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The Effects of Quantitative Easing on Nonperforming Loans

Did the ECB's Quantitative Easing Policy Really Help Reduce Nonperforming Loans on The Balance Sheets of Eurozone Banks?

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Abstract:

The European central bank have initiated its quantitative easing policy to boost inflation in the eurozone, reduce yields and interest rates. To some extent, this policy has achieved all of these goals with varying degrees of success as some might argue. however, how does this unconventional monetary policy affect the issue of nonperforming loans on the balance-sheets of Eurozone banks. As the nonperforming loans are intricately linked to the interest rates as well as other macroeconomic determinants, it would be interesting to see if this policy have influenced the nonperforming loans ratios. Using Arellano and Bond difference GMM estimator, this thesis attempts to find what effect did this policy have on nonperforming loan. The results suggest that the effect was partially channeled through ex-ante channels such as interest rates. However, evidence of the announcement reducing the nonperforming loans was weak, especially when accounting for changes in the economy as well as the bank's financial position.

Keywords:
Quantitative easing (QE), Asset Purchasing Program (APP), Nonperforming loans (NPL), unconventional monetary policy, Eurozone banks, European Central Bank (ECB), Zombie banks, Arellano and Bond Difference Generalized Method of Moment (GMM), Dynamic model.

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1 Introduction

> *"While NPL remain a permanent feature of banks' balance sheets, policies and reforms should be geared to avoiding sharp increases that set into motion the adverse feedback loop between macroeconomic and financial shocks" (Nkusu, 2011)*

Eight years after Nkusu's paper, *nonperforming loans* remain one of the biggest issues on the balance sheets of banks. The nonperforming loans 'NPL' for Eurozone banks have underwent a series of changes following the financial crisis of 2008. The new guidelines and definitions addressing the nonperforming loans, the introduction of Basel III framework, and the *quantitative easing* 'QE' policy by the European central bank 'ECB'. While some of these changes are fundamental to the way nonperforming loans are recognized by banks, the ECB *quantitative easing* policy is not. This policy was introduced to boost lending, lift inflation rates above subzero levels, and stimulate the economy. In Nkusu's words, it is vital for policies -hence 'QE'- to avoid increasing nonperforming loans as that triggers an adverse feedback loop. However, the link between these nonperforming loans and quantitative easing remains unclear. While it is not the ECB's mandate to help cure *zombie banks*[1], it is still vital to see what effect if any did the policy have on the banks, and how such an effect could influence future policies. Therefore, a profound understanding of the mechanism between the QE policy and the NPL problem is essential. The unconventional monetary policies that the ECB adopted in recent years was been combined with other measures such as negative deposit rates. So, what effect -if any- did the *quantitative easing* policy have on the asset quality of banks within the euro area?[2]

European banks, in general, had nonperforming loans worth around €1 trillion on their books at the end of 2016[3] (Non-performing loans, 2017). Just like in the US and the UK, the Eurozone

[1] Zombie banks: banks with considerably higher than the EU average nonperforming loans level as defined by the banking supervision of the ECB (Non-performing loans, 2017).

[2] Asset quality of banks is a term that is often used interchangeably to describe performing loans as opposed to the remaining 'nonperforming loans'.

[3] €1 trillion represented nearly 6.2% of the total loan number of big banks (compared with 1.3% in the United States and 0.9% in the United Kingdom).

witnessed a largescale Asset Purchasing Program s 'APP' under the title of '*quantitative easing'* that supposedly simulates the economy in a way that should reduce nonperforming (NPL) rates (Dell'Ariccia, Rabanal, & San, 2018). Some researchers argue that the effect of such policy works only in theory, but in practice, it is not that effective. Then again, others argue that quantitative easing does not work in theory, but the effect should be there in practice. The NPL rates in the Eurozone remain higher than those found in the US and the UK. So why would the ECB's quantitative easing policy affect the asset quality of Eurozone banks? And if there is an effect, then what is the impact of that effect on an average bank.

The quantitative easing policy is expected to have a two-tier effect Nonperforming loans; a direct performative effect and an indirect 'channeled' effect. To see if such a claim is substantiated by evidence, an empirical analysis approach will be performed. The empirical analysis will use longitudinal data for 3541 banks operating within the Eurozone with annual data from 2008 until 2018. The model of choice is the dynamic panel-data estimator, specifically, the Arellano and Bond '*Difference Generalized Method of Moments (GMM)*' two-step estimator. Due to the persistent nature of the nonperforming loans (Radivojević, et al., 2019), previous studies have used the GMM model as the inclusion of a lagged dependent variable would produce biased coefficients if standard methods are used (Holtz-Eakin, Newey, & Rosen, 1988). Having endogenous regressors means that the error term is correlated with the regressors; that leads to inefficient estimations (Nickell, 1981). The model includes a set of macroeconomic variables as well as bank-specific variables to control for changes within the bank as well as the economy it operates in. The model tests the effect of the quantitative easing policy announcement as well as the Asset Purchasing Program 'APP' liquidity injection mandated by it. The results suggest that the liquidity injection executed under the QE policy have a statistically significant though an economically moderate effect on nonperforming loans. On the contrary, the results did not corroborate the claim of a performative effect from the policy; the announcement of the quantitative easing policy had negative effect on nonperforming loans, however, that effect is wiped out after accounting for changes in the economy and the bank characteristics. The results could potentially mean that quantitative easing has reduced nonperforming loans by improving economic outlook, reducing debt servicing costs, and by providing banks with enough liquidity to extend forbearance measures to troubled borrowers as opposed to being inclined to brand them as nonperforming.

The outline of the thesis

In the theory section, the definition of *nonperforming loans* will be presented and contrasted with the *forbearance* measure to establish the link between the two terms as well as their potential effect on results. Thereafter, an extensive review of the literature, and previous research on determinants of nonperforming loans -both macroeconomic and bank-specific-. Next, the ECB's *Asset Purchasing Program* -which is also known as *quantitative easing* policy- will be discussed with the potential effects according to the academic literature and the publications of the governing bodies. The effects of the quantitative easing policy will then linked to the determinants of nonperforming loans in order to establish a base for the research questions.
In the empirical analysis section, the research problem will be presented along with the related hypotheses. Next, the data collection process is explained and discussed as well as the variables that will be used in the analysis. Afterward, the model choice will be discussed with some depth before presenting the Generalized Method of Moments- in the methodology section as the model in which this analysis will be carried out. In the results section, the outcomes of the empirical analysis will be addressed and discussed; along with the implications and limitations. Lastly, the conclusion part will briefly present the findings of this thesis together with some areas where future research can explore.

2 Theory and literature review

The link between *nonperforming loans* 'NPL' and *quantitative easing* 'QE' has not explicitly been researched yet. To be able to find this link, the determinants of nonperforming loans need to be discussed first, the review of which encompasses the previous literature on the subject. Later on, the ECB's quantitative easing policy will be presented along with effects that it exerts according to previous research. Lastly, the similar channels that QE affects; and that NPL is effected by will be distinguished in order to find common connectors. These common factors could explain and maybe even capture the effect that QE exerts on NPL.

2.1 Non-performing loans

Nonperforming loans (NPL) have been a persistent issue in today's banking world. However, the term NPL is based on different definitions. Therefore, a clear the definition of NPL will be

presented and contrasted with the forbearance measures. The most prominent determinants of NPL for banks will be outlined and discussed.

Definition

The European Banking Authority (EBA) uses the uniform term non-performing exposure -or NPE for short- (Guidance to banks on non-performing loans, 2017, p. 47). This issue is also present due to the definition by the regulatory framework of "*NPEs*" verses the accounting framework definition of "*impaired*" in which a bank operates in. There are two key criterions to that drive the *NPE* definition, the first being the "past-due" criterion, and the second is the "unlikely-to-pay" criterion. The *NPE* concept is broader than both "*impaired*" and "*defaulted*". In plain English, all defaulted loans and impaired loans are *NPEs*, however, the opposite is not necessarily true. As banks within the euro area use different recognition criterion, that could potentially bias the results, however, this data is not disclosed (Baudino, Orlandi, & Zamil, 2018). That means that it is not possible to control for or incorporate within the model. This detail might help to explain some anomalies that could arise post regression phase.

It is important to mention that the definition of *Forbearance* and NPE are unambiguously connected. Forbearance measures consist of concessions –either modification of the contract, or refinancing the exposure– extended to any exposure –In the form of debt or a loan– towards a debtor facing or about to face financial difficulties in meeting its financial commitments (Guidance to banks on non-performing loans, 2017, pp. 54-55). As the definitions of default and forbearance are not unified and are open to changes through each bank's internal policy. The management of a bank has discretion on whether an exposure would be accounted as NPE or to consider it as forbearance. This decision -in our opinion- could be influenced not only by the type of debtor, but also by the economic outlook. This ability to artificially change the amount of NPEs which could lead to biased estimates due to this discrepancy depending on the economic outlook. While a person that is experiencing financial difficulties might require the non-performing status, a positive sentiment following policy announcement could influence the decision of whether a loan is to be placed in the forbearance bucket.

For the remainder of this thesis, the term NPL, which stands for nonperforming loans will be used to refer to NPEs as a consistency measure with the database terminology. While the two terms can be used interchangeably, it is important to note that in order to clarify any misconceptions.

Macroeconomic determinants

The ability to pay back loans is dependent on the financial situation of the entity in question. An individual's ability is determined by the assets they own as well as the income and expenses they have at a given point in time. This financial situation is influenced by whether they are employed, the value of their assets, and other factors such as the residual income after deducting taxes and expenses. For instance, an increase in income tax, interest rates could disrupt the equilibrium of residual income to the state where the individual/company cannot afford to repay their loans. Therefore, a change in the state of the economy, as well as a policy change, could impact the ability of individuals/companies to fulfill their debt servicing costs. Or could result in them defaulting on their loans. The determinants of nonperforming loans (NPL) have been the focus of numerous works of literature. The main factors are interest rates, GDP, inflation, unemployment, and asset prices. A closer look at these factors -as well as others- is necessary in order to establish possible linkages to the quantitative easing.

The first factor is the list is the GDP growth; which has been found to have a significant negative effect on NPL levels according to the literature (Beck, Jakubik, & Piloiu, 2013). Hence, an increase in economic activity means a drop in nonperforming loans ratios. While some research found an opposite sign, it was criticized for using inappropriate models (Manz, 2019). Another macroeconomic variable that effects nonperforming loans is inflation and currency depreciation. Evidence shows that countries with currency mismatches experience an increase in NPL following a currency depreciation mainly due to the negative balance sheet. Contrarily, currency depreciation in countries without currency mismatches reduces NPL due to improvement in the financial position following the increase in exports (Beck, Jakubik, & Piloiu, 2013). Inflation, on the other hand, has a more complicated effect as both subzero levels and high levels are linked to a bad economic outlook. Studies found evidence that low inflation leads to better financial conditions which in turn means a reduction in NPL (Rinaldi & Sanchis-Arellano, 2006). Other studies on aggregate level revealed that high inflation leads to lower NPLs as the real value

of the outstanding debt declines (Nkusu, 2011). Therefore, the effect is not as straight forward as one might hope for or expect. The third index that influences nonperforming loans is equity prices. While the effect is found to be negative, studies have shown that in countries with relatively large stock markets, nonperforming loans are more sensitive to a decline in stock prices (Beck, Jakubik, & Piloiu, 2013). This is attributed to the negative effect of collateral depreciation on the quality of consumer loans and corporate loans alike. Given the relative homogeneity within the Eurozone with regards to the market size and liberal markets means that all countries should experience this effect with varying degrees. Following the introduction of the new liquidity standards after the financial crisis of 2008, *collateral* became more important to the liquidity management of banks (Capel, 2011). As collateral becomes a more important factor for banks, so does the value of the collateral, which leads us to the next macroeconomic factor. Similar to the equity prices, house prices have been found to negatively affect the nonperforming loans -especially in the short term- (Rinaldi & Sanchis-Arellano, 2006); this is particularly the case in advanced economies (Nkusu, 2011). The argument is that the houses can be used as collateral which can help forbearance measures in case of external shocks (Ghosh, 2015). The bank would be more lenient to extend its financial aid for a client when sufficient collateral is available in order to avoid placing the loan in the NPL basket. The mechanism in which house price index (HPI) affects NPLs through collateral is like that of equity prices. As assets decline in value, the financial position of the owner is weakened. As for the bank, a decline in the value of the collateral inflates the loan to value figures, which is problematic from a credit risk point of view -especially for real estate and mortgage banks as their collateral is mostly made of real estate-. Credit risk managers are more likely to brand a loan as nonperforming as opposed to extending forbearance measures if the loan to value 'LTV' ratio was high.[4] Next on the list of determinants for nonperforming loans are the interest rates. Nonperforming loans have been found to correspondingly increase as lending interest rates increases (Beck, Jakubik, & Piloiu, 2013). This is ascribed to the upsurge of debt service expenses for borrowers with variable rate loans. Even though interest rates are directly influenced by central

[4] LTV [or loan to value] is calculated as loan amount divided by the appraised collateral value. It is one of the measures used to assess the risk of loans for the banks. As the value of a collateral declines, the LTV becomes higher, and the risk profile becomes higher as well. (2019, May 13). Loan-to-Value Ratio – LTV Ratio Definition - Investopedia. Retrieved July 5, 2019, from https://www.investopedia.com/terms/l/loantovalue.asp

banks, the regulations are not geared towards the reduction of nonperforming loans as it is seen as the task of the managers for those banks (Ozili, 2015, p. 7). On the other hand, some argue that low interest rates -which corresponds to low yields- could lead to excessive risk-taking in search of higher returns if the period on low interest rates is long (Altunbas, Gambacorta, & Marques-Ibanez, 2009). Therefore, low interest rates could also increase NPL in the long run. Hence, the effect could differ between the short and long run. The equilibrium of income and expenses for an individual can be disrupted by multiple factors, one of the most obvious is unemployment. Previous studies have found that nonperforming loans are positively linked to unemployment rates (Makri, Tsagkanos, & Bellas, 2014). Sluggish economic growth is usually accompanied by high unemployment; that translated into less income for individuals (Nkusu, 2011). This means that the ability to pay back their debt obligation becomes lower, and thusly higher nonperforming loans (Anastasiou, Louri, & Tsionas, 2016). The other index that affects the aforementioned equilibrium of income and expenses is the household disposable income 'HHDI'. Using data from 1990 to 2015, Anastasiou et al. (2016) found that income tax is positively linked to the levels of nonperforming loans. As the income tax increases, the disposable income together with the capacity to meet debt obligation is reduced (Anastasiou, Louri, & Tsionas, 2016). Thus, a strong negative link between the levels of HHDI and NPL is expected. As to public spending indices, nonperforming loans have been found to be negatively linked to public debt. According to the *sovereign debt hypothesis*, an increase in NPL can be linked to the increase in public debt (Louzis, Vouldis, & Metaxas, 2012). Sovereign debt can be measured in debt as a percentage of GDP, fiscal deficit, or government spending (Ghosh, 2015). Using the data of the largest Greek banks between from 2003-2009, Louzis et al. used a dynamic panel data models to assert the effect of sovereign debt on the levels of NPL. Later research on banks of the euro area, Makri et al. (2014) found corroborating results for the period 2000–2008, evidencing a strong link between NPL and sovereign debt.

Bank-specific determinants

Previous studies have linked nonperforming loans in banks to bank-specific factors (Manz, 2019). Causation is an important aspect when attempting to uncover what drives the nonperforming loans ratio from within the bank as opposed to what is driven by it. First category is the *asset quality ratios* which include the subject of this research. The ratio of nonperforming loans as a percentage

of total loans have been found to exhibit a persisting nature according to the literature. That means that the current NPL ratio of a certain bank in a certain period of time is a good predictor of the NPL ratio in the next period for the same bank (Makri, Tsagkanos, & Bellas, 2014). This has a crucial impact on the model choice as will be discussed later in the methodology section. Previous research on the determinants of NPLs has often opted the use of dynamic panel data model as opposed to static ones. In other words, they included a lagged version of the dependent variable of NPL in the model as one of the regressors (Radivojević, et al., 2019). The next ratio is loan loss provision which exhibits the *anticipation effect* from risk managers to reduce their exposure to NPL. If a bank were to increase its lending to riskier borrowers, the risk departments would increase the level of loan loss provisions as a result of their prediction of future losses (Ozili, 2015). Other ratios such as the loan loss provisions as a percentage of NPL measures the capacity that a bank can absorb the losses, while loan loss provisions as a percentage of their net interest income measures their ability to finance such provision.

The next category is the *capital ratios*; such as the capital adequacy ratio and total capital ratio. Those measures capture the capacity of banks to tolerate risks (Makri, Tsagkanos, & Bellas, 2014). Other studies have used it as a proxy to capture risk-taking behavior. While the exact effect is unclear, poorly capitalized banks tend to gamble more, which means higher NPL ratio is correlated with lower capital ratios -at least in theory- (Jeitschko & Jeung, 2005).

The third category is the *operational ratios*. According to the *'bad management'* hypothesis, a reduction in cost-efficiency is often followed by an upsurge in nonperforming loans. Using Granger-causality analysis, Berger and DeYoung found that suboptimal practices that are associated with bad management increase nonperforming loans, which in turn supported the bad management hypothesis (Berger & DeYoung, 1997). A working paper by the national bank of Czech also found that a fall in cost-efficiency precedes an upsurge in NPL levels (Podpiera & Weill, 2008). The results from their dynamic panel data models rejected the reverse causality of higher NPL proceeding lower cost efficiency. Consequently, Podpiera and Weill rejected the '*bad luck'* hypothesis and supported the '*bad management'* hypothesis. While studies used both profitability ratios [the return on assets and the return on equity] as a proxy for managerial efficiency (Anastasiou, Louri, & Tsionas, 2016). Makri et al. (2014) found that the return on equity ratio exerted a significant negative influence on NPL.

The last category is the *liquidity ratios*; such as the loans to deposits ratio which was used in previous research as a proxy for moral hazard that reflects risk-taking behavior by bank managers (Anastasiou, Louri, & Tsionas, 2016, p. 198). This means that higher ratio should be associated with higher NPL. On the other hand, the interbank ratio could measure the ability of the bank to secure funding as well as capturing the status of the bank in the eyes of its peers. While this cannot be directly linked to NPL ratios, it can hold important information on the accessibility to extra liquidity of banks when building up their reserves.

2.2 Quantitative easing policy

The first round of quantitative easing (QE) that the ECB engaged in was a modest 60 billion euro-denominated covered bond back in 2009, and 40 billion in 2011. While this is not the round that this research is geared into; as most literature focuses on the subsequent round due to the scale of it compared with the later round. However, it could hold an interpretive power that is vital when discussing the results. In January 2015, the European Central Bank 'ECB' announced the launch of its expanded Asset Purchase Program 'APP' that began in March of the same year (ECB Economic Bulletin, 2015). The second round, which was initiated back in March 2015, averaged 15-80 billion euros monthly and ended in December 2018. The overall liquidity injection of the QE era mounted to 2.6 trillion euros (Asset Purchase Programs, 2019). The projected inflation in December 2014 was at -0.2 percent for the euro area with a weak short-term outlook. This method was believed to prevent inflation from going below the zero mark (Reuters, 2018). In line with the ECB's mandate of inflation close to but less than 2 percent over the medium term, this experimental monetary policy -which is known as quantitative easing (QE)- was initiated to help the European economy counter the effects of the credit crunch, deflation as well as the eurozone debt crisis. According to the ECB, the QE came as part of the non-standard measures that were used in response to the *third phase* (Economic Bulletin, 2015). These measures include:

- A negative interest rate on the deposit facility to stimulate bank lending.
- A targeted longer-term refinancing operation that was designed to facilitate and support the lending to businesses and households via banks.
- An Asset Purchasing Program (APP) that targeted both private and public sector securities to put downward pressure on the term structure of interest rates.

- Lastly, forward guidance by which the ECB explicitly declares how would the policies change as well as what conditions that may trigger a change in policy.

The aim of these non-standard measures was to influence an entire set of interest rates that which are most important for financing conditions within the euro area. As of December 2018, the ECB's quantitative easing purchasing era came to an end as the ECB continues to reinvest the matured amounts. As of early 2019, inflation projection was at 1.8 percent -near to the ECB's target of less than but close to 2 percent- (ECB Economic Bulletin, 2018). As a result of the APP program, the balance sheet of the ECB has more than doubled in size reaching an all times high of 4.65 trillion euros making it the second-largest balance sheet today after the Bank of Japan.

The effects of quantitative easing on the euro area

While the effects of this unconventional monetary policy are controversial, the effects that are credited to quantitative easing (QE) should be examined. The literature has accredited the reduction of interest rates to the quantitative easing policy. The main effect of QE on the interest rates is through the ex-ante channels of forward guidance and announcement that flattened the yield curve (Valiante, 2015), which in turn would reduce the nonperforming loans ratios (Beck, Jakubik, & Piloiu, 2013). The effect that Asset Purchasing Program 'APP' -which was performed under the term quantitative easing- is the increase of liquidity in the hands of investors. Joyce et al. argues that the increase in liquidity along with the improvements in the functionality of the market would lower liquidity premiums, and thus the asset prices will increase as a result (Joyce, Lasaosa, Stevens, & Tong, 2011). A spillover of this would indicate lower NPL as asset prices appreciate in value. The Asset Purchasing Program (APP) had an upward effect on both real-GDP growth as well as HICP inflation[5] mainly through the *portfolio rebalancing channel* (Gambetti & Musso, 2017). As the purchasing of assets usually leads to financial institutions having to buy similer assets. That would push the price of these assets up, and their yields down. The same can be said about the assets that the ECB already holds. The effect on real-GDP was stronger in the

[5] Inflation is measured by the Harmonized Index of Consumer Prices (HICP) in the euro area. (Measuring inflation – the Harmonised Index of Consumer Prices (HICP), 2019)

short-term. The impact of APP on real-GDP growth was measured 0.18 percentage points in the first quarter of 2015, compared with 0.02 percentage points in the last quarter of 2016 (Gambetti & Musso, 2017). QE also raised the prices of equity, although the demand in the Eurozone seems unaffected by QE (Loonstra, 2017) which could mean artificially inflated prices, however, other studies showed that QE increased the stock prices mainly through the channels of confidence signaling (Apergēs, 2018). All of the aforementioned effects of the APP program is linked to lower nonperforming loans ratios. While conventional monetary policy could induce similar effects, quantitative easing announcement signals a long term commitment of keeping interest rates low. Unlike interest rate cutting policies, a rise in the interest rates would incur huge losses on the assets they purchased under QE program (Hausken & Ncube, 2013). On the contrary, some studies suggested that uncertainty is crucial to the effectiveness of the QE policy. Nellis explored how QE effectiveness changes relative to the level of certainty around it. He suggests that the effect of QE is diminished if the markets can anticipate it; which means the element of surprise can be crucial to the effectiveness of QE policy (Nellis, 2013). As the first round of quantitative easing policy was in 2009, it might be that the anticipation of the market has lowered the effect, or diminished it entirely. Studies on the impact of the second round of QE was much less effective in the US due to the predictability of it. The second round was much more anticipated compared to the first and third rounds which were less explicit about the total amount and duration of the purchasing programs (Nellis, 2013). As uncertainty becomes an essential factor for the effectiveness of the QE, it is interesting to see how effective QE policy in the euro area was; given that the ECB's QE policy was highly anticipated after both the US and the UK initiated their version of it following the financial crisis of 2008 (Hausken & Ncube, 2013). According to the anticipation effect that Nellis argues for, markets anticipate the upcoming rounds of QE, and subsequently, are able to factor them into the pricing process. However, the long-term commitment that QE entails as it signals confidence does not necessarily conflict with the uncertainty principle earlier discussed. Central banks can perform a hybrid combenation where the QE timeline is explict (e.g. signaling confidance) and the amounts and targeted assets are implicit (limiting the ability to factor them into the pricing models) in order to keep a level of uncertainty in the market preception.

The effects of quantitative easing on the macroeconomic and bank-specific determinants of nonperforming loans

The link between the effects of quantitative easing policy and the determinants of nonperforming loans is the basis of this research. And to be able to model this relationship, a reconciliation of the common factors is performed to find similarities. Firstly, and perhaps most notably, are the interest rates. Lower interest rates are credited to the QE policy as well as linked to the reduction of NPL levels in the short run according to the findings of Beck at al. (2013). Studies have shown that long periods of low interest rates may lead to an upsurge in risk-taking behavior. That means that in the long run, a low interest rate could increase NPL. As earlier discussed, QE policy was linked to higher inflation, higher GDP growth, higher asset prices. One can also see the link in other factors such as unemployment in a less direct way. The literature has extensively looked into how higher GDP growth and inflation corresponds to lower unemployment. Quantitative easing may have indirectly affected the nonperforming loans through these channels, yet the effect can also be direct and performative -as is the case with all policies-.

> *"Economic performativity is always also political" (Cochoy, Giraudeau, & McFall, 2010)*

In the realm of economics, quantitative easing policy might have some direct effects as announcements can be just as influential as carrying them out. Previous papers found that the announcement of ECB's quantitative easing policy has led to a strong depreciation of the Euro against the US dollar (Palu, 2015). Therefore, the effect of QE -through exchange rate depreciation- leads to an increase (decrease) in nonperforming loans in banks operating in countries with(out) currency mismatch (Beck, Jakubik, & Piloiu, 2013). While QE is linked used by the ECB to meet inflation goals, some research on the effect of QE policy by the Federal Reserve shows no real link between QE and inflation rates. A possible explanator was the decreasing money from the banking system to the economy (Yue & Leung, 2011, pp. 39-40). Following the financial crisis of 2008/2009, the Basel III international framework was introduced to address certain vulnerabilities within the banking sector (Caruana, 2010). The impact of the Basel III framework mounts up to a supply shortage of 4.7 trillion euros between 2010 and 2019 (Härle, et al., 2010, pp. 1-2). While the ECB's quantitative easing injected 2.6 trillion euros into the economy (Asset Purchase Programs, 2019). This might indicate that in total, the net supply of money into the European economy is negative after accounting for the Basel III capital requirements on the balance sheets of banks. While QE could have a reverse effect than first

suspected, but under the irrelevance theorem, QE might end up having no effect at all. The irrelevance theorem suggests that the asset purchases under QE have had no effect because it was to initiated to counter a spillover effect of Basel III rather than geared toward improving the status quo. This fact is one of the novelties of this thesis as these two were not linked before in the literature. A paper by Koijen et, al. have found that Eurozone investors have less elastic demand of the for euro-area bonds (Koijen, Koulischer, Nguyen, & Yogo, 2017). Their results show that the overwhelming majority of the sellers that engage in the Asset Purchasing Program are foreign investors; which is another reason that may lead to insignificant results under the irrelevance theorem. Hitherto, only macroeconomic variables have been linked to both quantitative easing policy as well as nonperforming loans. However, on the disaggregate bank-level, there is little research done on the subject of how QE affected the ratios of banks. Some studies focused on the changes in lending behavior of banks after the announcement of the QE policy. A working paper by Lojschova found some evidence that QE has boosted bank lending; especially to households (Lojschova, 2017). However, it also omits the fact that in some cases, central banks have required banks to increase lending to households as a part of bailout packages.[6] Lastly, quantitative easing could have lowered nonperforming loans by nudging risk managers' behavior. That is yet another novelty of this thesis; as risk managers have discretion over troubled loans being categorized as nonperforming or extending forbearance measures. This decision is influenced by both the borrower's situation as well as the economic outlook in which the bank decides to either accept the loan as nonperforming or give concessions to the borrower in anticipation that they will be able to fulfill their adjusted payments. This decision can logically be influenced by whether the economic outlook, hence, influenced by quantitative easing.

3 Empirical analysis

In this section, the motivation for the research problem and the subsequent hypotheses will be presented. The data collection process will be discussed to some detail along with the relevant sources. Next, the variables that will be used in the empirical analysis will be outlined. The next step is the model choice process where the GMM method will be compared to the alternative

[6] This information was the result of a discussion with some experts in the field that declined to be mentioned.

methods; and tested using a different set of explanatory and control variables in order to find the best model by trial and error. The best model will be used to perform an event study on the announcement of ECB's quantitative easing policy effects on nonperforming loans as well as the effect of the liquidity injections -under the Asset Purchasing Program mandated by the quantitative easing policy- on nonperforming loans.

3.1 Research problem

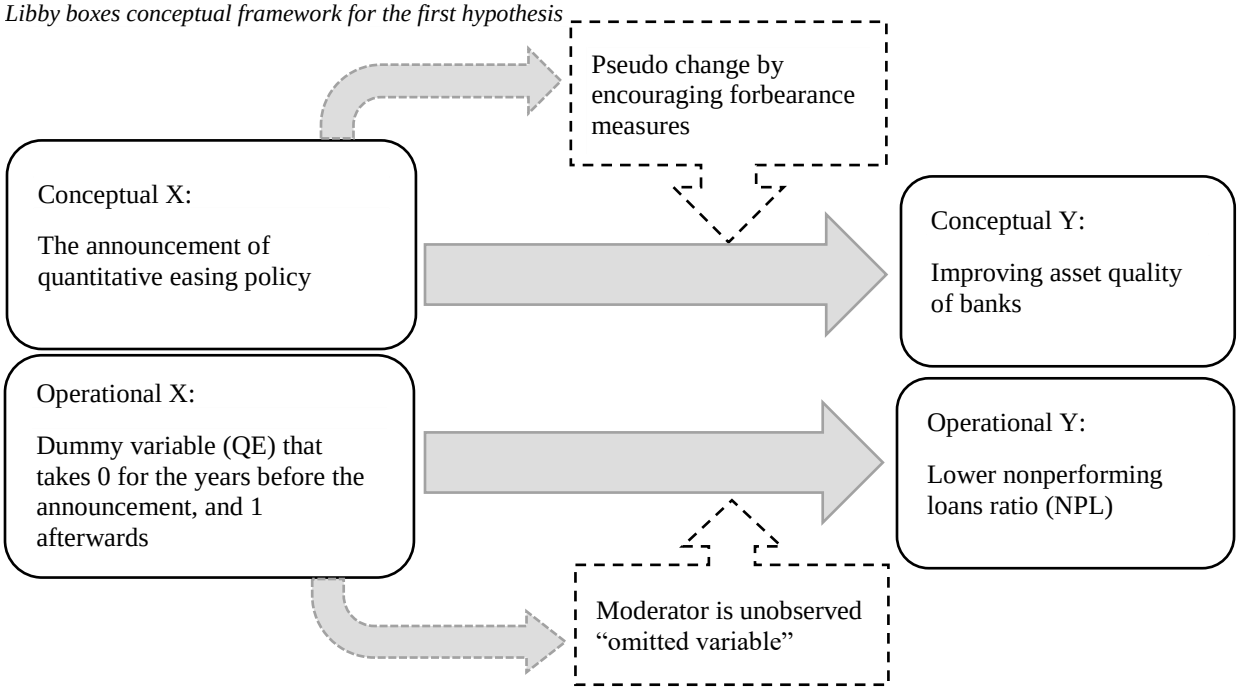
The objectives of the quantitative easing policy in the Euro area is not to help banks reduce their nonperforming loans, however, it is interesting to see what effect -if any- did this policy have on the asset quality of the banks operating in the Eurozone. QE works through ex-ante indirect channels like interest rates, and direct channels such as signaling (Valiante, 2015). Some of these channels are thought to affect the nonperforming loans ratios. The effect of the QE policy expands to stimulating higher inflation as well as GDP growth (Gambetti & Musso, 2017). The improvements in the economic outlook are already linked in the literature to the reduction of nonperforming loans ratios. Nonetheless, if quantitative easing has affected NPL ratio beyond what is expected given the changes in the economy as a whole and the changes on each bank, then QE policy could have a potential unobserved effect on the asset quality of the banks.

It is important to distinguish between a real change in the NPL ratio compared to a pseudo one since the prudential treatment of problem assets "*definitions of non-performing exposures and forbearance*" has only been released in April 2017. As earlier discussed, the definition of forbearance could include nonperforming loans that would otherwise satisfy the definition of default, and therefore be recognized as NPL. Subsequently, as banks have some option in how to categorize an exposure, the decision of whether to forebear a non-performing exposure can be at the discretion of the bank managers. Hence, it is possible that the policy announcement directly influences that decision in terms of scope and scale. In most cases, banks prefer to have lower levels of nonperforming loans; which can be achieved aesthetically by adjusting internal policies and practices –at least before the recent guidelines were released-. By investigating the effects of the QE policy while controlling for other potential factors, one could see the extent of which the announcement and the liquidity injection have affected NPL's beyond what the changes in the economy could explain. Therefore, the hypotheses are:

Hypothesis 1: *The announcement of the ECB's quantitative easing policy has reduced the nonperforming loans ratios of the banks operating in the Eurozone.*

The literature suggests that the announcement of the QE policy adoption directly affected the market through signaling. Therefore, the announcement of QE policy could potentially lead to a reduction of NPL ratios. As the positive sentiment could influence the decision of whether a loan is to be placed in the forbearance bucket rather than giving it the non-performing badge. But such phenomena is not possible to operationalize in a model, thus, the effect is unobserved. On the other side of the aisle, borrowers could opt not to default on their loans if they expect improvements in the economic conditions and lower debt servicing rates to finance their financial obligations. It is important to note that a pseudo-accounting-based change in the NPL levels could inflate the results of the QE announcement depending on the economic outlook. That can be explained since the definitions of default and forbearance are not unified and are open to changes through each bank's internal policy.

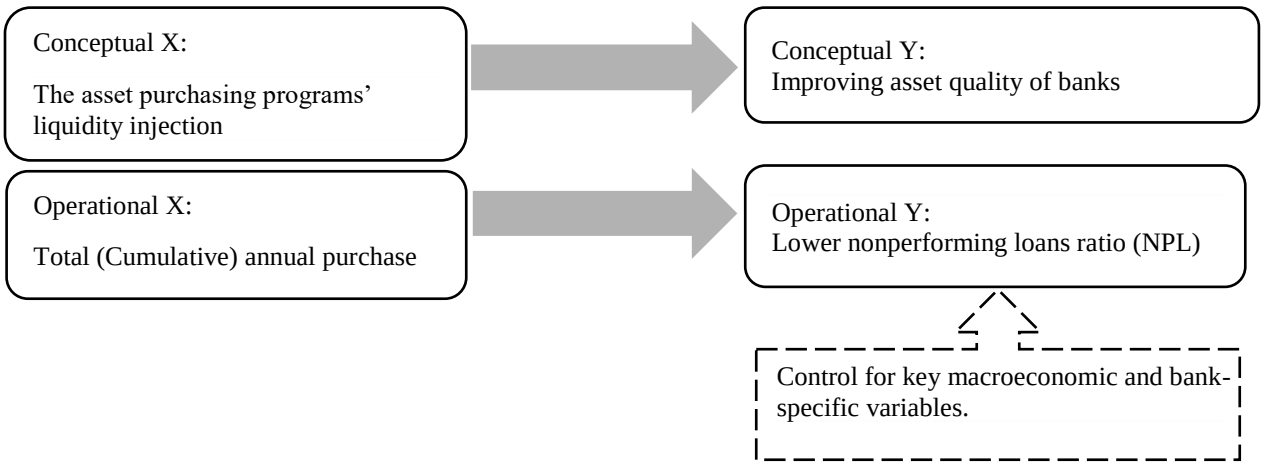
Libby boxes conceptual framework for the first hypothesis



Hypothesis 2: *The ECB's liquidity injection preformed under the quantitative easing policy has exerted a negative effect on the ratio of nonperforming loans for banks operating in the Eurozone.*

The large-scale Asset Purchasing Program performed under the quantitative easing policy has injected 2.6 trillions of euros in the span of three years. The liquidity could have potentially lowered nonperforming loans. The reduction of nonperforming loans could have been mainly due to lower interest rates and other macroeconomic and bank-specific changes, therefore, a set of control variables should be included to capture the effect of these changes on the NPL ratios. As

Libby boxes conceptual framework for the second hypothesis

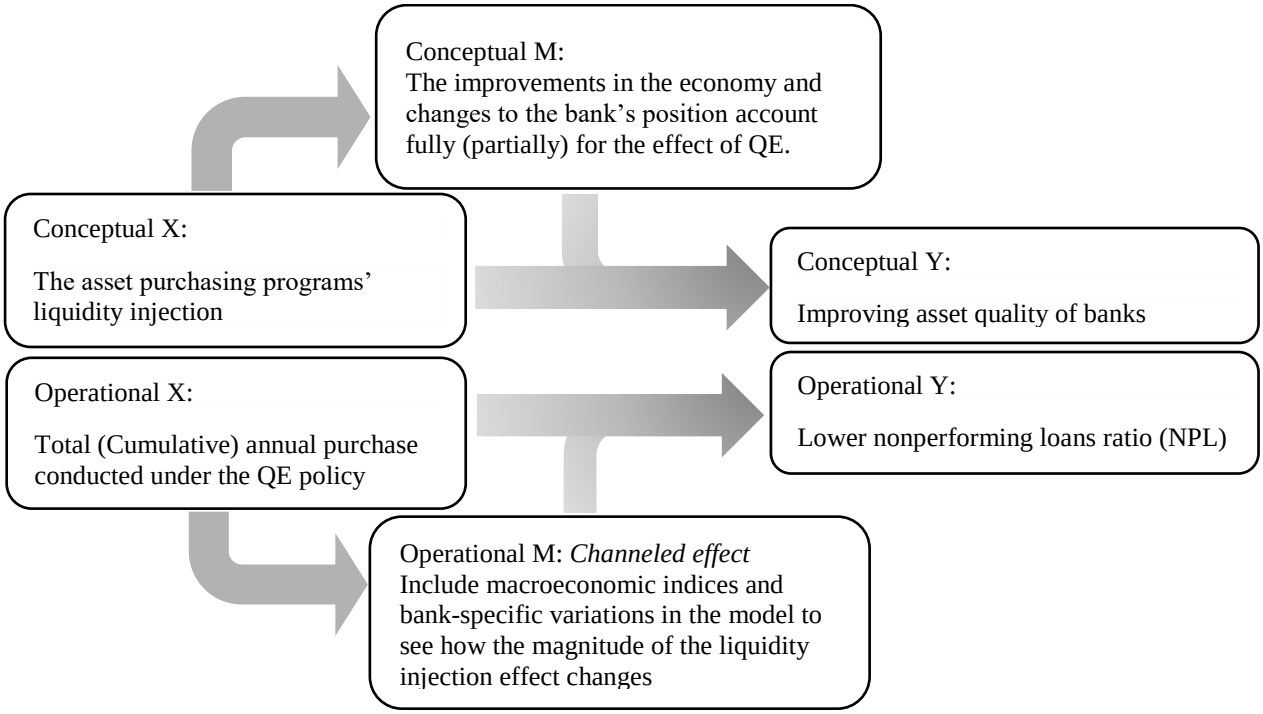


the Asset Purchasing Program was being carried out, the economic conditions were improving. Lower debt servicing ratios, lower levels of unemployment, and higher GDP growth are all linked to lower NPL ratios. Every euro that the ECB has injected into the system is designed to help the economic machine to recover –at least in theory-. In a similar manner to the way signaling could affect the NPL ratio by encouraging banks to avoid putting the NPL badge on problem loan, having unrestricted access to liquidity should have also reduced nonperforming loans. Banks were provided with liquidity at historically low lending rates while having negative deposit rates. That may have made them more inclined to providing assistance to troubled borrowers by extending forbearance measures. As the economic outlook improves, one would expect that the effect of the QE policy implementation -hence, the Asset Purchasing Program 's liquidity injection- would exert a negative effect on the NPL ratios.

Hypothesis 3a (b): *The effects of the liquidity injection preformed under the quantitative easing policy by the ECB on the ratio of nonperforming loans for banks operating in the Eurozone was fully (partially) channeled through ex-ante channels such as interest rates.*

As the literature suggests that QE policy implementation works through indirect channels such as interest rates. One would expect that when accounting for such factors would eliminate (reduce)

Libby boxes conceptual framework for the third hypothesis



the effect of the liquidity injection. If the effect was significantly lower after controlling for the suspected channels, then the effect of the Asset Purchasing Program was partially channeled. However, if the effect becomes no different than zero, then the effect was fully channeled.

3.2 Data

In order to test the hypotheses, a longitudinal dataset of 11 years will be used for banks operating within the Eurozone. The data includes a set of bank-specific variables which is complemented by several macroeconomic variables on the country level and on the Eurozone level. All the variables are based on annual intervals. The data contains banks which has the Euro as their primary currency only. The dataset includes records from the year 2008 until 2018. Although previous research on the subject at hand opted to used country-level aggregate data (Makri, Tsagkanos, & Bellas, 2014) (Boudriga, Taktak, & Jellouli, 2009). This thesis is focused on the effect of policy on the balance sheet of banks; therefore, the overall performance of the banking system is less relevant. Having bank-level data could potentially risk the sample not being representative enough,

which means that the model could be biased. The limited data availability concerning the sample used can be a scope for future research to investigate if discrepancies were to arise when using a larger sample.

The first set of data is bank-level data which contained mainly global ratios [see table 1]. other relevant variables such as the swap rate on a 5-year senior debt are also included [see appendix for the full table]. Several categorical data about the status of the bank, the country where it is located, the regulatory environment it is operating under, the specialization of the bank was extracted and used in the initial analysis of the data. The initial dataset was obtained from Bureau van Dijk's Bankfocus software database (Orbis Bank Focus, 2019). The chosen banks need to have at least 5 years' worth of data of nonperforming loans, that resulted in having 3548 banks. A further step was to eliminate banks that have a main currency other than the euro. The remaining dataset included 118 banks with observations over 11 years with an average NPL ratio of 7.85.

Table 1: Bank-specific global ratios categorized by type

Type	**Ratio name**
Asset-quality ratios	Non-Performing Loans / Gross Loans Loan Loss Prov. / Gross Loans Loan Loss Prov. / Non Perf. Loans Loan Loss Prov. / Net Int. Rev. Impaired loans / Equity
Capital ratios	Tier Ratio Total Capital Ratio Capital Adequacy Ratio Equity / Total assets
Operational ratios	Return on Average Assets Return on Average Equity Cost to Income Ratio
Liquidity ratios	Interbank Ratio Net Loans / Total assets Net Loans / Deposits
Other ratios	Cost to Asset ratio

Over half of the banks within the dataset are cooperative banks, with over 22% made up of commercial banks, 20% are saving banks. The remaining 4% is split between investment banks, and real estate and mortgages banks. [See figure 3-1]

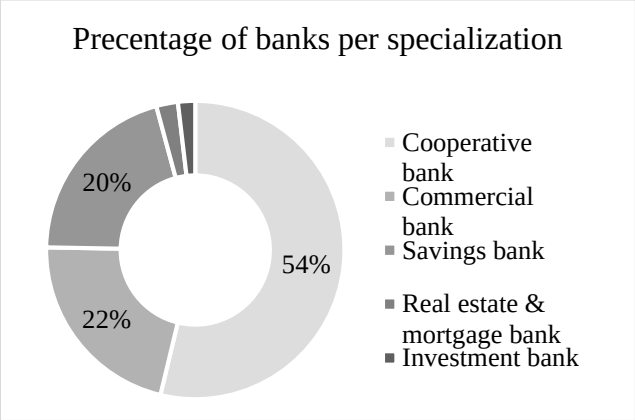


Figure 3-2: Bank types in the dataset

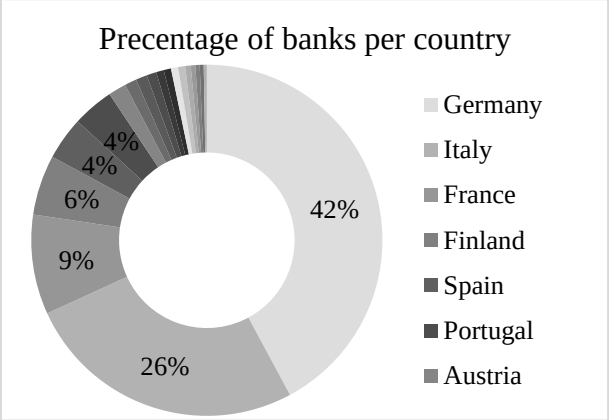


Figure 3-1: Geographical distribution of banks in the dataset

Geographically, the data contains a diverse set of banks, however, more than three-quarters of the banks are in three different countries. German-based banks make up over 40 percent of the data set. Italian based banks account for 26 percent. The remainder of the banks are based in one of the Eurozone countries. [See figure 3-2]

The second set of variables are the country-level macroeconomic indices collected mainly from the Organization for Economic Co-operation and Development "OECD", and the International Monetary Fund "IMF" websites. The missing values have been filled using data from European Statistical Office "Eurostat" where the average of the Euro area was used in case of missing values that are not found in either of the aforementioned databases.

The macroeconomic variables that have been collected are considered the most relevant to the main dependent variable "nonperforming loans ratio". The annual growth rate of the Real GDP and the general government debt as a percentage of GDP are collected from the IMF database (IMF Data, 2019). The stock market index of the entire Eurozone is represented by the Euro-Stoxx-50 which is retrieved from FactSet database (FactSet Research Systems, 2019). The remaining variables are all collected from the OECD database. The variables include household disposable income (OECD, 2019), harmonized unemployment rate (OECD, 2019),

inflation measured by consumer price index (OECD, 2019), Government-debt as a percentage of GDP (OECD, 2019), long-term interest rates (OECD, 2019).

Lastly, the policy data is retrieved from the ECB's website and database. The data includes the total liquidity injection by the ECB which is made of different programs referred to as the Asset Purchase Programmes (APP) by the ECB. The largest in terms of the amount is the Public Sector Purchase Program (PSPP) which accounts for three-quarters of the total injection by the ECB (Asset Purchase Programs, 2019). Therefore, the effect of quantitative easing is assumed to mainly affect the sovereign debt. The third Covered Bond Purchase Program (CBPP3) accounts for 16%, while the Corporate Sector Purchase Program (CSPP) mounts to 7% with the Asset-Backed Securities Purchase Program (ABSPP) accounts for only 3%. [See Figure 3-3]

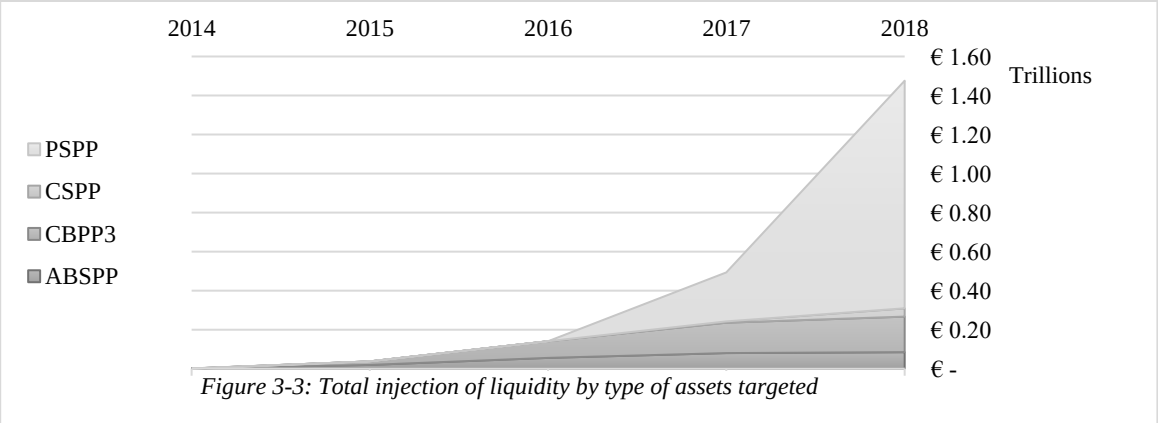


Figure 3-3: Total injection of liquidity by type of assets targeted

3.3 Variables

The variables that will be used in this analysis contain the main dependent variable for nonperforming loans, the independent variables -which include a set of macroeconomic and bank-specific variables-, and policy variables. The main dependent variable is the bank-specific NPL ratio which is calculated as follows: $NPL\ ratio = \frac{Nonperforming\ loans}{Gross\ loans}$

Macroeconomic variables

Long-term interest rates (INT): Interest rates affect both preexisting loans as well as newly issued ones. As for preexisting loans with variable rate, an increase in interest rate means higher debt servicing ratio. That means that it is more costly to repay the loan than otherwise anticipated. As for newly issued loans, an increase in interest rates means that counterparties are less able to

finance their debt using their lines of credit. For corporations, issuing more debt to finance their debt servicing costs are more costly. This also translates to more defaults for fixed-rate loans.

ECB's Main refinancing operation rate (ECB_MRO): One of the ECB's tools that are used to lower interest rates. While it is not the focus of this research, it is important to control for its effect when trying to distinguish the effect of other tools such as QE and interest rates. The expected effect should be positive for a similar reason as other interest rates have nonperforming loans.

Government bond yield (Bond): The yield on government bonds is directly affected by the QE policy as it is the main target of the APP program. As the PSPP targets public sector, and accounts for 75% of total purchases, it is important to separate how the lower yield on this assets affects NPL from the direct effect of APP on NPL ratios.

Real-GDP growth rate (GDP): GDP growth has been strongly linked to NPL ratios in banks (Beck, Jakubik, & Piloiu, 2013) (Boudriga, Taktak, & Jellouli, 2009). The effect of GDP growth is expected to be positive as it indicates an improvement in the economy, however, some studies found an opposite effect of GDP growth on loan quality (Makri, Tsagkanos, & Bellas, 2014). The contradicting results have been attributed to the misspecification of the models used. As the use of non-dynamic models biases the estimation (Manz, 2019).

Public debt as a percentage of GDP (DEBT): Public debt is expected to have a negative effect on NPL ratio as public spending is aimed at improving the economic conditions (Makri, Tsagkanos, & Bellas, 2014). However, high public debt could also mean sub-optimal economic conditions, therefore, the sign could be opposite of what is expected.

Unemployment rate (U): Expected to have a positive effect on NPL ratio in banks (Makri, Tsagkanos, & Bellas, 2014). High unemployment is usually a sign of the economy being in a recession. The less income people have, the more likely that they default on their loans.

Inflation (INF): Inflation is measured using the consumer price index (CPI) (Yue & Leung, 2011). It can also be used as a proxy for currency depreciation. While the effect is expected to be negative, the effect could vary between countries depending on whether they have currency mismatch or not (Beck, Jakubik, & Piloiu, 2013), the unavailability of data makes controlling for currency mismatch difficult.

Household disposable income (HHDI): It is believed to exert a strong negative effect NPL as it represents the ability of individuals to repay their debts. Conversely, personal tax is thought to exert a negative effect on the individual's ability to pay (Anastasiou, Louri, & Tsionas, 2016).

Market index (INDEX): Measured by the EuroStoxx50 index, this variable is thought to have a negative effect on NPL due to the positive effect on the value of the collateral.

House price index (HPI): The positive effect on the value of the collateral would mean a negative effect on NPL. As the bank's tendency to extend forbearance measures becomes lower for debtors with low valued collateral. It is noteworthy to mention that some studies found a correlation between the equity prices and the house prices which could mean that only one of these should be included in the model (Beck, Jakubik, & Piloiu, 2015).

Bank-specific variables

Return on equity (ROE) and return on assets (ROA): Makri et al. (2014) found that ROE exerted a significant negative influence on NPL. While other studies used both ratios as a proxy for managerial efficiency (Anastasiou, Louri, & Tsionas, 2016). Both are expected to have a negative effect on NPL ratio.

Loans to deposits ratio (LTD): A proxy for moral hazard that reflect risk-taking behavior (Anastasiou, Louri, & Tsionas, 2016, p. 198). It is expected to exert a positive effect as more risk could entail lower quality borrowers and thus higher defaults.

Total capital ratio (CAP): A measure for the banks capacity to tolerate risks (Makri, Tsagkanos, & Bellas, 2014). It is unclear whether CAP effects NPL positively or negatively, but poorly capitalized banks tend to gamble more (Jeitschko & Jeung, 2005).

Loan loss provisions ratio (LLP): This variable exhibits the anticipation effect from risk managers to reduce their exposure to NPL. Including a lagged version might prove significant with a positive effect on the NPL levels of next period. As banks can manipulate the level of loan loss provisions and loan growth to minimize the relative size of their NPL (Ozili, 2015).

Credit default swap "CDS" spread (CDS): Credit default swap spread is the annual cost to protect against the default by a particular company/bank. The 5-year CDS spreads is measured in basis

points for senior unsecured debt. It is widely used as a monitor for the health of a bank. It indicates the credit risk of a bank (IMF, 2006, pp. 51-83). However, CDS can also indicate other info like systematic credit risk, liquidity premium, or risk aversion (Annaert, De Ceuster, Van Roy, & Vespro, 2013). A high CDS spread signals that the cost of doing business with a certain bank is higher for counterparties as the latter searches for more profitable or less risky investments. Therefore, a positive effect is expected as nonperforming loans are generally higher for banks with lower efficiency. While the link between NPL and CDS is not very explicit, it is useful to control for such heterogeneity between banks as well as between periods of different CDS for the same bank in this analysis.

Cost to income ratio (Efficiency): This efficiency ratio is a common productivity and efficiency indicator which is applied to banks. It is usually defined as the percentage of expenses relative to revenues. A lower rate means that a bank is more efficient. While some studies favor separating big bank from small banks -as the latter exhibits different trends related to their core ratios- (Kovner, I. Vickery, & Zhou, 2014), it is usually dependent on an arbitrary point. However, this measurement can capture some aspect of the differences between big banks and smaller banks without relying on some arbitrary point. Though this ratio is not without its flaws as it is criticized for neither correctly measuring the productivity of a bank nor its efficiency due to other factors that are not accounted for (Burger & Moormann, 2008).

Cost/Assets ratio (CTA): The cost to assets ratio is calculated as the operating expenses divided by the average assets over a certain period. While similar to the efficiency ratio, it is less prone to the effect of interest rate swings (Cost/income ratio, 2018). Hence, in periods of changing interest rates, it can provide a more precise reflection of the bank's efficiency.

Policy variables

The expanded Asset Purchasing Program was announced on January 2015, therefore, the policy dummy takes the value of 1 in the years of 2015 till 2018, while it takes the value of 0 in the years before the announcement. While controlling for other factors, this dummy can give us the estimated effect of the announcement of the ECB's QE policy on the nonperforming loans for the banks within the Eurozone. However, it is possible to capture other effects within the designated timeline. Including a set of comprehensive variables can limit this effect, however, eliminating it

requires much more in-depth analysis of what could the dummy also capture in the years following the announcement.

The additional policy variable is the total annual amount that the ECB injected into the market through its asset purchase program in each year (QE-tot). The amounts are quoted in trillions of euros and include all the different programs that are encompassed under the APP term. Those programs are the PSPP, the CBPP3, the CSPP, and the ABSPP. A complimentary variable to the total annual amount is the cumulative amount of liquidity injected through the APP purchases. This variable could capture the effect of the liquidity injected while placing less emphasis on the changes from year to year. [See figure 3-4]

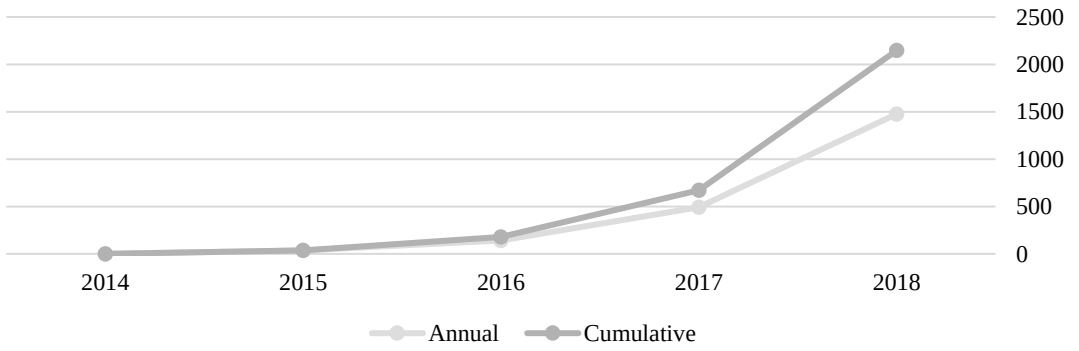


Figure 3-4: A comparison between the APP's annual and cumulative liquidity injections

Looking at the aggregated effect of QE over time means to account for previous injections as the decrease in injection, does not necessarily mean that the NPL ratios would increase -given that NPL decreases with each injection. In other words, NPL rates are assumed to react to the QE stimulus, however, the effect should remain negative even is the amount swings year to year. On the other hand, it is argued that the effectiveness of the QE decreases with each purchase (Nellis, 2013), therefore the effect becomes is less prominent as time passes by. This could be a limitation to the interpretability of this variable; thus, it is good to keep that in mind.

3.4 Model choice

Due to the nature of the data, the model which will be used to test the hypotheses is restrictively a panel data model. To test the effect of the announcement as well as the implementation of the ECB's quantitative easing policy, an efficient estimator is needed in order to model the relationship

between nonperforming loans ratio (NPL) -the dependent variable- and the independent variables. First, the dependent variable should be examined, transformed, and specified correctly. Thereafter, an analysis of the relationship between the dependent variable, the independent variables, and the error term would determine which type is going to be used to model the relationship. The model should have the ability to overcome the special characteristics of the variables and produce an efficient estimator. After examining of the histogram of the dependent variable, it seems that the NPL ratio has a gamma distribution [see figure 3-5].

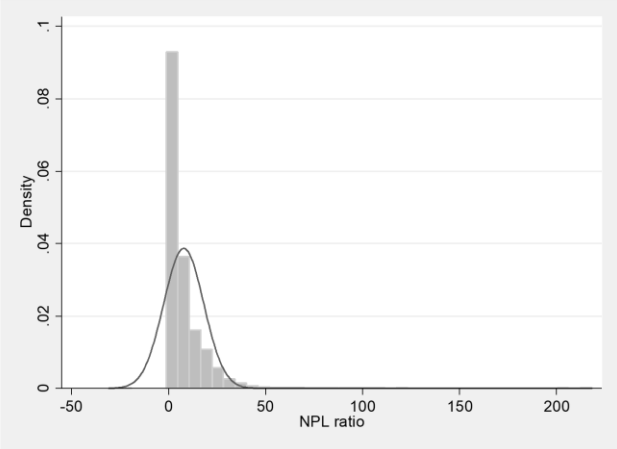


Figure 3-5

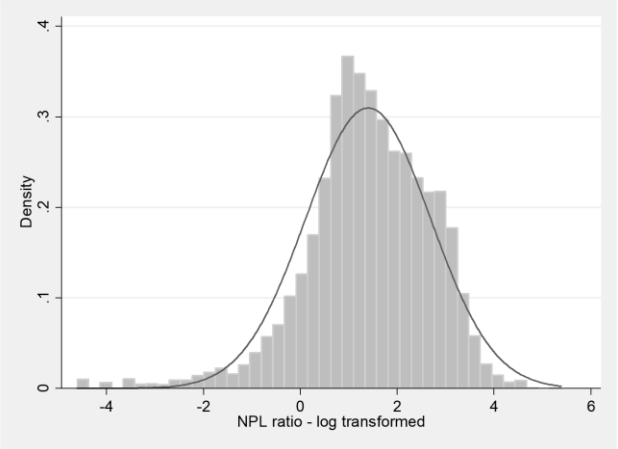


Figure 3-6

As NPL ratio is a continuous variable with mainly positive with values ranging between 0 and +218 -with few outliers having a negative value-, a log transformation was the best way to transform it into an almost normally distributed variable with a positive mean. [see figure 3-6]. Next, the relationship between the dependent variable and its determinants will be analyzed. The correlation between the dependent variable (NPL_t) and the lagged dependent variable (NPL_{t-1}) is relatively high at around 0.93 [see *table 2*].

Table 2: Correlation table for the lagged dependent variable and the macroeconomic variables

	log_NPL	GDP	UNEMP	INF	HPI	HHDI	INDEX	DEBT	INT	ECB_ MRO
log_NPL	1.00									
GDP	-0.19	1.00								
UNEMP	0.52	-0.30	1.00							
INF	-0.16	-0.15	-0.24	1.00						
HPI	-0.06	0.04	-0.03	0.27	1.00					
HHDI	-0.28	0.62	-0.43	-0.47	-0.12	1.00				
INDEX	-0.09	0.44	-0.17	-0.35	0.06	0.56	1.00			
DEBT	0.56	-0.43	0.68	-0.19	-0.05	-0.47	-0.09	1.00		
INT	0.42	-0.56	0.59	0.05	-0.06	-0.57	-0.58	0.55	1.00	
ECB_ MRO	0.09	-0.49	0.17	0.29	-0.22	-0.47	-0.75	0.06	0.67	1.00

Further inspection of the correlation between the dependent variable and the macroeconomic variables show a high positive correlation with unemployment, government debt, long term interest rates as well as the main refinancing operation rate [see *table 2*]. There is no alarmingly high correlation between the independent variables beyond what is expected.

The next step is to examine the bank specific variables. The first takeaway is that the loan loss provisions are extremely high. That could be explained by the anticipation effect by credit risk managers (Ozili, 2015).

Table 3: Correlation table with bank-specific variables [Asset-quality ratios and capital ratios]

	Log_NPL	L.log_NPL	LLP/ Loans	LLP/ NPL	LLP/ Int	IL/ Equity	TIER1	CAP	CAR	ETA
log_NPL	1.00									
L.log_NPL	0.93	1.00								
LLP/Loans	0.67	0.65	1.00							
LLP/NPL	-0.10	-0.06	0.05	1.00						
LLP/Int	0.32	0.29	0.43	0.02	1.00					
IL/Equity	0.14	0.13	0.15	0.00	0.11	1.00				
TIER1	-0.02	-0.02	0.12	0.00	0.05	-0.03	1.00			
CAP	-0.04	-0.04	0.09	0.00	0.04	-0.03	0.99	1.00		
CAR	-0.04	-0.04	0.09	0.00	0.04	-0.03	0.99	1.00	1.00	
ETA	0.04	0.05	0.20	0.00	0.03	-0.06	0.42	0.36	0.36	1.00

Due to the persistent nature of the nonperforming loans, the NPL ratio of each bank is not independent over time (Makri, Tsagkanos, & Bellas, 2014, p. 203). Thus, the model includes an autoregressive/dynamic part, which means that the value of the dependent variable at time (t) is dependent on the value of the previous period (t-1) of the dependent variable itself.

Table 4: Correlation table with other bank-specific variables [Operational / liquidity / and other ratios]

	log_NPL	ROA	ROE	Interbank	LTA	LTD	LTD2	CDS	Efficiency	CTA
log_NPL	1.00									
ROA	-0.29	1.00								
ROE	-0.12	0.55	1.00							
Interbank	-0.41	0.16	0.10	1.00						
LTA	0.40	-0.08	-0.04	-0.46	1.00					
LTD	0.18	-0.03	-0.02	-0.28	0.73	1.00				
LTD2	0.42	-0.05	-0.02	-0.45	0.98	0.75	1.00			
CDS	0.24	-0.35	-0.38	-0.20	0.21	0.14	0.20	1.00		
Efficiency	0.20	-0.04	0.01	-0.07	0.09	0.09	0.10	0.00	1.00	
CTA	0.44	-0.15	-0.02	-0.28	0.49	0.26	0.50	0.08	0.14	1.00

The dynamic model takes the following form where each bank is denoted by the subscripts (i) which denotes the cross-sectional part, whereas (t) denote the time dimension of the panel sample. [See equation 1]

$$Y_{it} = \beta_1 + \rho\, Y_{i,t-1} + \beta_2\, X_{it} + u_{it} \qquad (1)$$

ρ: The autoregressive parameter [persistence rate]

Y_{it-1}: The lagged dependent variable,

X_{it}: The vector of independent variables [both country and bank-specific]

u_{it}: The error term, where: $u_{it} = v_i + \epsilon_{it}$ (2)

v_i: Unobserved individual/country-specific effects

ϵ_{it}: Idiosyncratic error

The inclusion of a lagged dependent variable presents us with an endogeneity problem as one of the regressors at least is not strictly exogenous. As a result, a simple *pooled OLS* will not be appropriate as that violates the OLS assumption of no autocorrelation of the error term[7] (Hicks, 1994, p. 171). If the model was *static*, then the *fixed effects* model could be a good model to employ given no time-invariant variables are used. However, using traditional fixed effects model on short panel data that is dynamic creates inconsistent results (Holtz-Eakin, Newey, & Rosen, 1988). Dynamic models with short panel data produce what is called as the "*Nickell bias/ Hurwicz type bias*" (Nickell, 1981). The *Nickell bias* is present whenever a dynamic model is combined with first-order lagged variable with a dataset that has a large number of individuals and limited time periods. That results in inconsistent estimates for dynamic models due to the *Asymptotic bias*[8]. The issue arises as the individual's means of each variable are subtracted -as part of the demeaning process- creates a correlation between the exogenous regressor and the error term (Baum, 2013). In other words, the estimators would not be efficient mainly due to the variables not being strictly exogenous, and the error term being correlated with the regressors (Nickell, 1981). This correlation between the error and the regressor produces bias estimates of the coefficient of the lagged

[7] Autocorrelation [also known as serial correlation] is the correlation of a signal with a delayed copy of itself as a function of delay. Informally, it is the similarity between observations as a function of the time lag between them.

[8] Asymptotic bias is due to having few time periods and a high number of individuals.

dependent variable. A bias which is not eased by increasing the number of individuals since the mean of the lagged dependent variable encompasses observations from zero until t-1. The cause of this bias is not attributed to autocorrelating of the error term, but it is amplified by it. Taking the first differences transformation does not remove the correlation between the first-order moving average disturbance process and the differenced lagged dependent variable. For the model to be appropriate, it should account for the issue of autocorrelation that resulted from the inclusion of the dynamic part. Following the work of Arellano and Bond, a more efficient estimator for dynamic panel data can be obtained by taking advantage of all the information provided in the panel data. Using instrumental variables that exploit all the information available in the sample in a Generalized Method of Moments (GMM) context (Baum, 2013). The issue of having a dynamic short panel data model is that the fixed effect of a country's shock persist (Roodman, 2006), however, the Arellano and Bond model is designed for short panels.

Comparing different models

The Arellano and Bond *Generalized Method of Moments (GMM)* method accounts for having endogenous variables. Whenever the causality is not one-sided, the regressors and the error term my correlate (Mileva, 2007). Using the GMM method incorporate accounts for endogenous variables, consequently, the error term is not correlated. The main dependent variable is the NPL ratio, the value of which relays on its previous value, followed by a number of variables [both country-level macroeconomic variables as well as observation-level individual bank variables]. The efficiency of the model is enhanced by incorporating more instruments. However, the assumption of uncorrelation between the first differences in the instrument variables with the fixed effects must be satisfied. GMM specifies that the time-invariant country-level (bank-level) effects may be correlated with the macroeconomic (bank-specific) variables.

Initial inspection of the lagged dependent variable showed that the autoregressive variable has a correlation of 0.93 with the dependent variable. Although this number is high, most of the differences come from between the banks as the differences between banks are higher than those within a bank [see appendix table 16]. The first takeaway from these figures is that the first differences estimation has neither a significant coefficient nor a considerable r squared. That can be explained by the fact that the NPL ratio seems to follow a random walk regardless of its initial

level. Therefore, the change in the NPL ratio is not linked to the existing level but follows a random walk theory. The Hausman specification test was performed to ensure that the fixed effects model is in line with the underlying assumptions. The result was the rejection of the null hypothesis that states that the differences in coefficients are not systemic. Therefore, the use of the fixed effects model is preferred over the random-effects model; meaning that the differences are systemic.

Table 5: Comparison between the different dynamic models without control variables

	(1) OLS	(2) FD	(3) FE	(4) FE with AR	(5) RE	(6) GMM
L.log_NPL _cons	0.973*** -0.0113	0.0108	0.434*** 0.783***	0.0978*** 1.266***	0.891*** 0.0956	0.816*** 0.219***
N	14258	10730	14258	10818	14258	10730
R-sq: Within Between Overall			0.1886 0.9309 0.8571	0.0080 0.9591 0.8735	0.1886 0.9309 0.8571	
R^2	0.857	0.0001	0.189			
Rho			0.78979		0.27944	
rho_ar *sigma_u* *sigma_e* *rho_fov*			 0.79544 0.41036	0.28084 1.2127 0.39166 0.90555	 0.25555 0.41036	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In the fixed-effects model, the error (u_{it}) contains both observation-specific error (ϵ_{it}) as well as the unobserved country-specific effects (v_i) [see equation 1], while first differencing would wipe out the unobserved country-specific effects (v_i). However, the observation-specific error (ϵ_{it}) would remain when using the first differencing approach. That translates to having the correlated error term, which in turn renders the first differences approach unusable. [See table 5]. While it can be helpful to use the first differences approach to remove the fixed effects, the endogeneity problem is transformed to be present in the Y_{it} and the Y_{it-1}. The problem is much more pronounced given the data set suffers from missing observations, hence, the gaps are amplified in the first differences transformation (Baum, 2013). In the fixed-effects model [using the within transformation], the coefficient of the lagged dependent variable is biased downwards because of the negative sign of the v_{t-1} in the transformed error. On the other hand, In the regular pooled OLS estimation, the coefficient of the lagged dependent variable is biased upwards due to the positive

correlation between the lagged dependent variable and the error term. Therefore, it is realistic to assume that the coefficient of the consistent estimator is situated between the two aforementioned coefficients given that the biases are in two opposite direction and that the second lag is insignificant (Baum, 2013). Hence, one could safely assume that the efficient coefficient of the lagged dependent variable should be less than the upper bound of 0.97 and higher than the lower bound of 0.43. This heuristic information is useful when assessing the best model to use. Another argument against the use of the fixed effects model is that it makes every observation for a certain individual endogenous. Although the statistical software allows for a fixed-effects model with autoregressive error [AR disturbances], the results were unacceptably biased. The estimated coefficient of the lagged dependent variable using this option was lower than the low-bound of 0.43 that the fixed effect model produced [see table 5]. Therefore, the fixed effects model with AR disturbances cannot be used in this case.

3.5 Methodology

Our employed method is the Arellano and Bond "Difference Generalized Method of Moments (GMM)" two-step estimator. This model has been used in earlier studies to identify the factors affecting the NPL Eurozone countries (Anastasiou, Louri, & Tsionas, 2016). It is assumed to produce unbiased, efficient and consistent results for dynamic panel data models as discussed earlier in the model choice section (Gutierrez & El-Khattabi, 2017). The standard covariance matrix is robust to panel-specific autocorrelation and heteroskedasticity for the two-step estimation, however, the standard errors are downward biased (Mileva, 2007). The use of two-step robust can help get the finite-sample corrected two-step covariance matrix. However, the Sargan test cannot be calculated for robust standard errors, thus, the robust standard error option will only be used to check the estimated p-values. The main econometric model takes the following functional form where each bank is denoted by the subscripts (i), each country is denoted by the subscripts (j), whereas the time dimension is denoted by the subscript (t):

$$\boldsymbol{NPL_{ijt} = \beta_0 + \beta_{x1} X_{ijt} + \beta_{x2} M_{jt} + \rho\, NPL_{ij,t-1} + v_{ij} + \epsilon_{ijt}}$$ [9]

NPL_{ijt}: The dependent variable where NPL ratio = (Nonperforming loans/Gross loans).

β_0: The regression intercept.

X_{ijt}: The vector of bank-specific variables. *[see appendix table 15]*

M_{jt}: The vector of macroeconomic variables. *[see appendix table 15]*

ρ: The persistence; given that $|\rho| < 1$.

$NPL_{ij,t-1}$: The dynamic (autoregressive) part of the model.

v_{ij}: The individual/country level effect of the two-tiered error structure.

ϵ_{ijt}: The observation-level regression idiosyncratic error of the two-tiered error structure.

In addition to the control variables, the ECB's main refinancing operations rate (ECB_MRO) is specified as a predetermined variable as it is set by the ECB. The first lag of the loan loss provisions as a percentage of NPL (LLP/NPL) is assumed to be endogenous due to the anticipation effect (Ozili, 2015). The use of dynamic panel data models is highly common as it can provide efficient estimates of instrumental variables (Radivojević, et al., 2019, pp. 1-4). Previous research that used pooled OLS or dynamic fixed effects has produced contradicting signs when attempting to assert the effect of variables on NPL ratios. A two-step least squares can usually solve this issue only if the instruments are not weak. However, the limitations of using standard approaches such as fixed effects make the GMM method the best choice. The GMM method accounts for the endogeneity of including a lagged dependent variable. The fact that it uses moment conditions produces more efficient estimations of the instrumental variables under the condition of *orthogonality* [10]. It is more efficient, and at the same time, it is less prone to the Nickell bias than other models that suffer from endogeneity problems (Radivojević, et al., 2019). However, the GMM estimator is not without faults. It can be biased in finite samples due to the fact that instruments are usually somewhat correlated with the endogenous components of the instrumented regressors (Roodman, 2006). A limitation of this approach is due to the limited number of groups in the dataset as this

[9] Noting that (ijt) corresponds to bank (i) in country (j) observed at time (t).

[10] "The orthogonality principle says that the error vector of the optimal estimator (in a mean square error sense) is orthogonal to any possible estimator" (Kay, S. M.,1993)

estimate can be efficient only if the number of instruments is smaller than the number of groups. Therefore, it is difficult to find an efficient estimator with a limited number of estimates as each endogenous variable that is included in the model adds more instruments.

In order to test that the model satisfies the assumptions of the Bond-Arellano estimator, the Wooldridge test for autocorrelation in panel data, where the null hypothesis states that there is no first-order autocorrelation will be used (Wooldridge, 2010). Preforming the "Arellano-Bond" test for zero autocorrelation in first-differenced errors. The null hypothesis of which states that there is no autocorrelation. In order for the model to be correct, the null hypothesis should be rejected for the first-order only, and not rejected for the second-order autocorrelation. The second test is the Sargan over-identification test which is used to test whether the instruments are valid (Mileva, 2007). The failure to reject the null hypothesis indicates that the instruments which are used in the model are valid. The initial suspicion was that the relationship between quantitative easing and nonperforming loans is partially or fully mediated through channels such as interest rates. However, performing a mediation effect test using a GMM estimator was challenging. Future research could explore the testability of such claim using more advanced techniques.

4 Results

To test the effect that quantitative easing policy has on the nonperforming loans ratios of Eurozone banks, four separate *two-step difference-GMM* regressions were performed. All models have the same explanatory and control variables. The combination of variables that are included was the result of a trial-and-error approach to find the best set of instruments that are not weak. Several different combinations have been tested to come up with the best possible model. As the inclusion of some variables causes the model to be incorrectly specified, this process was complemented by preforming the two specification tests which are used on all models to examine whether the models satisfy the assumption of the GMM model. The first test is the Wooldridge test for autocorrelation in panel data (Wooldridge, 2010) [Also called the Arellano-Bond test for zero autocorrelation in first-differenced errors]. The second test is the Sargan test of over-identification which is used to verify that all the instruments are valid. In the four regressions that were performed, the first model will be the reference point as it excludes any policy variables. In the second model, the quantitative easing dummy variable was added to test the performative direct effect that the announcement of

the quantitative easing policy has had on the nonperforming loans on the nonperforming loans. The 'QE' dummy takes the value zero before the year 2015, and 1 in the year 2015 an onwards. In the third model, the cumulative liquidity injection of the ECB's quantitative easing '*Assets Purchasing Program*' was included. The 'QE_cum' variable is equal to the total cumulative injection amount in the years leading up to and including the respective year value. In the fourth model, the total annual liquidity injection of the ECB's quantitative easing '*Assets Purchasing Program*' was included. The 'QE_tot' variable is equal to the total annual amount of QE injection in each year alone as discussed in the variable section.

Table 6: Difference GMM two-step estimations with macroeconomic and bank-specific control variables

	(1) without QE effect	(2) QE dummy	(3) QE cumulative injection	(4) QE annual injection
L.log_NPL	0.668***	0.667***	0.659***	0.659***
ECB_MRO	0.331***	0.333***	0.0766**	0.0750**
UNEMP	0.0691***	0.0690***	0.0266***	0.0263***
HHDI	-0.0135***	-0.0132***	-0.0246***	-0.0248***
DEBT	0.00647***	0.00653***	0.0117***	0.0118***
GDP	-0.00216*	-0.00209*	0.00198	0.00192
HPI	0.00354***	0.00361***	0.00764***	0.00771***
INT	-0.0421***	-0.0416***	-0.0101**	-0.0113**
ROA	-0.0365***	-0.0361***	-0.0195***	-0.0197***
CAR	-0.000803	-0.00107	-0.00237**	-0.00221*
LTD	0.00306***	0.00301***	0.000558	0.000527
CDS	-0.0143***	-0.0143***	-0.00881***	-0.00892***
Efficiency	0.000153***	0.000153***	0.0000933***	0.0000939***
CTA	-0.145***	-0.145***	-0.101***	-0.101***
QE		0.00324		
QE_cum			-0.143***	
QE_tot				-0.212***
N	594	594	594	594
Arellano-Bond test order 1	0.0006	0.0007	0.0001	0.0001
Arellano-Bond test order 2	0.3926	0.3896	0.4505	0.4483
Sargan test	0.1175	0.1054	0.4038	0.4035

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results show that the coefficient of the lagged NPL ratio '*persistence rate*' lies between the expected upper limit of 0.97 that the pooled OLS produced and the expected lower limit of 0.43

that the fixed effects model produced. [see table 6]. [12] The Arellano-Bond test was performed for all four models [see table 6]. The results show no violations in the assumptions as the test results were significant for the first-order and insignificant for the second-order in all the models. This test is crucial to make sure that the model is in line with the assumptions of the Arellano-Bond estimator. To test whether the instruments are overidentified, all four models have been tested for the validity of instruments using the Sargan overidentification test. The results show no significance, which means that the instrument is valid.

With regards to the policy announcement dummy (QE), the results show that the estimated coefficient is no different from zero. The efficient market theory states that as soon as information becomes available in an efficient market, the market adjusts before the execution [before the actual purchase happening] (Nellis, 2013). This means that the control variables account for the changes in the NPL levels as the results suggest. However, having only annual data limits the ability to perform an event study in this regard.

On the other side, the results corroborate the hypothesis that the liquidity injections of the *Assets Purchasing program* as part of the ECB's quantitative easing policy have reduced the nonperforming loans. The coefficient of the liquidity injections variables (QE_cum and QE_tot) are statistically significant as well as economically modest. Keeping in mind that the variables are quoted in trillions of euros, the effect can therefore be seen as mild. The results show that 1 trillion euros of stimulus by the ECB decreased the log of NPL ratio on a bank by 14%. Since the dependent variable is log-transformed, the coefficients are transformed back to better measure the effect[13]. The result of this transformation was -13.06% for QE_cum and -19.1% for QE_tot. That indicates that 1 trillion euros of annual stimulus have reduced the NPL ratio by percent on average, while an additional 1 trillion euros reduced the NPL ratio by 13 percent on average. As for the macroeconomic variables, the results show that both unemployment rate (UNEMP), and

[12] The upper bound of 0.97 is estimated using a pooled OLS, while the lower bound of 0.43 is estimated using the fixed effects panel data model. Therefore, the coefficient of the consistent estimator is situated between the two aforementioned coefficients given that the biases are in two opposite direction (Baum, 2013).

[13] We transform the coefficients by exponentiating it first. Then subtracting 1 and multiplying it by a 100 to calculate the percent change.

government debt (DEBT) have exerted a positive and significant effect on NPL ratios as expected and documented by most of the previous literature. Similarly, results show that household disposable income (HHDI) have had a negative and significant effect on NPL; similar to previous research. On the other hand, house price index (HPI) has been found to have a positive and significant effect contrary to the expectation, although having less than 5 percent real estate and mortgage banks in the dataset may have played a role in this. The coefficient of long-term interest rates also seem to have a sign contradicting the positive effect initially expected. As the correlation table shows a positive relationship between (INT) and both (NPL) and (log_NPL) [see table 2]. This might be due to the inclusion of the ECB's main refinancing operations rate. The coefficient of the GPD growth rate (GDP) has low significance but with the correct sign, however, the coefficient losses significant when including any of the QE policy variables. The evidence shows that the ECB's main refinancing operation rate (ECB_MRO) have had a statistically as well as economically significant effect; especially in model 1 and 2. While the magnitude of the effect seems to drop dramatically when accounting for the liquidity injection -both cumulative as or annual- [in model 3 and 4]. A similar trend can be seen with regards to the long-term interest rate (INT) as it loses magnitude when accounting for the liquidity injection [in model 3 and 4], however, it has a modest economic effect relative to the ECB's main refinancing operation rate (ECB_MRO).

The second step is to perform the same four estimations without including any explanatory or control variables to see the original effect of the policy variables on the NPL ratios; bearing in mind that the GMM method always includes the lagged dependent variable as default.

Table 7: Difference GMM two-step estimations without control variables

	(1) without QE effect	(2) QE dummy	(3) QE cumulative injection	(4) QE annual injection
L.NPL ratio - log transformed	0.816***	0.839***	0.523***	0.523***
QE dummy		-0.0572***		
QE cumulative amount			-0.198***	
Observations	10730	10730	10730	10730

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The intuition of this thesis seems to be corroborated -to some extent- by the results as it shows that QE policy announcement did have a significant negative effect on the NPL [see the QE dummy variable in table 7]. However, the fact that this variable was insignificant when a vector of explanatory/control variables where included could mean that the policy announcement did not have any effect beyond what the economic conditions can explain. The policy effect is therefore fully channeled by these variables and capturing the entirety of it. Another explanation might be that using annual intervals -which is not ideal for event studies- limits the ability to measure the reaction as policy reaction is hard to distinguish in such a long interval that encompasses many other influencing events and changes in the ecosystem. The results of model 3 and 4 are similar to the earlier estimations -when including the control variables- [see table 6 and 7]. While the magnitude of the was found to be 35% to 39% weaker after the inclusion of the control variables, it remained ststistically significant. That provides us with confidence over the results obtained earlier.

Implications

The empirical evidence did not support the first hypothesis which states that the announcement of *quantitative easing* policy by the European central bank have had an impact on *nonperforming loans* of Eurozone banks. While the coefficient of the announcement dummy (QE) had a significant negative effect on the nonperforming loans, the inclusion of control variables wiped out the effect making it no different than zero [see table 8]. It is plausible that the efficiency of the Eurozone markets, in general, influenced the underpinning determinants under the efficient market theory in such a way that it absorbs any statistical significance. The evidence that the ECB's quantitative easing announcement have directly affected the nonperforming loans ratios in Eurozone banks was found to be weak, which could also be due to the high anticipation as earlier mentioned that uncertainty is key to the effectiveness of this policy (Nellis, 2013).

Comparison Table 8: The effect of the quantitative easing policy announcement on nonperforming loans ratio

	Without control variables	With control variables
L.NPL ratio - log transformed	0.839***	0.667***
QE dummy	-0.0572***	0.00324
Observations	10730	594

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

On the contrary, the results show compelling evidence that corroborates the second hypothesis with both total annual amount and cumulative amount exerting a significant negative effect on the nonperforming loans ratios [see table 7]. The results indicate that a trillion euro of annual stimulus has reduced the nonperforming loans by a factor of 19 percent on average. On the other hand, an additional trillion of stimulus can reduce the NPL by 13 percent. While this is substantial, studies show that the diminishing effect of this policy means it becomes more costly to achieve the same result in the future (Nellis, 2013).

Lastly, the results of the empirical analysis show support for the third hypothesis (H3-b) which suggests a partial channeling of the effect. As the liquidity injections of the *Assets Purchasing Program* remained a significant explanatory variable of the NPL ratios; despite the inclusion of a set of control variables. The channeled effect through the control variables (e.g. interest rates) does not yet capture the full effect that the ECB's *quantitative easing* policy implementation had on the nonperforming loans ratios of Eurozone banks. While this could mean that there is a missing channel that is not accounted for, it is plausible that some of the changes in the nonperforming loans ratio are attributed to the signaling effect that bank managers, as well as borrowers, could have taken into account.

Comparison Table 9: The effect of the liquidity injection on nonperforming loans ratio

	Without control variables		With control variables	
L.NPL ratio - log transformed	0.523***	0.523***	0.659***	0.659***
QE cumulative amount	-0.198***		-0.143***	
QE total amount		-0.288***		-0.212***
Observations	10730	10730	594	594

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Limitations

Due to the low-frequency intervals in the dependent variable, it may be difficult to prove causality between the policy implementation, and the changes in the NPL using publicly available data alone. The annual data that was used limits the viability of an event study as many changes happen in the spawn of one year. Quarterly data would have been more able to capture such variation. This could be a good window to explore for future research. The missing values within the dataset may

bias the results. Despite best efforts, the available statistical software that was used in this research was unable to test the unit-roots of the variables. That could have an implication on the validity of the findings (Radivojević, et al., 2019). However, the two-step GMM should account for heteroscedasticity as well as autocorrelation. On top of that, the use of multiple methods as a robustness check should provide some confidence in the findings. Lastly, the different definitions of NPEs and NPLs might cause the dependent variable to change accordingly regardless of the determinant factors. The operationalization of this omitted variable was not possible given this data is not publicly disclosed.

4.1 Robustness checks

To check whether the p-values are biased when using the two-step GMM standard errors option, the same difference GMM regressions were performed using the robust standard errors. This option usually produces lower P-values than that of the two-step difference GMM estimator [see table 10].

Table 10: Difference two-step GMM estimations with robust standard errors

	(1) without QE effect	(2) QE dummy	(3) QE cumulative injection	(4) QE annual injection
L.log_NPL	0.668***	0.667***	0.659***	0.659***
ECB_MRO	0.331**	0.333**	0.0766	0.0750
UNEMP	0.0691***	0.0690***	0.0266*	0.0263*
HHDI	-0.0135	-0.0132	-0.0246***	-0.0248***
DEBT	0.00647	0.00653	0.0117***	0.0118***
GDP	-0.00216	-0.00209	0.00198	0.00192
HPI	0.00354	0.00361	0.00764*	0.00771*
INT	-0.0421**	-0.0416**	-0.0101	-0.0113
ROA	-0.0365**	-0.0361**	-0.0195	-0.0197
CAR	-0.000803	-0.00107	-0.00237	-0.00221
LTD	0.00306	0.00301	0.000558	0.000527
CDS	-0.0143*	-0.0143*	-0.00881	-0.00892
Efficiency	0.000153	0.000153	0.0000933	0.0000939
CTA	-0.145**	-0.145**	-0.101*	-0.101*
QE		0.00324		
QE_cum			-0.143***	
QE_tot				-0.212***
N	594	594	594	594

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

When comparing the two different tables with GMM standard errors and robust standard errors, one can see that the significance drops in most bank-specific and macroeconomic variables [see tables 6 and 10]. However, regarding the policy variables -which are the focus of this thesis-, the results seem to be robust enough with no change in sign or significance. This provides confidence in the estimations obtained in the results section. A full table for each regression (2, 3, 4) is provided in the appendix to compare the p-values of the GMM standard error regressions and the robust standard error regressions.

As for regressions 1 and 2, all bank-specific coefficients have lost significance with the exception of return on assets (ROA), and cost to assets ratio (CTA). The only significant variables are unemployment (UNEMP) and long-term interest rates (INT) along with the persistence rate (L.log NPL). In regression 3 and 4, the significance of the bank-specific variables is lost with only cost to assets (CTA) being significant at 90 percent confidence. The ECB's main refinancing operations (ECB_MRO) also loses significance as well as other macroeconomic variables. The only significant explanators are household disposable income (HHDI), government debt as percentage of GDP (DEBT), and long-term interest rates (INT) along with the persistence rate (L.log NPL). An explanation to this is that the banks specific variables are hardly determinant of NPL ratios. The fact that bad management explains variations could not be accepted with the results obtained. The overwhelming evidence points to the state of the economy being responsible for the changes in the NPL levels in those banks. The loss of significance can be attributed to a number of factors. For example, regarding the house price index (HPI), while it is still plausible that HPI significantly affects the NPL rates in real estate and mortgage banks, the fact that only 2% of the banks in the data is of this type could explain the loss of significant. GDP growth and government debt are not intuitively linked to NPL, but unemployment is. The inclusion of both these into the model revealed the more prominent one. The only significant explanator in all four estimations is the persistence rate (ρ) which means that the ratio of NPL follows a random-walk. This results corroborate the '*bad luck'* hypothesis as the change in the nonperforming loans when accounting for previous value seem to be independent to some degree. This finding contradicts earlier research by Podpiera and Weill where their results corroborated the *'bad management'* hypothesis. All regressions were tested using the Arellano-Bond test. The results show no violations in the assumptions. However, testing whether the instruments are overidentified using the Sargan

overidentification test is not possible when opting for robust standard errors. To make sure that the hierarchical structure of the dataset -where macroeconomic variables lay on a different level than bank-specific- does not bias the estimates, two separate regressions were performed to crosscheck the estimated coefficients. All regressions are *two-step difference-GMM* regressions which are complemented by two specification tests. The first model includes macroeconomic variables only; while the second has bank-specific variables only [see appendix table 11]. The results of which seem to be robust and similar enough to give confidence in the obtained results.

5 Conclusions and future research

The link between *Quantitative easing* and Nonperforming loans is yet to be explicitly investigated on a disaggregated level. This paper tries to uncover how the ECB's APP policy announcement and implementation affected the asset quality of banks operating in Eurozone in the period between 2015 and 2018. As the *Quantitative easing policy* is believed to affect the economy through ex-ante channels as well as directly through signaling effects, the research was aimed to see if either of these effects can be linked to the asset quality of banks, hence, their nonperforming loans ratios. Using a panel data comprised of 1541 Eurozone bank with 11 years of annual data between 2008 and 2018 to study this effect. The data is comprised of Eurozone banks with euro as their main currency as they are more prone to the effect of the ECB's QE policy. A dynamic panel data model is known as the Arellano-Bond '*Difference Generalized Method of Moments (GMM) two-step estimator*' was used. The GMM model takes into account the inclusion of a lagged dependent variable due to the persistent nature of the NPL problem on a bank's balance sheet. The main drivers that was found to significantly affect nonperforming loans were unemployment, government debt as percentage of GDP, household disposable income, long-term interest rates, return on average assets, cost to income ratio, and the ECB's main refinancing operations rate. Nevertheless, none of the variables were significant in all four regressions. The four regressions contained the same set of variables whist introducing the policy variables one by one into the GMM model. The first regression was acting as a reference point. The only significant regressor in all four regressions was the lagged dependent variable; proving the importance of the dynamic nature of the model as well as providing some support to the *'bad luck'* hypothesis. The fact that

nonperforming loans might be following a random-walk when accounting for previous values remains open for further investigation; an area left for future researchers.

The evidence suggests that the period following the quantitative easing policy has witnessed less nonperforming loans on average, however, the results did not corroborate that the effect was directly linked to the announcement. The results suggest that the effect was accounted for by changes in the economy and the bank characteristics. The effect was accounted for by the cost to income ratio, unemployment, long-term interest rates, return on average assets, and the ECB's main refinancing operations rate. On the other hand, the results suggest that the stimulus provided by the ECB's *Assets Purchasing Program* "liquidity injection" has significantly reduced the nonperforming loans of Eurozone banks. With some degree of diminishing effect, a trillion euros of stimulus have reduced nonperforming loan ratios by 13 to 19 percent compared to their previous figures and not in absolute values. The results suggest that the effect was only partially channeled which suggests that there is an effect that the control variables are not able to capture. The management of a bank have discretion over whether an exposure [read loan] is placed in the forborne performing-loans bucket or the forborne nonperforming-loans bucket. As the definition of default as well as the definition of forbearance could play a role in explaining this result, controlling for such variable might have been essential. However, it was also infeasible given that this data is not publicly accessible. As This could be a domain for future research to explore, however, operationalizing such variable with the current public data seems farfetched. Using privet data could be the way to go here. It is also logical to assume that the effect was mediated, however performing a mediated effects test on the GMM model was challenging. Future researchers could attempt to find out if such an approach would introduce similar findings.

As ECB's president 'Mario Draghi' prepares to leave the ECB, recent news indicate that the ECB is considering a fresh round of quantitative easing (Jones, 2019). Hence, a better understanding of the mechanism in which nonperforming loans are affected by the large scale asset purchasing is imperative to avoid the adverse feedback loop. An adverse feedback loop that could potentially further stress an already struggling European banks, and ultimately jeopardizing the entire Eurozone.

6 Glossary

APP	Assets Purchasing Program
CAP	Total Capital Ratio
CAR	Capital Adequacy Ratio
CDS	Credit Default Swap
CTA	Cost To Assets Ratio
ECB_MRO	European Cental Bank
ECB_MRO	European Cental Bank's Main Refinancing Operations fixed rate
Efficiency	Cost to Income ratio
ETA	Equity to Assets
GMM	Generalized Method of Moments
HHDI	Household Disposable Income
HPI	House Price Index
ILtoEquity	Impaired Loans to Equity
Interbank	Interbank rate of borrowing
LLP	Loan Loss Provision
LTA	Loan To Assets
LTD	Loans To Deposits Ratio
NPL	Nonperforming Loans
QE	Quantitative Easing
ROA	Return On Assets
ROE	Return On Equity

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8 Appendices:

Table 11: Difference GMM estimation using macroeconomic variables only verses bank-specific variables only

	(1) Macro	(2) Bank-Specific
L.NPL ratio - log transformed	0.810***	0.478***
HouseholdDisposableIncome	-0.0260***	
Unemployment	0.0251***	
Inflation	-0.0339***	
Market index	0.0949***	
GovernmentDebt/GDP	-0.000613	
RealGDPgrowth	-0.00989**	
House Price Index	-0.000804	
3-Year government bond yield	0.106***	
LLP/Loans		0.0296**
LLP/NPL		-0.00936***
LLP/Interest		-0.000455*
ImpairedLoans/Equity		0.00373***
Tier 1 ratio		-0.0586***
Equity/TotalAssets		0.0565***
Return on Assets		0.0193
Return on Equity		-0.00775*
Interbank ratio		0.0000561
NetLoans/TotalAssets		-0.0155*
NetLoans/Dep.&ST.Funding		0.0138***
NetLoans/Tot.Dep.&Bor.		-0.00998
5 Year Swaps Spread		0.0440**
Capital Adequacy Ratio		0.0517***
Cost to income (Efficiency) ratio		-0.00616***
Cost to average asset ratio		0.103**
Observations	10730	138
Arellano-Bond test order 1	0.00	0.0652
Arellano-Bond test order 2	0.8272	0.0759
Sargan test	0.00	0.8794

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Difference GMM two-step estimations with GMM SE and robust SE

	GMM standard errors		Robust standard errors	
L.log_NPL	0.667***	(37.68)	0.667***	(6.90)
ECB_MRO	0.333***	(16.89)	0.333**	(2.94)
LLPtoNPL	-0.000289***	(-142.47)	-0.000289***	(-21.16)
L.LLPtoNPL	0.000252***	(39.49)	0.000252***	(7.87)
UNEMP	0.0690***	(25.32)	0.0690***	(4.68)
HHDI	-0.0132***	(-7.32)	-0.0132	(-1.66)
DEBT	0.00653***	(7.33)	0.00653	(1.71)
GDP	-0.00209*	(-2.20)	-0.00209	(-0.53)
HPI	0.00361***	(3.48)	0.00361	(0.84)
INT	-0.0416***	(-18.06)	-0.0416**	(-2.75)
ROA	-0.0361***	(-11.36)	-0.0361**	(-2.60)
CAR	-0.00107	(-0.85)	-0.00107	(-0.17)
LTD	0.00301***	(6.61)	0.00301	(1.09)
CDS	-0.0143***	(-9.08)	-0.0143*	(-2.22)
Efficiency	0.000153***	(12.16)	0.000153	(1.88)
CTA	-0.145***	(-18.69)	-0.145**	(-2.92)
QE	0.00324	(0.57)	0.00324	(0.10)
N	594		594	

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Difference GMM two-step estimations with GMM SE and robust SE

	GMM standard errors		Robust standard errors	
L.log_NPL	0.659***	(47.87)	0.659***	(7.47)
ECB_MRO	0.0766**	(3.13)	0.0766	(0.87)
LLPtoNPL	-0.000293***	(-163.01)	-0.000293***	(-23.40)
L.LLPtoNPL	0.000241***	(49.39)	0.000241***	(8.02)
UNEMP	0.0266***	(9.03)	0.0266*	(2.13)
HHDI	-0.0246***	(-10.66)	-0.0246***	(-3.51)
DEBT	0.0117***	(11.49)	0.0117***	(3.43)
GDP	0.00198	(1.37)	0.00198	(0.53)
HPI	0.00764***	(9.36)	0.00764*	(2.10)
INT	-0.0101**	(-2.84)	-0.0101	(-0.68)
ROA	-0.0195***	(-7.08)	-0.0195	(-1.38)
CAR	-0.00237**	(-2.61)	-0.00237	(-0.47)
LTD	0.000558	(1.21)	0.000558	(0.21)
CDS	-0.00881***	(-9.21)	-0.00881	(-1.75)
Efficiency	0.0000933***	(10.03)	0.0000933	(1.68)
CTA	-0.101***	(-9.56)	-0.101*	(-2.08)
QE_cum	-0.143***	(-26.42)	-0.143***	(-5.70)
N	594		594	

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Difference GMM two-step estimations with GMM SE and robust SE

	GMM standard errors		Robust standard errors	
L.log_NPL	0.659***	(47.89)	0.659***	(7.49)
ECB_MRO	0.0750**	(3.03)	0.0750	(0.85)
LLPtoNPL	-0.000293***	(-162.72)	-0.000293***	(-23.41)
L.LLPtoNPL	0.000240***	(49.48)	0.000240***	(8.05)
UNEMP	0.0263***	(8.91)	0.0263*	(2.11)
HHDI	-0.0248***	(-10.64)	-0.0248***	(-3.54)
DEBT	0.0118***	(11.43)	0.0118***	(3.47)
GDP	0.00192	(1.34)	0.00192	(0.51)
HPI	0.00771***	(9.43)	0.00771*	(2.13)
INT	-0.0113**	(-3.18)	-0.0113	(-0.76)
ROA	-0.0197***	(-7.19)	-0.0197	(-1.39)
CAR	-0.00221*	(-2.48)	-0.00221	(-0.44)
LTD	0.000527	(1.15)	0.000527	(0.20)
CDS	-0.00892***	(-9.22)	-0.00892	(-1.77)
Efficiency	0.0000939***	(10.09)	0.0000939	(1.71)
CTA	-0.101***	(-9.46)	-0.101*	(-2.06)
QE_tot	-0.212***	(-26.86)	-0.212***	(-5.73)
N	594		594	

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15: Conceptual framework complete variable list, expected sign, and source.

Type	Code	Exp sign	Description	Source
Dependent	NPL	n. a	$NPL\ ratio = \frac{Nonperforming\ loans}{Gross\ loans}$	Bankfocus
Policy variables	QE	-	A dummy that takes 1 after the announcement of QE, and zero otherwise (2015-2018) =1	ECB database
	QE_tot	-	Annual amount of liquidity injected as part of the ECB's APP.	
	QE_cum	-	Cumulative amount of liquidity injected as part of the ECB's APP.	
Predetermined macroeconomic	ECB_MRO	+	ECB's Main refinancing operation rate	
Independent Macroeconomic	Bond	+	Yield on 3-year or 5-year government bond	Eurostat
	INT	+	Long-term interest rate Maastricht criterion bond yields using EMU convergence criterion on annual basis.	
	GDP	-	Real-GDP growth rate	OECD/IMF
	DEBT	-	Public debt as a percentage of GDP	Factset
	UNEMP	+	Unemployment rate	
	INF	-	Inflation rate measured by CPI (proxy for currency depreciation)	
Independent Macroeconomic	HHDI	-	Households Disposable income	
	INDEX	-	Market index "EuroStoxx50" (proxy to equity prices)	
	HPI	-	House price index	
Independent Bank-specific	ROA ROE	-	Return on assets or equity (proxy for managerial efficiency)	Bankfocus
	LTD	+	Loans to deposits ratio (proxy for moral hazard)	
	CAP/CAR	+/-	Total capital ratio or capital adequacy ratio (measures the capacity for risk)	
	LLP/INT	+	% Loan loss prov./interest income Measures the capacity to finance reserves	
	LLP/NPL LLP/Loans	+	% Loan loss prov./NPL (proxy for anticipation) % Loan loss prov./total loans (proxy for anticipation)	
	CDS	+	Spread on a 5-year swap rate spread (Proxy of a bank's health)	
	Efficiency	-	Cost to income ratio	
	CTA	+	Operating expenses/Average assets (Measures efficiency but not effected by the interest rates changes)	
	ILtoEquity	+	Impaired Loans to Equity measures the capacity to absorbs losses form impairment.	
	ETA	-	Equity to assets which measures the leverage of a bank	
	Interbank	+	Interbank rate measures the cost of funding to a bank	
	LTA	+	Loan to assets which is a proxy to excessive risk-taking behavior and moral hazard	

Table 16: Descriptive statistics table of the variables

Variable		Mean	Std. Dev.	Min	Max	Observations
NPL	overall	7.904699	10.30733	0.01	218.18	N = 18097
	between		10.3823	0.01	210.26	n = 3528
	within		4.183051	-62.0736	79.8597	T-bar = 5.14153
log_NPL	overall	1.401577	1.287218	-4.60517	5.38532	N = 18097
	between		1.258427	-4.60517	5.347635	n = 3528
	within		0.4601868	-3.76765	5.268146	T-bar = 5.12954
ECB_MRO	overall	0.813636	1.125361	0	3.75	N = 38951
	between		0	0.813636	0.813636	n = 3541
	within		1.125361	0	3.75	T = 11
QE	overall	0.363636	0.4810519	0	1	N = 38940
	between		0	0.363636	0.363636	n = 3540
	within		0.4810519	0	1	T = 11
QE_tot	overall	0.19516	0.4288815	0	1.47585	N = 38945
	between		0.003935	0.19513	0.429286	n = 3541
	within		0.4288733	-0.23397	1.47588	T-bar = 10.9983
QE_cum	overall	0.275753	0.6219031	0	2.14643	N = 38945
	between		0.00556	0.275711	0.606564	n = 3541
	within		0.6218918	-0.33065	2.146472	T-bar = 10.9983
HHDI	overall	0.468594	1.726919	-12.64	7.03	N = 38940
	between		0.8398095	-3.38727	2.353636	n = 3540
	within		1.509023	-12.4723	6.867685	T = 11
UNEMP	overall	8.295359	3.924719	3.4	27.49	N = 38940
	between		3.436332	5.173636	20.00182	n = 3540
	within		1.896858	-3.56828	16.15172	T = 11
INF	overall	1.37397	1.132557	-4.48	15.4	N = 38940
	between		0.2366997	0.378182	2.865455	n = 3540
	within		1.107553	-3.48421	13.97033	T = 11
INDEX	overall	2.95243	0.352567	2.31655	3.50396	N = 38940
	between		0	2.95243	2.95243	n = 3540
	within		0.352567	2.31655	3.50396	T = 11
DEBT	overall	87.5255	27.89001	4.5	183.3	N = 38940
	between		25.93572	8.227273	163.8273	n = 3540
	within		10.26471	33.09822	122.98	T = 11
GDP	overall	0.707455	2.660966	-14.8	25	N = 38940
	between		0.8887437	-2.36364	4.636364	n = 3540
	within		2.508203	-15.738	21.14382	T = 11
INT	overall	2.795373	1.781074	0	14	N = 38940
	between		0.9462598	0	5.274545	n = 3540
	within		1.508989	-1.49826	12.3481	T = 11
HPI	overall	95.51273	25.02937	0	151.51	N = 38940
	between		7.057546	79.62091	115.9482	n = 3540
	within		24.01403	-5.96727	140.79	T = 11
LLPtoLoans	overall	4.115703	6.499114	-13.22	109.1	N = 18536
	between		6.790129	0	99.915	n = 3515
	within		2.627342	-65.8626	63.3757	T-bar = 5.2734
LLPtoNPL	overall	144.6314	4159.221	-105	382600	N = 17971
	between		1935.03	-81.5	85543	n = 3504
	within		3608.363	-85336.4	297201.6	T-bar = 5.12871

Variable		Mean	Std. Dev.	Min	Max	Observations
LLPtoInt	overall	23.17691	171.4646	-4081.4	15771.74	N = 19237
	between		80.37854	-1836.3	2461.905	n = 3525
	within		157.0752	-6294.17	13333.01	T-bar = 5.4573
ILtoEquity	overall	66.36941	679.04	-21688.5	59560	N = 18203
	between		407.0846	-5546.53	16141	n = 3540
	within		584.9309	-16747.1	49253.36	T-bar = 5.14209
TIER1	overall	18.04037	21.97552	-7.3	1700	N = 16256
	between		34.93766	2.4	1700	n = 3169
	within		8.199098	-273.876	524.6837	T-bar = 5.12969
CAP	overall	20.29555	23.15852	-5.7	1974	N = 17232
	between		38.31615	3.88	1974	n = 3273
	within		8.707556	-279.589	626.9005	T-bar = 5.26489
ETA	overall	9.486809	41.77261	-4403.95	100	N = 19478
	between		44.33672	-2340.91	98.99	n = 3540
	within		28.532	-3284.43	1048.997	T-bar = 5.50226
ROA	overall	-0.10776	35.16676	-4677.9	30.22	N = 19455
	between		51.63143	-3069	11.164	n = 3536
	within		16.34159	-1609.01	1608.792	T-bar = 5.50198
ROE	overall	1.724431	60.35238	-5429.09	4871.17	N = 19453
	between		24.03413	-935.975	627.3837	n = 3536
	within		54.82109	-4491.39	4245.511	T-bar = 5.50141
Interbank	overall	294527.4	1.99E+07	0	2.36E+09	N = 19047
	between		1.74E+07	0.18	1.02E+09	n = 3491
	within		1.31E+07	-6.91E+08	1.35E+09	T-bar = 5.45603
LTA	overall	58.77653	17.74869	-0.59	99.66	N = 19471
	between		16.95276	0.002	99.11572	n = 3540
	within		5.26491	-3.61181	115.1265	T-bar = 5.50028
LTD	overall	200.3062	16392.09	-1.88	2285581	N = 19444
	between		6452.033	0.002	383555	n = 3535
	within		14943.74	-383266	1902227	T-bar = 5.50042
CDS	overall	2.238558	3.024218	0	29.77	N = 978
	between		1.971093	0.413333	11.95125	n = 155
	within		2.229375	-2.80144	26.82356	T-bar = 6.30968
BaselCap	overall	5805698	1.56E+07	0	9.71E+07	N = 1057
	between		1.24E+07	0	9.06E+07	n = 426
	within		1591738	-1.29E+07	1.93E+07	T-bar = 2.48122
CAR	overall	20.29555	23.15852	-5.7	1974	N = 17232
	between		38.31615	3.88	1974	n = 3273
	within		8.707556	-279.589	626.9005	T-bar = 5.26489
Efficiency	overall	58.7681	1371.496	-187750	7341.44	N = 19447
	between		1036.49	-61206.9	2069.464	n = 3536
	within		1135.518	-126484	64881.77	T-bar = 5.49972
CTA	overall	2.22813	2.469719	-18.4	130.17	N = 19448
	between		2.848386	-0.09	92.675	n = 3536
	within		1.051503	-19.7102	110.0598	T-bar = 5.5