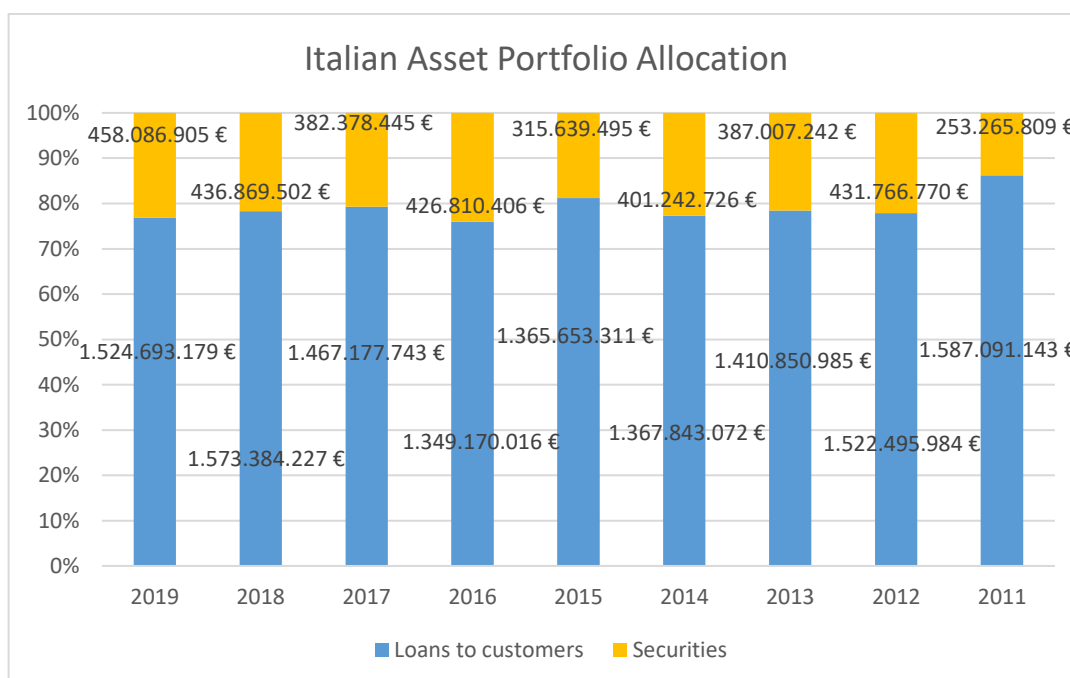
FIGURE 14. ITALIAN ASSET PORTFOLIO ALLOCATION. ELABORATION OF DATA TAKEN FROM OUR DATASET.

The charts above clearly show the portfolio allocation of banks in the period analyzed. We consider a yearly cumulative value of all banks in the sample, distinguishing between loans to customers and long-term securities. As we can notice, in the Italian sample even more of the 70% of funds are invested in illiquid loans, while the remaining 30% or less is invested in securities.

For what concern the German case, instead, there is, in general, a slight prevalence of loans with respect to securities in banks' balance sheets.

After having illustrate the three main variables which contribute to determine the direction of the lending activity of banks, we now introduce the other variables included in the regression, used as control for some bank-specific factors.

To measure the bank credit risk, we incorporate the variable measuring the amount of non-performing loans in banks' balance sheet, given by the ratio between NPL to total loans: $NPL_{i,t-1}$. We consider the first lag of this variable: banks which held a significant amount of deteriorated credit in t-1 will be less incentivized to offer credit in t, since they would not take additional risk given they already unstable position on credit.

The ratio of non-performing loans is useful to assess the ability of banks to collect repayments: it is a good indicator of the credit risk which, in turn, influences the lending activity of banks.

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NPLs can be defined as credit positions towards customers which cannot be repaid, fully or in part, due to a worsening of the liquidity position of the client. In order to better classify the deterioration of credit according to the gravity of the situation, we can distinguish between three types of loans: bad loans, for which debtors are in insolvency or in comparable situations; unlikely-to-pay, for which bank assesses a low probability of being repaid, without the introduction of guarantee measures; finally, past due loans, include past due exposures by more than 90 days.

As we have discussed before, we expect a negative relation between NPL and the dependent variable, since the higher the fraction of deteriorated credit the lower the new loans issued, due to the worse financial stability of bank.

Another controlling variable is $Dep_{i,t}$, which we include to control for the possible existence of a liquidity channel, the bank lending channel, searching for changes in credit supply due to changes in deposits (Butt et al. 2014). This variable represents the growth rate of deposits: it is calculated as the difference between the amount of deposits at time t and the amount of deposits at time t-1, divided by the last term. We consider this variable taking in consideration another ratio, total loans over total deposits, focusing on the denominator of it. Measuring the variation of liquidity held by the bank, an increase of it enables the financial institution to increase the amount of loans in order to maintain the same ratio.

For this reason, we expect a positive relationship with the dependent variable: when there is a positive variation of deposits, we should observe an increment in the supply of loans.

The following variable is $ROA_{i,t}$. It is one of the main performance indexes, valuing the ability of banks in making profitable investments, defined as the ratio between the income after taxes over the average of total assets, during the same period t.

We use this control variable to verify whether there are changes in loan supply determined by variations in banks' performance. However, it is difficult to determine a priori the coefficient sign, since it is largely influenced by the amount of capital ratio held: banks with a low capitalization might not increase the lending activity just to not augment the risk borne, since they have not enough capital buffer to overcome eventual defaults. On the other hand, banks with a high level of capitalization should increase the newly issued loans, in order to increase profits, and thus ROA.

For these reasons, we need, firstly, to run the regression, then analyze the direction of the relationship between this variable and the dependent one, and finally draw some conclusions.

Going on, we include in the equation another control variable, $Tier1_{i,t-1}$, constituting an important determinant of the bank's capitalization, which is a significative element determining the tendency to increase the supply of credit. We consider the first lag assuming that banks satisfying capital requirements and holding a higher percentage of capital in t-1, are more likely to invest in loans.

In general, banks have to satisfy specific capital requirements according to the Basel II and, after 2013, to Basel III. The aim of capital requirements, acting as a buffer, is to help banks to absorb losses due to market, credit and operational risk.

Tier 1 capital is defined as the sum of Common Equity Tier 1 and Additional Tier 1. The former is also known as the best quality capital and comprises common shares, stock surpluses resulting from the issue of common shares, retained earnings, common shares issued by subsidiaries and accumulated other comprehensive income. The latter, instead, is formed by instruments that are not common equity, but are eligible to be included in this tier and share premium account related to such instrument. Together with Tier 1 capital, the Basel III Accord requires the Tier 2 capital, constituted by loan loss provisions, subordinated loans and other capital instruments that fulfill the related criteria.

The optimal level required is a total capital ratio, hence the sum of Tier 1 and Tier 2, not below the 8%, divided as following: the CET1 must be at least 4,5%, while Tier 1 (CET1 + AT1) should not be less than 6%, where the percentages are calculated in relation to the risk-weighted assets (total assets held by banks weighted by the credit risk).

Focusing on the expected sign of the variable coefficient, one can think that, given the objective of capital requirements, and in particular Tier 1 capital, higher value of bank capitalization implies a higher supply of loans by such banks, since they can better manage risks deriving by the operations, absorbing financial difficulties: on the other side, lower capitalized banks should be more reluctant in granting credit because of their financial instability due to the lower level of capital. However, it is not so easy to determine the correct direction of the relationship with the dependent variable, because there is another strand of literature that, instead, considers the willing to increase the risk borne by low capitalized banks.

The following variable considered is $Size_{i,t}$, used to control for the impact of the bank's size on the dependent variable. It is calculated with the natural logarithm of the total assets, thus permitting us to better compare dimensions of banks, reducing the differences between banks, considering the big variety that constitutes our samples. We expect a positive relation with the supply of loans. Bigger banks can better shield financial shocks, given their ability to diversify

investments, but in turn this can reverse the situation expanding the assets included in their portfolio instead of increasing the amount of loans supplied.

We include in the regression also the variable measuring the GDP_t, fixed in terms of banks, but varying in time, in order to better study the relation between the demand and the supply of credit. GDP includes consumption, investment and the public expenses in the whole economy: positive growth of this variable implies, in general, a better situation in the economy, leading to an increase in credit demand and, thus to a consequent increment in the supply side. We consider the growth rate of GDP, given by the difference between the current GDP and the previous year one over the last year GDP.

Finally, the last variable is a measure of the country risk: the amount of government net debt in relation to GDP, D_t. We decided to include this value, instead of the simple debt-to-GDP ratio because it is a broader aggregate of the latter and, moreover, is one of the elements to consider to verify the compliance criteria set out in Maastricht.
It measures the impact on the percentage of GDP of the government net debt; this implies that banks in riskier countries, being more capital constrained, due to the higher capital buffer required, offer less credit to customers.

After having discussed the expected results of the variables considered and the impacts on the dependent variable, in the next chapter we are going to conduct the analysis, observe the effective results and comment them in relation to our initial hypothesis on the portfolio rebalancing channel existence. After all, we will draw our conclusions.

6. MODEL AND RESULTS

6.1. The Italian case

From here we begin to illustrate the main statistics and the panel regression model for the variables considered. The total number of observation is 225, given by the 9 yearly observations for each of the 25 banks in the sample: there are three exceptions, Yield, GDP and D, which do not vary across cross-sectional observations but only across time, hence we have only 9 observations; however, due to incomplete data, as we will discuss later, in the table we can observe lower observations for some regressors.

Variable	N. Obs.	Mean	Std. Dev.	Min	Max
Loans_it	223	55.27433	22.94647	2.48	88.7
Yield_t1	9	.7942222	1.354024	-2.069	2.7
Interbank_it	223	-6.87527	34.10274	-398.3221	81.99613
Securities_it	217	17.53407	15.67114	.2644879	128.5572
NPL_it1	213	10.56883	8.622737	.14	38.63
Dep_it	218	3.471596	25.07574	-99.67736	128.2792
ROA_it	213	.3515129	1.177601	-3.88	8.91
Tier1_it1	220	13.01794	5.02021	5.7	40.75
Size_it	218	17.6093	1.335431	15.18011	21.04579
GDP_t	9	.08	1.437073	-2.98	1.67
D_t	9	2.622222	.536144	1.6	3.6

TABLE 1. DESCRIPTIVE STATISTICS OF VARIABLES: ITALIAN CASE.

The percentage of loans on total assets amounts, on average, to a level of 55, with a minimum of 2.48 and a maximum of 88.7. As regard as the yield, it moves within a range of values going from -2.069 and 2.7. In addition, the average level of securities held in banks' financial portfolios is 17, supporting the hypothesis that banks, in the period observed, are more likely to invest in loans rather than in long term securities. The mean level of NPL is 10,57: not significantly high, but, however, we reach a maximum level of 38.63 in our sample, thus maintaining a consistent amount of impaired assets. Focusing on ROA, we can notice that in the sample the minimum value of the variable reached -3.88, meaning that, reasonably during the first years of the time under consideration, coinciding with the sovereign debt crisis, banks

suffer a reduction in profitability. Finally, another variable that is worth to consider is the Tier1 ratio, which suggests that on average banks are well capitalized, with a mean value of 13.02%, reaching maximum levels of 40%.

	Y_t	Int_it	Sec_it	NPL_it1	Dep_it	ROA_it	T1_it1
Y_t	1.0000						
Int_it	-0.0252	1.0000					
Sec_it	-0.0524	0.0655	1.0000				
NPL_it1	-0.0931	-0.1258	-0.0925	1.0000			
Dep_it	0.1118	-0.0008	0.0920	-0.1522	1.0000		
ROA_it	-0.0320	0.2204	0.2313	-0.2150	0.0503	1.0000	
T1_it1	0.0898	0.6643	0.0306	-0.2370	0.0517	0.1312	1.0000

	Size_it	GDP_t	D_t
Size_it	1.0000		
GDP_t	0.0148	1.0000	
D_t	0.0831	0.2003	1.0000

TABLE 2. CORRELATION MATRIX OF VARIABLES: ITALIAN CASE.

Going on with the analysis, it is important to have a look on the correlation between the explanatory variables in order to study the extent to which they are related with each other, thus allowing us to avoid redundant information, once we know how much one variable is already explicated by another. Our matrix shows that there are not cases of strong correlation between variables, thus reducing the probability of biases due to multicollinearity. However, since the Pearson's correlation coefficient is not recommended to quantify problems of multicollinearity when, for example, there are not much historical data: hence, in order to be sure of our values, we compute the VIF of each estimator. This measure indicates by how much multicollinearity increases the variance of an estimated coefficient. VIF equal 1 (9 out of 10 variables of our model) indicates that for that variable there is no case of multicollinearity. There is not a threshold determining serious cases of multicollinearity: a rule of thumb is that if VIF is greater than 10, then multicollinearity is high. In our case, we do not even pass the threshold of 5, which is however commonly used.

Now, we perform a panel regression analysis to study the relationship linking the amount of loans granted to customers and the selected independent variables.

In preparing our data, the software STATA indicates that we are working with a strongly balanced panel data, meaning that there are no missing values for the observations in each year. However, we obtain this result because the command used controls only for some variables: in fact, we will work with an unbalanced dataset, due to the unavailability of data for certain years. We will run the regression in three different ways, pooled OLS, Random Effect and Fixed Effect, in order to detect for some potential bias. Then, we will conduct specific tests to determine the best appropriate method. Finally, also some robustness tests will be performed.

6.1.1. Pooled OLS

The following table reports the Pooled OLS estimation model, one of the three used for a panel regression model. This is the simplest method, and in calculating it, all the individually specific effects are ignored: to obtain consistent estimates, it is necessary to assume that the unobserved effect is uncorrelated with the error term.

At a first look, we do not obtain the expected results for all the variables considered: only the coefficient of net interbank position and securities respect the predictions of a negative relationship with the dependent variable, while the one of yield is in contrast with what we expected.

The R-squared stands at a medium-low level (0.43), indicating a scarce goodness of the model since this value mirrors the amount to which the variance of the dependent variable is explained by the independent ones.

According to the results, there are seven coefficients significant at a 1% significance level: *Yield_t1*, *Interbank_it*, *Securities_it*, *NPL_it1*, *Tier1_it1*, *Size_it* and *D_t*, since their p-values are lower than 0.01. These results confirm that there exists a relation between the supply of loans and the introduction of unconventional monetary policy, since the key explanatory variables are significant.

Source	SS	df	MS		Number of obs	=	203
					F(10, 192)	=	14.67
Model	43368.0625	10	4336.80625		Prob > F	=	0.0000
Residual	56766.3681	192	295.658167		R-squared	=	0.4331
					Adj R-squared	=	0.4036
Total	100134.431	202	495.715003		Root MSE	=	17.195

Loans_it	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Yield_t1	-3.2567	1.2417	-2.62	0.009	-5.705826	-.8075745
Interbank	-.1411977	.0402055	-3.51	0.001	-.2204989	-.0618965
Securities_it	-.4385442	.0851099	-5.15	0.000	-.6064146	-.2706737
NPL_it1	.5466669	.1853288	2.95	0.004	.1811249	.9122088
Dep_it	.0168013	.0681754	0.25	0.806	-.1176676	.1512702
ROA_it	-1.900332	1.341427	-1.42	0.158	-4.546157	.7454933
Tier1_it1	-1.437454	.2948265	-4.88	0.000	-2.018968	-.8559388
Size_it	-4.007481	.9865948	-4.06	0.000	-5.953437	-2.061525
GDP_tgrowth	2.118002	1.313931	1.61	0.109	-.4735918	4.709595
D_t	-9.357213	2.899774	-3.23	0.001	-15.07672	-3.637708
_cons	173.7562	21.94362	7.92	0.000	130.4747	217.0377

TABLE 3. POOLED OLS ESTIMATION RESULTS: ITALIAN CASE. SOFTWARE: STATA.

As we have anticipated before, the pooled OLS is a helpful guideline for further investigations, but rarely it is the best estimation method for the analysis, due to the limit assumptions that distinguish it.

For these reasons, we continue with the analysis, computing the random effects of the panel model.

6.1.2. Fixed Effects Model

The Fixed Effects model is another efficient way to eliminate the unobserved effect, the bank specific intercept a_i, which captures the heterogeneities across entities that would be considered an integral part of the error term. The unobservable values, in addition, might be correlated with the explanatory variables, returning a biased estimation. The elimination of the term is based on a time-demeaning process, consisting on the subtraction of the group average from each variable and on the estimation of the model without intercept with a pooled OLS estimator. This one is called within estimator, since it uses time variation in y and x within each cross-sectional observation, which considers individual effects, but it erases them using for each banks, in our specific case, the information deriving from time variations.

To obtain an unbiased estimation, using the Fixed Effects model, it is necessary to make some strict exogeneity assumptions: firstly, the idiosyncratic error term should be uncorrelated with each explanatory variable at each time t, namely $Cov(u_{i,t}, u_{i,s}|X_i, a_i)=0$; secondly, the within

estimator allows for arbitrary correlation of the unobserved effect a_i with the explanatory variables at each time, hence Cov(a_i; $\mathbf{X}_{i,t}$)≠0.

In addition to these assumptions, further ones are needed to obtain valid estimations: the homoskedasticity and absence of serial correlation among error terms across time.

Focusing on the obtained results, we can notice that the within R-squared is very low and equal to 27%: this represents the amount of variance of the lending activity that is explained by the predictor variables. Furthermore, there are three coefficients that are significant at a 1% level: *Yield_t1*, *NPL_it1* and *D_t*, while *GDP* is significant at a 5% level and *Securities_it* at a 10% level. Nevertheless, the signs we obtain are in contrast with the expectations, in particular the one of the yield variable, which is negative.

We can obtain a similar result by running a joint-F test to check whether the explanatory variables are jointly different from zero under the alternative hypothesis. The software used does it automatically, and the outcome is:

$$F\ (24,168) = 31.17 \qquad\qquad Prob > F = 0.0000$$

thus, indicating the significance of the model estimates.

```
Fixed-effects (within) regression              Number of obs      =        203
Group variable: banknum                        Number of groups   =         25

R-sq:                                          Obs per group:
    within  = 0.2753                                        min =          4
    between = 0.2138                                        avg =        8.1
    overall = 0.0021                                        max =          9

                                               F(10,168)          =       6.38
corr(u_i, Xb)   = -0.2850                       Prob > F           =     0.0000
```

Loans_it	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Yield_t1	-1.58462	.5827518	-2.72	0.007	-2.73508	-.4341597
Interbank	-.009923	.0222319	-0.45	0.656	-.0538128	.0339669
Securities_it	-.0940152	.0549829	-1.71	0.089	-.2025617	.0145314
NPL_it1	-.4299826	.1225392	-3.51	0.001	-.6718977	-.1880675
Dep_it	-.0441369	.0341131	-1.29	0.197	-.1114824	.0232086
ROA_it	.394364	.7895698	0.50	0.618	-1.164393	1.953121
Tier1_it1	.0654392	.1881174	0.35	0.728	-.3059394	.4368177
Size_it	-1.091769	2.362244	-0.46	0.645	-5.755276	3.571737
GDP_tgrowth	1.55145	.6583693	2.36	0.020	.2517065	2.851193
D_t	-6.401338	1.455484	-4.40	0.000	-9.274732	-3.527944
_cons	98.84934	43.25598	2.29	0.024	13.45402	184.2447

```
sigma_u |   23.112109
sigma_e |   7.8718098
    rho |   .89605476   (fraction of variance due to u_i)
```

TABLE 4. FIXED EFFECTS MODEL ESTIMATION RESULTS: ITALIAN CASE. SOFTWARE: STATA.

By estimating the same regression using the Random Effects model, we can observe the effects of the time-invariant component included in the dependent variable.

6.1.3. Random Effects Model

On the other hand, the base assumption that is made in conducting the Random Effects model is that the unobserved effect a_i is uncorrelated with the independent variable $X_{i,t}$ (hence $\text{Cov}(a_i;$ $X_{i,t})=0$). In this model, the time-invariant effects are treated as realizations of a random variable, from which it takes the name. In this way, we can include in the analysis also these effects considering them as part of the error term. In addition, while the Fixed Effects model subtracts the time averages from the corresponding variables, the Random Effects one subtracts a fraction of that time averages, and because of this mechanism it uses *quasi-demeaned* variables. As in the case of pooled OLS, even under the random effects model the unobserved effect is partially included in the error term; however, contrarily to the former case, the latter exploits a Generalized Least Square estimator in order to overcome problems of autoregressive serial correlation.

The results obtained in conducting the analysis are reported in the following table:

```
Random-effects GLS regression              Number of obs      =         203
Group variable: banknum                    Number of groups   =          25

R-sq:                                      Obs per group:
    within  = 0.2489                                    min =           4
    between = 0.0802                                    avg =         8.1
    overall = 0.0755                                    max =           9

                                           Wald chi2(10)      =       47.85
corr(u_i, X)    = 0 (assumed)              Prob > chi2        =      0.0000
```

Loans_it	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yield_t1	-1.800429	.6546685	-2.75	0.006	-3.083556	-.5173024
Interbank	-.0267117	.0245575	-1.09	0.277	-.0748435	.0214202
Securities_it	-.1485378	.0594787	-2.50	0.013	-.2651138	-.0319618
NPL_it1	-.2771584	.1322797	-2.10	0.036	-.5364218	-.0178949
Dep_it	-.0380195	.0376827	-1.01	0.313	-.1118763	.0358374
ROA_it	-.2858868	.8673235	-0.33	0.742	-1.98581	1.414036
Tier1_it1	-.136803	.2059974	-0.66	0.507	-.5405504	.2669444
Size_it	-1.364579	1.687613	-0.81	0.419	-4.67224	1.943082
GDP_tgrowth	1.604474	.7338261	2.19	0.029	.1662018	3.042747
D_t	-6.844519	1.604309	-4.27	0.000	-9.988906	-3.700132
_cons	106.0435	31.59362	3.36	0.001	44.1211	167.9658

sigma_u	12.099776	
sigma_e	7.8718098	
rho	.70261842	(fraction of variance due to u_i)

TABLE 5. RANDOM EFFECTS ESTIMATION RESULTS: ITALIAN CASE. SOFTWARE: STATA.

The information provided highlights two variables statistically significant at a 1% level (*Yield_t1* and *D_t*), and three regressors at a 5% significance level (*Securities_it*, *NPL_it1* and *GDP_tgrowth*). For these variables, the direction of the relation with the dependent variable is the one that we expected, with the exception of *Yield_t1*, which indicates that an increment of the difference between the cost-of-borrowing of new long-term loans and the 10 year government bond yields produces a reduction in the supply of loans.

After this quick synthesis of the results provided by each regression method, we need to determine the best fitting one, in order to obtain a suitable indication of the functioning of the portfolio rebalancing channel and of the factors, in general, that affect the lending behavior.

To do this, we need to run some tests to identify the best appropriate model: the first we will examine is the Hausman test, which allows us to choose between the Fixed and the Random models; then, the Breusch-Pagan-LM model, which, instead, compares the Pooled OLS estimation with the Random Effects, determining the best estimation method; finally, other diagnostic tests will be conducted in order to check whether additional assumptions of the models hold or not.

Hausman test. Hausman (1978) was the first who proposed a test to verify the statistically significant differences in the coefficients of the time-varying explanatory variables of both the Fixed and Random Effects models.

The null hypothesis of this test is that the variance of the unobserved effect a_i is uncorrelated with the explanatory variables, meaning that one should use the Random Effects unless the Hausman test rejects the null hypothesis. If, alternatively, H_0 is rejected, then individual effects are significantly correlated with at least one regressor and, for this, it should be better to use the Fixed Effects model, since the Random one might be biased.

- H_0: $Cov(a_i; X_{i,t}) = 0$
- H_1: $Cov(a_i; X_{i,t}) \neq 0$

Essentially, a failure in the rejections of the null hypothesis means that RE and FE estimates are sufficiently close so that it does not matter which one is used, since the difference between the two is negligible.

Below we report the results:

```
                  ──── Coefficients ────
                    (b)            (B)          (b−B)      sqrt(diag(V_b−V_B))
                    fe             re        Difference         S.E.
    ─────────────┼──────────────────────────────────────────────────────────
        Yield_t1 │  -1.58462     -1.800429     .2158093        .0522013
        Interbank│  -.009923     -.0267117     .0167887        .0049668
     Securities~t│  -.0940152    -.1485378     .0545227        .0173745
          NPL_it1│  -.4299826    -.2771584    -.1528242        .0396647
           Dep_it│  -.0441369    -.0380195    -.0061174        .0076154
           ROA_it│   .394364     -.2858868     .6802508        .1988422
        Tier1_it1│   .0654392    -.136803      .2022422        .0501054
          Size_it│  -1.091769    -1.364579     .2728094       2.058933
      GDP_tgrowth│   1.55145      1.604474    -.0530249        .109599
              D_t│  -6.401338    -6.844519     .4431805        .3416931
```

```
                         b = consistent under Ho and Ha; obtained from xtreg
              B = inconsistent under Ha, efficient under Ho; obtained from xtreg

     Test:  Ho:  difference in coefficients not systematic

           chi2(10) = (b−B)'[(V_b−V_B)^(−1)](b−B)
                    =          48.68
           Prob>chi2 =         0.0000
```

TABLE 6. HAUSMAN TEST: ITALIAN CASE. SOFTWARE: STATA.

According to the results, we obtain a p-value equal to 0.0000, meaning that we reject the null hypothesis and we accept the alternative one, assessing the Fixed Effects as the more appropriate for our analysis.

Breusch-Pagan-LM. At this point, we conduct the Breusch-Pagan-LM test to be sure that we can exclude the pooled OLS from our analysis. It is used to test for the heteroskedasticity in a linear regression. The null hypothesis of this test assumes that the variance of the unobserved effect is zero, thus supporting the goodness of the pooled OLS estimation method. If the null hypothesis is accepted, then it means that we can ignore the panel effect of the regression, since it is possible to obtain significant estimation by simply using the Ordinary Least Squared method. Otherwise, if we reject H_0, then there exists a significant correlation between a_i and at least one explanatory variable, hence the random effects model better explains the heterogeneity with respect to the pooled OLS.

The outcomes of the test are then presented:

```
          Breusch and Pagan Lagrangian multiplier test for random effects

               Loans_it[banknum,t] = Xb + u[banknum] + e[banknum,t]

               Estimated results:
                                         Var       sd = sqrt(Var)
                          ─────────────────────────────────────────
                Loans_it  │     495.715            22.26466
                       e  │     61.96539            7.87181
                       u  │     146.4046           12.09978

           Test:    Var(u) = 0
                                   chibar2(01) =    143.55
                               Prob > chibar2 =    0.0000
```

TABLE 7. BREUSCH-PAGAN-LM TEST: ITALIAN CASE. SOFTWARE: STATA.

According to the results, we obtain a p-value equal to 0.0000, hence we reject the null hypothesis, confirming the presence of a panel effect that makes the Random Effects model the most suitable.

The final results of our first analysis lead us to assess the Fixed Effects model to be the most fitting and appropriate to capture the variations in the lending activity in the Italian banking system, in relation to certain factors linked to monetary policy.
We will analyze in detail the results obtained with the FE model, considering each coefficient at a time and discussing the resulted relationship with the dependent variable.

Going in the order of the regression, the first variable we encounter is *Yield_t1*. This is one of the key explanatory variables of our model, and it is statistically significant at 99% confidence level. However, the sign of the coefficient does not fulfill our expectations. The large negative value obtained implies that an increase of 1 unit of *Yield_t1*, produces a reduction in the amount of loans supplied to customers of 1.58. This negative relationship is quite complex to explain. We start from the composition of the variable, which is determined by the interest rates applied on new loans and the yields of government securities. In addition, we need to consider that in the regression we include the government net debt to GDP, which is a proxy to measure the risk of the country.
Considering these two elements together, the assumption that we make is the following: given that the Italian government net debt to GDP is established at a high level, the yields of the government securities is, as a consequence, fairly high, since it includes the intrinsic risk of the country. Established that, if the yield of the 10-y government securities remains at a consistent level, due to the fact that the debt variable prevails on this one, the difference between the two

values will increase, turning negative, if the interest rates applied on new loans to customers reduces.

For this reason, since increases of the variable *Yield* are associated to reductions in the interest rates on loans, enhanced even by the fact that the reduction was more pronounced in vulnerable countries, banks will not increase the amount of credit granted and, on the contrary, they will reduce it.

Therefore, although if we are reasoning in negative terms, we can observe the tendency of banks in directing the reinvestment decisions towards higher-yielding assets, which in this case are not loans: the search-for-yield behavior has a crucial role in taking investment decisions and shaping the banks' asset portfolios.

Moreover, the next variable we will discuss is ***Interbank_it***, which examines the net interbank position of each bank at time t. In this case, we obtained the expected sign of the coefficient, but it does not appear to be significant for our analysis.

This ratio is included in the regression because we want to study how various monetary policy interventions, in this case the negative interest rates, have influenced the banks' lending behavior. Even if it is not significant, we can still explain the sign: since key monetary policy interest rates are the first to change after the implementation of monetary measure, we can efficiently control the effects of this maneuver on the supply of loans. Changes in the abovementioned interest rates, would lead banks to reduce their interbank loans, incentivizing them to increase loans to customers; a reduction in the ratio is associated to an increment of credit.

The third key explanatory variable, ***Securities_it*** is statistically significant at a 90% confidence level and, as expected, the coefficient is negative, equal to -0.0940152. Since this variable is one of the most important considered, in order to demonstrate the existence and the functioning of the portfolio rebalancing channel through which monetary policy affects banks' lending behavior, this negative coefficient is determinant.

We can affirm that an increase by one unit of the amount of securities in the portfolio of banks leads to a reduction by 0.09 units the loans granted, and viceversa.

One of the initial assumptions we have made before starting our study was the perfect substitutability between loans and securities: for this reason, if a bank decides to direct its investment decisions towards credit, then the amount of securities held, with respect to total assets, will decrease, highlighting the correct functioning of the portfolio rebalancing channel.

The following variable is *NPL_it1*: it results to be significative at 99% confidence level, indicating a reduction in the amount of loans granted to the public by 0.43 units consequently to an increase by 1 unit in the amount of deteriorated credit. High levels of bad quality loans in banks' financial portfolio affect the managers investment decisions, because of the underlying risks and potential losses. This supports our decision to consider the lagged value of non-performing loans: in fact, if in the previous year the bank has accumulated bad loans, the next year managers will be more reluctant to invest in loans again.

Going on, the deposit growth rate, *Dep_it*, is not statistically significant. However, we can further discuss the unexpected sign: this result is particularly interesting and representing of the assets and liabilities management strategies of banks.

The negative coefficient might be explained considering that investors might have more convenient options in which allocate their resources and, because of this, the growth rate of deposits slow down, while credit still increases. In the recent periods analyzed, banks had the possibility of getting funds from other sources, like the consistent liquidity injections by the ECB, hence being able to satisfy the increasing demand for loans.

Moreover, strong of this fact, financial institutions may decide to invest in different ways the liabilities arising due to customer deposits.

ROA_it, instead shows a positive coefficient, even if it is not statistically significant. We should explain this result reflecting on the fact that since loans are risky investments due to the probability of default of the counterparty, they yield higher returns compared to other assets and, because of that, they should increase the profitability of the bank. However, this is not automatically correct, since the higher profitability depends on other variables, such as the costs of funding. In order to be sure of the sign of this regressor, we will wait further tests.

Studying the relation between the bank's capitalization and the lending behavior, *Tier1_it1* investigates how the lagged Tier 1 ratio impacts on credit granted. Our coefficient is not statistically significant and it results to affect positively the dependent variable: this means that an increase in the Tier 1 capital ratio leads to an augment of the amount of loans. This is because increases of the capital ratio allow banks to create a capital buffer, which helps them to face potential losses.

The variable *Size_it*, again, is not statistically significant. The direction of the relation with the dependent variable is negative and equal to -1.091769. This result might be explained

considering the fact that bigger banks can better diversificate their portfolios, directing their investment decisions towards other asset classes, while smaller banks should rely more on loans as a traditional business model.

The penultimate regressor of our analysis is **GDP_tgrowth**, statistically significant at a 95% confidence level. The coefficient mirrors the general economic conditions and the lending activity. In facts, GDP reflects the demand side of loans, considering the economic situations: amelioration in consumption and investments should lead to increases in the demand for loans. The positive coefficient obtained means that an increase of one unit in the GDP growth rate implies an increase of exactly one unit in the supply of loans.

Finally, **D_t**. This last variable is statistically significant at 99% confidence level and fulfills the expectation regard the sign of the relationship with the dependent variable. In particular, a one unit change in the government net debt in relation to the GDP of the country impacts very negatively the amount of credit supplied to the non financial customers. This is an important value, as the higher the credit risk of the country, the more the ECB will ask for capital as a buffer to cover eventual losses and probability of default. Being more capital constrained, banks will not increase the amount investments in loans in their asset portfolios.

6.1.4. Other diagnostics

Now, as previously anticipated, we will study the other assumptions to be satisfied in order to obtain unbiased fixed effects estimations.

<u>Wooldridge test for autocorrelation.</u> To check for the correlation between the error term and its lagged value in our panel data, which can cause less efficient estimates, we conduct the Wooldridge test for autocorrelation, which study the null hypothesis of no first-order autocorrelation.

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      24) =      18.308
              Prob > F =       0.0003
```

Since the p-value is lower than 0.05 and even 0.01, we are led to reject the null hypothesis, hence assuming the presence of autocorrelation in our panel data. For this reason, it should be better to further investigate the goodness of the fixed effects model, in order to be sure that the serial correlation does not produced biased estimations.

<u>Modified Wald test.</u> The second test we are going to run is the modified Wald test, which searches for heteroskedasticity problems in the fixed effects model of the panel data. The null hypothesis tested refers to the presence of homoskedasticity in the groups.

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (25)  =      3969.08
Prob>chi2 =       0.0000
```

Again, we obtain a p-value lower than 0.01, thus we reject the null hypothesis and confirm the heteroskedasticity presence.

According to the results presented, we found autocorrelation and heteroskedasticity problems which cannot be ignored, since the Fixed Effects model might produce not consistent coefficient estimates.

In order to bypass this problem, many authors proposed different methods, such as the Feasible Generalized Least Square, by Parks and Kmenta.

As our panel data, like the most of microeconometric panels, presents a time dimension smaller than the cross-sectional dimension, this approach would not return satisfying results. To mitigate the problem of FGLS method, Beck and Katz proposed a different approach: the PCSE, or Panel-Corrected Standard Error, which performs well with small panels.

The results using the modified model, hereby presented, are similar to those obtained with the Fixed Effects model previously discussed. *Yield_t1* maintains the negative sign, but it is not anymore statistically significant. The coefficient of *Interbank_it*, instead, turned significant, demonstrating the effectiveness of monetary policies in rebalancing banks' portfolios; the coefficient is significative at 95% confidence level. *NPL_it1*, now, is significant and positive, probably indicating a moral hazard behavior. *Tier1_it1* became statistically significant at 5% significance level and negative, as well as *Size_it*, but at 1% level.

Looking at the R-squared, now it tells us that the 39% of the total variance of the dependent variable is explained by the model, thus we obtain an improvement of our original value, but still it does not reach higher and more satisfying levels.

```
Prais-Winsten regression, heteroskedastic panels corrected standard errors

Group variable:    banknum                        Number of obs     =        203
Time variable:     Year                           Number of groups  =         25
Panels:            heteroskedastic (unbalanced)   Obs per group:
Autocorrelation:   common AR(1)                                     min =          4
                                                                    avg =       8.12
                                                                    max =          9
Estimated covariances       =        25           R-squared         =     0.3950
Estimated autocorrelations  =         1            Wald chi2(10)     =      54.38
Estimated coefficients      =        11            Prob > chi2       =     0.0000
```

Loans_it	Coef.	Het-corrected Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yield_t1	-1.101389	.8079803	-1.36	0.173	-2.685001	.4822236
Interbank	-.062549	.0272631	-2.29	0.022	-.1159837	-.0091142
Securities_it	-.210606	.0649039	-3.24	0.001	-.3378153	-.0833968
NPL_it1	.3745709	.1409611	2.66	0.008	.0982921	.6508496
Dep_it	-.0291051	.052572	-0.55	0.580	-.1321444	.0739342
ROA_it	-1.370873	.8338073	-1.64	0.100	-3.005106	.2633587
Tier1_it1	-.8681668	.3552619	-2.44	0.015	-1.564467	-.1718663
Size_it	-2.907699	1.075221	-2.70	0.007	-5.015094	-.8003051
GDP_tgrowth	1.297852	.8646405	1.50	0.133	-.3968124	2.992516
D_t	-6.914845	2.055563	-3.36	0.001	-10.94367	-2.886016
_cons	137.7456	21.41622	6.43	0.000	95.77055	179.7206
rho	.5370706					

TABLE 7. PCSE ESTIMATION RESULTS: ITALIAN CASE. SOFTWARE: STATA.

6.2. The German case

The analysis for the German case takes up the same typology of the one for the Italian sample. The only difference that is worth to highlight for the transparency of the analysis is the difference in the data related to the securities: this time, we will consider the long-term securities in general, without further narrowing the field to government securities due to lack of data.

We will continue presenting the summary statistics and the correlation matrix, then the estimation of the panel regression using three methods introduced in the first analysis and, finally, we will conduct some tests to determine the best fitting model and to control for other possible biases.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Loans_it	225	52.00185	21.53935	1.34	87.77
Yield_t1	9	1.404444	.1623702	1.09	1.64
Interbank_it	225	.2268983	20.49214	-35.30927	80.22673
Securities_it	225	14.3963	11.12443	.0557001	57.41278
NPL_it1	203	2.359677	2.060049	.01	13.52402
Dep_it	221	1.648309	22.15486	-88.70076	200.9184
ROA_it	225	.251132	.2920176	-1.512725	1.354705
Tier_it1	213	16.63146	9.551967	6.26	61.3
Size_it	225	18.49542	1.219766	16.24723	21.49527
GDP_tgrowth	9	1.724444	1.085601	.43	3.91
D_t	9	-.7	.8196798	-1.9	.9

TABLE 8. DESCRIPTIVE STATISTICS OF VARIABLES: GERMAN CASE.

We can observe that in a total of 225 observations for each variable, the percentage of loans to total assets represents, on average, is almost half of the total assets of the bank, with a minimum of 1.34 and a maximum of 88 level. On the other hand, the average amount of securities held in the financial statements does not even reach the level of 15. As for the Italian situation, we can affirm that the German banking system firmly relies on the lending activity rather than other long-term securities, even if in lower terms with respect to the previous case. The yield variable has an average of 1.40, reflecting the effects that it has on the supply of loans, while the mean of Tier 1 shows that German banks present reasonably higher levels of capitalization with

respect to that required by the Basel Accord: ranging between 6.26% and 61.3%, it establishes ex ante at a higher lever related to the Italian sample.

The growth of deposits stands at a low positive value, while the average value of ROA at 0.25% indicates that banks did not suffer much in terms of profitability during the financial distress: the minimum value reached was -1.51%, presumably during the sovereign debt crisis, which coincides with the first period of our analysis.

The amount of NPLs held in financial portfolios is significantly lower with respect to the Italian banking system, reaching a maximum value of 13% of the total loans.

Going on, we consider the correlation between variables in the regression.

	Yield_t	Int_it	Sec_it	NPL_it1	Dep_it	ROA_it	T1_it1
Yield_t	1.0000						
Int_it	-0.0252	1.0000					
Sec_it	-0.0524	0.0655	1.0000				
NPL_it1	-0.0931	-0.1258	-0.0925	1.0000			
Dep_it	0.1118	-0.0008	0.0920	-0.1522	1.0000		
ROA_it	-0.0320	0.2204	0.2313	-0.2150	0.0503	1.0000	
T1_it1	0.0898	0.6643	0.0306	-0.2370	0.0517	0.1312	1.0000

	Size_it	GDP_t	D_t
Size_it	1.0000		
GDP_t	0.0148	1.0000	
D_t	0.0831	0.2003	1.0000

TABLE 9. CORRELATION MATRIX OF VARIABLES: GERMAN CASE.

We can observe that there are no case of serial correlation, reducing the probability of having biased estimates due to multicollinearity. As for the Italian sample, we calculate also the Variance Inflation Factor, determining how much of the variance of an estimated coefficient increases because of multicollinearity, to verify more accurately the presence of the aforementioned problem. Results report low values, demonstrating that we can continue with our analysis excluding problems of multicollinearity.

From now on, we will conduct the same previous analysis using the German sample, to study the effects of the monetary policy intervention on a less vulnerable country during the sovereign debt crisis.

We will work with an unbalanced panel data.

6.2.1. Pooled OLS

At an initial look, we obtained the hoped results in terms of sign of the coefficients, except for *Yield_t1* and *GDP_tgrowth*, which reflect a negative relationship.

The variables related to the net interbank position, and securities indicate a negative direction of the relation with the lending activity, both significant at a 99% confidence level. Also *Size_it* and *Tier1_it1* are significant at the same level, while *D_t* is statistically significant respectively at 5% level.

Source	SS	df	MS		Number of obs	=	198
					F(10, 187)	=	31.28
Model	60242.5037	10	6024.25037		Prob > F	=	0.0000
Residual	36015.6421	187	192.597016		R-squared	=	0.6258
					Adj R-squared	=	0.6058
Total	96258.1458	197	488.620029		Root MSE	=	13.878

Loans_it	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Yield_t1	-.0739184	7.666074	-0.01	0.992	-15.19702	15.04918
Interbank	-.5423221	.0661632	-8.20	0.000	-.6728443	-.4117998
Securities_it	-.4360774	.0949121	-4.59	0.000	-.6233134	-.2488415
NPL_it1	-.4604064	.5270938	-0.87	0.384	-1.500221	.5794078
Dep_it	.018183	.0458939	0.40	0.692	-.0723533	.1087193
ROA_it	-3.133522	3.758279	-0.83	0.405	-10.54759	4.280551
Tier1_it1	-.424418	.1484687	-2.86	0.005	-.7173068	-.1315293
Size_it	-8.271969	.9166501	-9.02	0.000	-10.08027	-6.463664
GDP_tgrowth	-.3356889	1.096203	-0.31	0.760	-2.498202	1.826824
D_t	-3.679573	1.469345	-2.50	0.013	-6.578196	-.7809507
_cons	218.0478	21.20417	10.28	0.000	176.2176	259.8779

TABLE 10. POOLED OLS ESTIMATION RESULTS: GERMAN CASE. SOFTWARE: STATA.

Since pooled OLS estimation is based on rarely satisfied assumptions, we proceed with the analysis performing the Fixed Effects model.

6.2.2. Fixed Effects Model

Looking at the obtained results, we can notice that the within R-squared, namely the amount of variance of the dependent variable explained by the predictor ones, is roundly the 63%. There are four statistically significant variables at 99% confidence level (*Interbank_it*, *Securities_it*, *Size_it* and *D_t*). The variable related to GDP now is positive, fulfilling our expectations. Moreover, the fact that all the coefficients are different from zero reflects the significance of the model, as we can demonstrate also through a joint F-test on regressors, which gives as result:

$$F\,(24,\,163) = 180.06 \qquad\qquad Prob > F = 0.0000.$$

```
Fixed-effects (within) regression              Number of obs      =        198
Group variable: banknum                        Number of groups   =         25

R-sq:                                          Obs per group:
    within  = 0.6273                                        min =          4
    between = 0.4239                                        avg =        7.9
    overall = 0.4070                                        max =          9

                                               F(10,163)          =      27.44
corr(u_i, Xb)  = 0.3224                         Prob > F           =     0.0000
```

Loans_it	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Yield_t1	-.4791537	1.593525	-0.30	0.764	-3.625768	2.667461
Interbank	-.1701224	.0408149	-4.17	0.000	-.2507165	-.0895284
Securities_it	-.4803016	.0589667	-8.15	0.000	-.5967387	-.3638646
NPL_it1	-.1979141	.1340493	-1.48	0.142	-.462611	.0667829
Dep_it	-.0023279	.0097556	-0.24	0.812	-.0215915	.0169357
ROA_it	.2649693	1.127982	0.23	0.815	-1.962372	2.49231
Tier1_it1	.0635779	.0845663	0.75	0.453	-.1034087	.2305645
Size_it	-4.788654	.9327725	-5.13	0.000	-6.630529	-2.946778
GDP_tgrowth	.2047895	.2277845	0.90	0.370	-.2449993	.6545783
D_t	-2.399888	.3529504	-6.80	0.000	-3.096832	-1.702943
_cons	144.4427	18.06905	7.99	0.000	108.7631	180.1223

sigma_u	17.791998					
sigma_e	2.8339097					
rho	.9752576	(fraction of variance due to u_i)				

TABLE 11. FIXED EFFECT ESTIMATION RESULTS: GERMAN CASE. SOFTWARE: STATA.

6.2.3. Random Effects Model

Finally, the last estimation model to take into account is the Random Effects one. According to the results, the significant coefficients are the same of the previous estimation, hence *Interbank_it*, *Securities_it*, *Size_it* and *D_t* at 99% confidence level. In addition, the within R-

squared is fairly high, standing at 62% and reflecting the situation in which the majority of the explanatory variables are significant.

```
Random-effects GLS regression              Number of obs     =        198
Group variable: banknum                    Number of groups  =         25

R-sq:                                       Obs per group:
    within  = 0.6243                                       min =          4
    between = 0.4996                                       avg =        7.9
    overall = 0.4747                                       max =          9

                                            Wald chi2(10)     =     280.52
corr(u_i, X)    = 0 (assumed)               Prob > chi2       =     0.0000
```

Loans_it	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yield_t1	-.4748636	1.628732	-0.29	0.771	-3.667121	2.717393
Interbank	-.2042689	.0403063	-5.07	0.000	-.2832679	-.12527
Securities_it	-.482708	.0591041	-8.17	0.000	-.5985499	-.366866
NPL_it1	-.1852265	.1367557	-1.35	0.176	-.4532628	.0828097
Dep_it	-.0023454	.0099732	-0.24	0.814	-.0218924	.0172016
ROA_it	.186532	1.149957	0.16	0.871	-2.067343	2.440407
Tier1_it1	-.0010678	.0836738	-0.01	0.990	-.1650654	.1629298
Size_it	-5.153433	.8968132	-5.75	0.000	-6.911155	-3.395712
GDP_tgrowth	.1911049	.2328053	0.82	0.412	-.265185	.6473948
D_t	-2.493317	.3582616	-6.96	0.000	-3.195497	-1.791137
_cons	153.2817	17.59385	8.71	0.000	118.7984	187.765
sigma_u	14.844927					
sigma_e	2.8339097					
rho	.96483825	(fraction of variance due to u_i)				

TABLE 12. RANDOM EFFECTS ESTIMATION RESULTS: GERMAN CASE. SOFTWARE: STATA.

After having briefly discussed the results obtained in each case, now we need to determine which is the more appropriate for our analysis. As before, we run a series of tests, such as the Hausman test, to choose between the FE or the RE model, and the Breusch-Pagan Lagrangian Multiplier to select between the Pooled OLS estimation and the Random Effects. In the end, other diagnostic tests will be performed to verify whether the assumptions underlying the models are satisfied.

Hausman test. Under the null hypothesis of the Hausman test, we should prefer the Random Effects model to the Fixed one. For this reason, if we reject it, the Fixed Effect results to be the best estimation method.

According to the results that we can observe in the following figure, the p-value obtained is low enough to permit us to reject the null hypothesis and accept the FE model as the most

appropriate to detect the effects of the unconventional monetary policy on the portfolio investment decisions.

	── Coefficients ──			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fe	re	Difference	S.E.
Yield_t1	-.4791537	-.4748636	-.0042901	.
Interbank	-.1701224	-.2042689	.0341465	.0064229
Securities~t	-.4803016	-.482708	.0024063	.
NPL_it1	-.1979141	-.1852265	-.0126875	.
Dep_it	-.0023279	-.0023454	.0000175	.
ROA_it	.2649693	.186532	.0784373	.
Tier1_it1	.0635779	-.0010678	.0646457	.0122536
Size_it	-4.788654	-5.153433	.3647792	.2564968
GDP_tgrowth	.2047895	.1911049	.0136846	.
D_t	-2.399888	-2.493317	.0934295	.

```
                   b = consistent under Ho and Ha; obtained from xtreg
        B = inconsistent under Ha, efficient under Ho; obtained from xtreg

  Test:  Ho:  difference in coefficients not systematic

         chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                  =      24.66
         Prob>chi2 =     0.0060
         (V_b-V_B is not positive definite)
```

TABLE 13. HAUSMAN TEST: GERMAN CASE. SOFTWARE: STATA.

Breusch-Pagan test. The next test we will consider is the Breusch-Pagan to be sure that we can exclude the Pooled OLS from the analysis. The null hypothesis of this test states that the variance across the entities is equal to zero, meaning that there are not significant differences across them and, because of that, the panel regression could be neglected since we can perform an unbiased estimation using the simple OLS method.

```
Breusch and Pagan Lagrangian multiplier test for random effects

     Loans_it[banknum,t] = Xb + u[banknum] + e[banknum,t]

     Estimated results:
                        |     Var      sd = sqrt(Var)
              ----------+--------------------------------
              Loans_it  |    488.62        22.10475
                     e  |   8.031044        2.83391
                     u  |   220.3718       14.84493

     Test:   Var(u) = 0
                          chibar2(01) =    683.57
                       Prob > chibar2 =    0.0000
```

TABLE 14. BREUSCH-PAGAN TEST: GERMAN CASE. SOFTWARE: STATA.

Again, we obtain a p-value equal to 0.0000, so we can affirm that the Random Effects model is the best fitting, given the presence of the panel effect.

Pulling the sums of our analysis, we end up with the result that the Fixed Effects model is the optimal one to study the presence of the portfolio rebalancing channel for the transmission of the unconventional monetary policy.
At this point of the analysis, we will discuss the obtained results with the Fixed Effects.

Yield_t1: the obtained result is in contrast both with our initial expectations and with the logic of a similar result in the Italian scenario. For this reason, we refrain to discuss it now in order to wait for the results deriving from the subsequent tests that we are going to conduct.

The second variable we encounter is ***Interbank_it***, measuring the ratio of the difference between interbank loans and interbank deposits over total assets. The coefficient is statistically significant at a 99% confidence level and, as predicted, the sign indicates a negative relationship between this variable and the amount of loans supplied to the customers. Increasing by one unit the net interbank position of banks leads to a reduction by 0.17 of the supply of loans. Being significant, this variable contributes to demonstrate the existence of the portfolio rebalancing channel after the introduction of unconventional monetary policy: specifically, thanks to it we can check for the effectiveness of the negative interest rates. In fact, the interbank rate is immediately affected by the monetary policy shocks. In addition, when banks' reserves are remunerated at a negative rate, there is much incentive to reduce them by investing in riskier assets.

The third variable is ***Securities_it***, which is significant at a 99% confidence level and, with the negative sign of the coefficient, contributes to illustrate the functioning of the portfolio rebalancing. Assuming the perfect substitution between securities and loans, an increase in the amount of securities held reduces the amount of loans by 0.48 and vice versa. We can state that, thanks to the additional liquidity injected by the ECB's unconventional maneuvers, German banks could reinvest it in loans rather than in securities.

The fourth variable is ***NPL_it1***, not statistically significant. However, the sign of this variable is consistent with our predictions and reflects the vulnerability of banks in relation to the

deteriorated credit. An increasing amount of non-performing loans held in the financial portfolio reduces the tendency of granting loans due to the higher risk of losses.

The fifth variable is **_Dep_it_**. It is not statistically significant and the relative coefficient is negative, in contrast with the predictions. Also in this case, as for the Italian analysis, we can try to explain this result considering the general economic environment, which is creating more lucrative options for the investors and in which they can allocate their resources rather than bank deposits, thus creating a decrease in the pace of growth. Nevertheless, the amount of credit still increases, due to the alternative ways in which credit institutions can fund themselves to face the demand of loans.

Going on, the following variable is **_ROA_it_**, positive and not significant. Even in this case, as for the Italian one, we can explain the result considering that investing in riskier assets, such as loans, will increase the yield, which in turn should augment the profitability. However, before drawing conclusions, we wait for the last tests that will confirm or not this result.

The seventh variable is **_Tier1_it1_**. This coefficient is not statistically significant and, with its positive coefficient, reflects the tendency of banks in increasing credit after an increase in Tier 1 holdings. Being more capitalized, banks held a higher fraction of buffer against operational risks and they feel confidence in taking higher risks associated with the supply of loans.

The negative sign of **_Size_it_** contributes to the thesis that bigger banks have more diversification possibilities and, for this reason, could exploit other allocation of resources rather than the lending activity. In addition, the coefficient is statistically significant at a 99% confidence level.

The ninth regressor is **_GDP_tgrowth_**, not significant and positive. The positivity can be easily explained considering that GDP is calculated as the sum of consumption, investments and public expenditures. An increase of GDP creates better economic conditions, which in turn lead to a higher demand for credit. In response to this, banks increase the amount of loans to customers, given that better economic conditions contribute to improve the financial wealth of borrowers, encouraging banks to accept their demands.

Finally, the last explanatory variable we consider is **_D_t_**. It is statistically significant at 99% confidence level and it describes a negative relationship with the dependent variable, meaning that an increase in the government net debt in relation to GDP reduces the amount of loans by

1.97. It is coherent with our predictions, since in such situations banks are required to hold more capital buffer to face eventual default loss: however, in comparison with the Italian sample, the percentage of government net debt is consistently lower, hence capital requirements are lower and the reduction in loans, as a consequence, is lower.

6.2.4. Other diagnostics

After all, we conduct some others diagnostic tests to study whether the assumptions underlying the Fixed Effects estimation model are satisfied. As in the previous analysis, we will run two tests: the Wooldridge test for autocorrelation and the modified Wald test for heteroskedasticity.

Wooldridge test. The null hypothesis of this test assumes that there is no correlation between the error term and its lagged value; if we reject it, we should run an estimation model that correct this problem in order to obtain unbiased estimates. The results obtain are hereby presented:

```
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      24) =     38.957
             Prob > F =      0.0000
```

Since the p-value resulted is lower than 0.01, then we can reject the null hypothesis at the 99% confidence level and we conclude affirming that there is autocorrelation.

Modified Wald test. We conduct the modified Wald test to control for heteroskedasticity presence in the Fixed Effects model. Results are the following:

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (25)  =      569.37
Prob>chi2 =      0.0000
```

We can notice that the p-value is equal to 0.0000, thus we can reject the null hypothesis of constant variance and assess, in contrast, the presence of heteroskedasticity.

Since the previous tests have brought problems of autocorrelation and heteroskedasticity, we cannot ignore them if we want to be sure to obtain unbiased estimations of the relationship between the explanatory variables and our dependent variable. As in the previous analysis for the Italian sample, we will run again the regression using a model that corrects for the abovementioned issues: the Panel-Corrected Standard Errors. We have observed in literature that this model fits well with small samples and, particularly, in cases in which the cross-sectional dimension is bigger than the time dimension.

```
Prais-Winsten regression, heteroskedastic panels corrected standard errors

Group variable:     banknum                        Number of obs     =        198
Time variable:      Year                           Number of groups  =         25
Panels:             heteroskedastic (unbalanced)   Obs per group:
Autocorrelation:    common AR(1)                                min =          4
                                                               avg =       7.92
                                                               max =          9
Estimated covariances       =        25              R-squared         =     0.7743
Estimated autocorrelations  =         1              Wald chi2(10)     =     167.50
Estimated coefficients      =        11              Prob > chi2       =     0.0000
```

Loans_it	Coef.	Het-corrected Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yield_t1	2.841249	2.007202	1.42	0.157	-1.092794	6.775293
Interbank	-.3165943	.0576012	-5.50	0.000	-.4294905	-.2036981
Securities_it	-.5231699	.108158	-4.84	0.000	-.7351556	-.3111842
NPL_it1	.3026123	.2451491	1.23	0.217	-.1778712	.7830957
Dep_it	.0050316	.0114144	0.44	0.659	-.0173401	.0274033
ROA_it	-1.538357	1.011684	-1.52	0.128	-3.521222	.4445085
Tier1_it1	-.3958963	.1256054	-3.15	0.002	-.6420784	-.1497142
Size_it	-8.096184	.9406197	-8.61	0.000	-9.939765	-6.252604
GDP_tgrowth	.2536791	.3382586	0.75	0.453	-.4092957	.9166538
D_t	-1.942156	.7835823	-2.48	0.013	-3.477949	-.4063626
_cons	211.049	18.26187	11.56	0.000	175.2564	246.8416
rho	.8390381					

TABLE 15. PCSE ESTIMATION MODEL: GERMAN CASE. SOFTWARE: STATA.

Analyzing the new results, we can observe that the yield-induced rebalancing portfolio is still not present, since the coefficient of the related variable is not significant, however the sign turned positive, indicating that the enlarging of the difference between the interest rate on loans and the securities yields should incentivize banks to rebalance their portfolios towards credit rather than securities.

The two values constituting the Yield variable moved in slightly different ways during the time period under observation: while the yield of government securities constantly decreased, after the introduction of unconventional monetary policy, the interest rates on new loans decreased

at a slower pace, thus enlarging the difference and making it positive. This would give the incentive to banks to redirect their investment towards more profitable investments, which are, in this case, loans.

Another difference with respect to the Fixed Effects model can be observed in the NPL coefficient, which is positive, indicating a possible moral hazard behavior. Furthermore, the growth rate of deposits turned positive, meaning that an increase in the amount of deposits affects positively the banks' lending activity. Also *ROA* changed its sign becoming negative.

The last difference that is worth to highlight is change in sign of the Tier 1 coefficient, which turned negative and became significant at a 99% confidence level: increases in the supply of loans after reductions in the Tier 1 capital ratio might be symptom of a moral hazard behavior and profitability matters that push banks towards riskier investments, which would increase the value of risk-weighted assets, denominator of the ratio.

7. CONCLUSIONS

The aim of our work was to study how the implementation of monetary policies has affected the issuance of new loans to the non-financial sector, leveraging mostly the portfolio rebalancing channel.

We have started this study with a theoretical part, in which we have illustrated the monetary policies undertaken by the ECB in normal and financial distress periods, studying, in addition, the different transmission channels that contributed to influence the real economy. Then, we went on introducing a literature review, with the purpose of presenting the topic of our analysis.

The period under observation in our work took over immediately after the financial crisis of 2008 and the subsequent sovereign debt crisis in 2010-2011. Because of these financial turbulences, the banks' financial wealth was compromised as well as the activity in the lending sector. Hence, moved by this scenario, European Central Bank decided to intervene to repristinate the correct functioning of the economy and incentivize banks to offer credit to firms and households.

We conducted our analysis considering two distinct samples, one for the Italian and the other for the German banking systems: the underlying reason is that we wanted to investigate how monetary policies affected the two economies in terms of liquidity pass-through from banks to non-financial sector, starting from different economic and financial environments. The selection of the banks was based, in both cases, on the amount of total assets, thus considering the dimension of the institutions, and on the availability of data: we ended up with 225 observations, split into 25 groups and 9 years, from 2011 to 2019.

Overall, findings of the analysis showed important implications as regard as the impact of ECB's monetary policies on the banks' investment decisions.

Firstly, we run the regression for the Italian sample.

The Pooled OLS estimation gave us a general understanding of the relations that we wanted to detect; however, due to the fact that the assumptions underlying this model are rarely satisfied, we proceeded with the Fixed Effects and the Random Effects models. Going on, we conducted some robustness tests, concluding the FE to be the best fitting and appropriate model for our purpose.

This estimation method brought us important results: the amount of loans held in banks' financial portfolios was affected by monetary policies. Specifically, we obtained a negative

relationship between the dependent variable of our model and the spread between the yield of loans and other long-term securities, detaching from our sign expectations.

After all, we performed other diagnostic tests to evaluate the presence of autocorrelation and heteroskedasticity issues. Since results were positive towards them, to outflank these problems we conducted the same analysis using the PCSE estimation method, which produced unbiased estimates and mostly consistent with those originated by the Fixed Effects model.

Considering results, we could affirm that credit was affected primarily by the negative interest rate policy (NIRP) and by the amount of liquidity injected in the system by ECB, implying a reinvestment decision towards loans rather than securities, since the related variable in the equation indicated a negative relationship between loans and securities. Our initial hypothesis of perfect substitution between the two investment alternatives made securities an important determinant for the definition of the amount of loans granted to the non-financial sector, since the negative sign of the coefficient established that the reinvestment decisions, arising from the liquidity injections following the APP and TLTRO measures, could be made either on loans or on securities, where one alternative excluded the other.

All things considered, the analysis for the Italian banking sector produced favorable results in terms of the existence of a portfolio rebalancing channel, but did not show the effective presence of a yield-induced rebalancing, since the coefficient of the regressor was not significant.

As regard as the German scenario, we conducted the same analysis using the sample constituted by German banks and, again, the Fixed Effects model resulted to be the most appropriate.
Then, we performed tests for autocorrelation and heteroskedasticity, which resulted positive, requiring us to use the PCSE estimation method to correct these issues.

Findings resulted consistent with our expectations, describing the behavior of banks after the implementation of monetary policy measures. Even in this case, reinvestment decisions were affected by NIRP and the increasing liquidity held in banks' financial portfolio (two out of three key explanatory variables in the regression). Both coefficients were higher for German banks, indicating that they were responding better to incentives of ECB in fostering the liquidity pass-through from banks to non-financial sector.

There was no sign of search-for-yield behavior; however, whilst the relation between this variable and the amount of loans granted was negative in the Italian environment, it was positive in the German one. Even if not significant, this result highlighted the different framework of the two countries, contributing to determine the efficacy of monetary policy.

Among the other variables, we have found evidence on the role of capital and the level of total assets that strongly influenced the supply of loans: the former was more pronounced in the Italian scenario, while the latter in the German one, reflecting the different management and activities of the two types of banks.

Although our scope was to include in the regression variables that were meant to capture specific phenomena, defining them as a good and appropriate proxy, to comprehend the complexity of the banks' lending behavior is very difficult. Nevertheless, our analysis has produced interesting results that can contribute to demonstrate the effective existence of the portfolio rebalancing channel, permitting us to distinguish the reaction of banks in different countries, with different backgrounds.

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APPENDIX

Hereby are presented the selected banks that constitute our samples:

Italian Banks	German Banks
Unicredit	KfW Bankengruppe
Intesa Sanpaolo	Deutsche Bank
Banca IMI	DZ Bank
Banco BPM[22]	Commerzbank
Banca Monte dei Paschi	Unicredit Bank
UBI Banca	ING-DiBa
BNL	Landesbank Baden-Wüttemberg
Mediobanca	Deutsche Kreditbank
BPER	DZ Hyp
Credit Agricole Italia	Bausparkasse Schwabisch Hall
Mediolanum	Deutsche Pfandbriefbank
Fideuram	Bayerische Landesbank
Credito Emiliano	Deutsche Apotheker
Iccrea	Norddeutsche Landesbank
Banca Popolare di Sondrio	Santander Consumer Bank
Fineco Bank	Landesbank Hessen-Thüringen
Banco Piccolo Credito Valtellinese	Münchener Hypothekenbank
Carige	Aareal Bank
Banca Popolare di Bari	NRW.Bank
Banco di Desio e Brianza	Comdirect Bank
Banco di Sardegna	Wüstenrot Bausparkasse
Cassa di Risparmio di Asti	Sparkasse KölnBonn
Banca Generali	Berlin Hyp
Banca Popolare dell'Alto Adige	HSBC Trinkaus&Burkhardt
Banca IFIS	Dekabank

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[22] We have data from 2017, since it results from the merge of Banca Popolare di Milano and Banco Popolare. For the previous years we have chosen to consider only data of Banco Popolare for the sake of simplicity.