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Collateral effect at the E.C.B. main refinance operations - A regional analysis

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Abstract

In this paper, I initiate the empirical research on the efficiency of the European Central Bank Main Refinance Operations. The focus is on the haircuts applied to assets used as collateral on the weekly liquidity provision operations and if there is a regionality additional dicount based on reputation and other non-economic characteristics between North European Countries (Austria, Belgium, France, Germany, Netherlands) and the European Periphery. One base model and three extensions are tested to discover this potential. A credit ratings extension to the base model, a banking sector group of variables added to the base model and a model that only contains the banking sector variables form the extension models. No sufficient indication of regionality in the haircut collateral has been discovered, with critical factors in the formation of haircuts to be Non-Performing Loans ratio, Loans to Deposits ratio, EONIA Rate and Debt to GDP. Asset encumbrance also shows statistical importance but through a converse relationship to the established literature. On the final extension, there is a signal of country-specific positive effects on collateral haircuts.

1 Introduction

Walter Bagehot in *Lombard Street: A description of the Money Market*, (1873), presented the first outline of the purpose and functions of a Central Bank. Central Banks should play the role of the Lenders of Last Resort (LOLR) for banks at liquidity bottlenecks and should be willing to provide infinite liquidity to solvent and well-functioning banks. This supply should be with favourable terms but always under the condition that it is secured by sufficient collateral. These proposals come from a period when Central Banking was quite different from what it is today. One fundamental difference is that during the publication, the Bank of England was a private institution without any regulatory, stabilising, or supervising role.

Today, Central Banks remain a fundamental part of any economy. They are public institutions with the sole purpose of assurance of social well-being through a well-functioning economic environment. Central Banks achieve this basically through the implementation of Monetary Policy. Central Banks, over the years, have found themselves with different mandates and a variety of mechanisms to implement monetary policy.

The main goal of Central Banks, with variations due to the different mandates, is the pursuit of price stability, by controlling inflation through the setting of leding interest rates. The centre of the research proposal is European Central Bank (ECB). ECB like all other central banks implements its monetary policy through the interest rates that banks from the Euro Area receive funds. There are three key interest rates, the levels of which are set in meetings every six weeks. The Main Refinancing Operation rate for borrowing funds with a duration of one week, the Marginal Lending Facility rate which is applied to overnight borrowing and Deposit rates in cases where there is a liquidity surplus, and it is paid to banks that deposit their funds overnight at ECB.

ECB implements the Liquidity Neutral Policy which means that liquidity deficit or surplus in the Eurosystem should be treated with liquidity injection or absorption respectively. Furthermore, contrary to the fundamental knowledge of maturity and yield, overnight marginal rates are higher compared to main refinancing rates lasting one week.

This paper focuses on the Main Refinancing Operations (MROs) that take place every week and is the most important monetary policy transmission mechanism at the moment. A typical MRO is scheduled and announced by the ECB. The main refinancing operations are conducted through regular tender operations, where eligible banks submit bids to borrow funds from the ECB. The ECB determines the amount of liquidity to be injected or absorbed through open market operations based on its assessment of the overall liquidity needs in the banking system. This calculation takes into account factors such as the current and expected liquidity conditions, economic developments, and the monetary policy stance. Banks in need of liquidity provide bids through their Central banks, quoting a rate that they are willing to pay and the amount they need. They can bid up to 10 quotes.

Except for the ECB, banks can also access the Overnight Interbank Market

to acquire the liquidity they need. They can receive funds directly from the money market (i.e. other banks) at rates formed by the market with or without pledging collateral. The risk with this market though is that during crises it dries up quickly.

This became pretty evident during the 2007 – 2008 crisis and the Federal Reserve had to step in and provide the necessary liquidity, so the banking system and the econoy could continue to operate smoothly. It was a modern-day bank-run but not in deposit, but the provision of liquidity(Gorton & Metrick, 2012). The Fed has long experience with liquidity shortages and bank runs, took action immediately and flooded the market with cash. In some cases, it even obliged liquid banks to receive liquidity injections.

A byproduct of the crisis in the United States was a banking crisis in Europe, as European banks were the main buyers of the toxic MBSs and CDOs produced by American banks. Strong euro-member economies like Germany, France and the Netherlands surpassed the sovereign crisis but the European periphery struggled to return to acquiring cheap funding. Even though ECB was willing to provide the appropriate liquidity, fulfilling its role as Lender of Last Resort the available collateral in the market shrank dramatically. This course of action is considered the most effective in periods of turmoil (Bindseil & Jablecki, 2013).

The reaction of ECB was, to proceed to the lessening of the ratings of collateral accepted because countries and banks could not provide the demanded collateral quality. In some cases, like Greece whose sovereign debt fell into speculative territory during the debt crisis, it was impossible to pledge any type of collateral to participate in the liquidity auctions of the ECB and keep the economy and banking sector running. However, ECB could not ignore the Greek economy as it would contrast its mandate so the ELA [1] was activated for the economy to resume its operation.

Despite the extensive literature on the importance of collateral and haircut policy in liquidity provision in the euro area, to my knowledge, there is not a work that focuses on the driving factors of haircuts between countries and more specifically on the difference between countries of the European Periphery (Portugal, Italy, Ireland, Greece, Spain) and the European North (Germany, the Netherlands, Austria, Belgium, France) covering the whole decade of the 2010s. In this paper, I try to uncover potential weaknesses in the ECB's monetary policy design. It is proven that central bank intervention is deemed to bring uncertainty to the interbank markets during periods of high counterparty risk (Brunetti, Di Filippo, & Harris, 2011) and a potentially inefficient monetary policy mechanism, reflected in the Collateral Haircut, is unable to help the whole spectrum of economies, with its different characteristics and needs could be an important driving factor. I will also study if the reputation of the issuer's country as collateral in the bank market (Nikolov, 2012) has also an effect on Central Bank operations against states.

[1] Emergency Liquidity Assistance. See `https://www.ecb.europa.eu/mopo/ela/html/index.en.html`

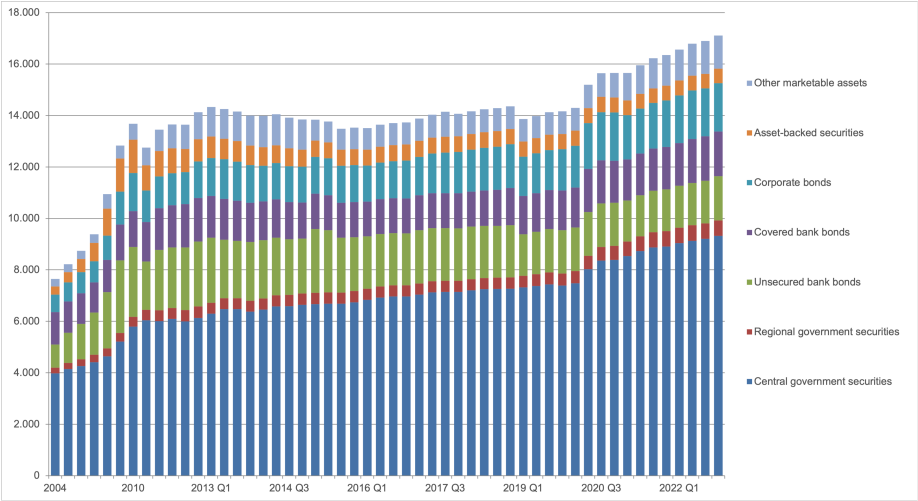

Figure 1: Asset eligible as collateral by class.

It is imperative to work towards researching potential inadequacies in the haircut policy because, as the current literature reveals, collateral frameworks can, under certain conditions expose countries to debt crises and corporations to change their debt structure. It is necessary to identify regional and reputational residuals in the haircut policies because these could deprive countries of the necessary liquidity. The impact of liquidity deprivation means that Central banks fail to fulfil their mandates and deteriorate the economic environment and citizen's well-being.

2 Institutional Background

For a bank to participate in the ECB's open market operations, it must provide eligible collateral as security. The ECB maintains a list of eligible collateral, which primarily includes marketable debt instruments issued by euro-area central governments and certain supranational organizations. More detailed information for the amounts of eligible assets and the amounts used as collateral per asset class you are presented in Figure 1 and Figure 2. The Main Refinancing Operations are typically conducted as fixed-rate tenders, where the ECB specifies the interest rate at which it is willing to lend funds to banks.

Haircuts are applied to the collateral provided by banks to account for the credit risk associated with these assets. It is a percentage reduction in the value of the collateral, which serves as a buffer to protect the ECB against potential losses in case of default. The ECB's Governing Council sets the haircut levels, taking into consideration the credit quality and market liquidity of the collateral and assigning them to categories per asset type and category group. The current category assignment is presented in Table 1. The general rules

for setting the collateral eligibility and corresponding haircuts are provisioned under the European European Collateral Framework. As this paper focuses on the setting and haircuts I present in brief some headline features of the ECB Haircut policy. As of the 1st of January, the haircut categories per asset type and liquidity category are presented in Table 1.

Table 1: Haircut Categories per asset type and category group as of 2017.

		IG1	IG2	IG3/IG11	IG4	IG5	IG6	IG7	IG8	IG9
		Central Bank	Central Government	Corporate & other Issuers	Credit Institutions (no agencies)	Regional Government	Super - national Issuer	Agency (non-credit Institutions)	Agency - Credit Institutions	Financial Corporations (no credit inst)
AT01	Bond	I	I	III	IV	II	II	II	II	IV
AT02	MTN	I	I	III	IV	II	II	II	II	IV
AT03	T-Bill / CP / CD	I	I	III	IV	II	II	II	II	IV
AT09	Jumbo Pfandsbriefestyle	N/A	N/A	N/A	II	N/A	N/A	N/A	II	N/A
AT10	EEA covered Bonds	N/A	N/A	N/A	II	N/A	N/A	N/A	II	N/A
AT11	ABS/MBS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	V
AT12	Multicedulas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	III
AT13	Non-EEA covered Bonds	N/A	N/A	N/A	III	N/A	N/A	N/A	II	III

Every asset type (AT) is reported on each row and the investment grade of the asset. According to the asset type and the investment grade derives a liquidity category ranging from I to V which are translated accordingly:

- ***Category I*** : High-Quality Marketable Assets. They are easily tradable and have a high market depth. Mainly sovereign bonds with high credit ratings.
- ***Category II*** : Other Marketable Assets with lower liquidity. Mainly government bonds with lower credit ratings.
- ***Category III*** : Non- Marketable Assets. Assets with limited liquidity. This category consists of loans, securitised debt and other assets less liquid than Category I & II
- ***Category IV*** : Additional Credit Claims. Lower liquidity assets with very low marketability. Credit claims, loansd and other non-marketable instruments compared to previous categories.
- ***Category V*** : Lower Quality Assets: Includes Assets Backed Securities and Mortgage Backed Securities of low-quality loans and credit claims.

Revision of haircuts is a rare occurrence by the ECB authorities and subsequently does not derive from market sentiment during their application. Furthermore, haircuts increase asset class risk and illiquidity as defined by the liquidity category. Haircuts also increase in risk as the duration increases. Haircuts are also affected by risk according to the asset rating. There are two possible ratings, Investment Grade and Non-Investment Grade. Controlling for the duration and the rating categories within asset classes (defined by the liquidity), the haircuts difference in the haircut deployed [2]. Finally, the haircut policy is not sensitive to counterparty. This paper will try to test this particular design feature at the regional and country level.

After the tender operations, the allocated funds are settled through the Eurosystem's payment system. The term of the liquidity provision depends on the specific operation. Main refinancing operations typically have a maturity of one week, while longer-term operations like LTROs and TLTROs can have maturities ranging from months to years. The ECB continuously monitors the impact of its open market operations on the banking system and the overall economy. If necessary, it can adjust the amount, frequency, and terms of the operations to ensure that the desired liquidity conditions are maintained and its monetary policy objectives are achieved. It's important to note that the specific details and procedures of the ECB's open market operations may be subject to change over time as per the ECB's monetary policy framework and evolving market conditions.

3 Literature

Bindseil and Papadia (2006) focus on the role of the collateral framework in the Eurosystem in open market operations. They consider collateralisation as

[2] https://www.ecb.europa.eu/pub/pdf/other/ecb.2022_49_f_sign~a031a65f68.en.pdf

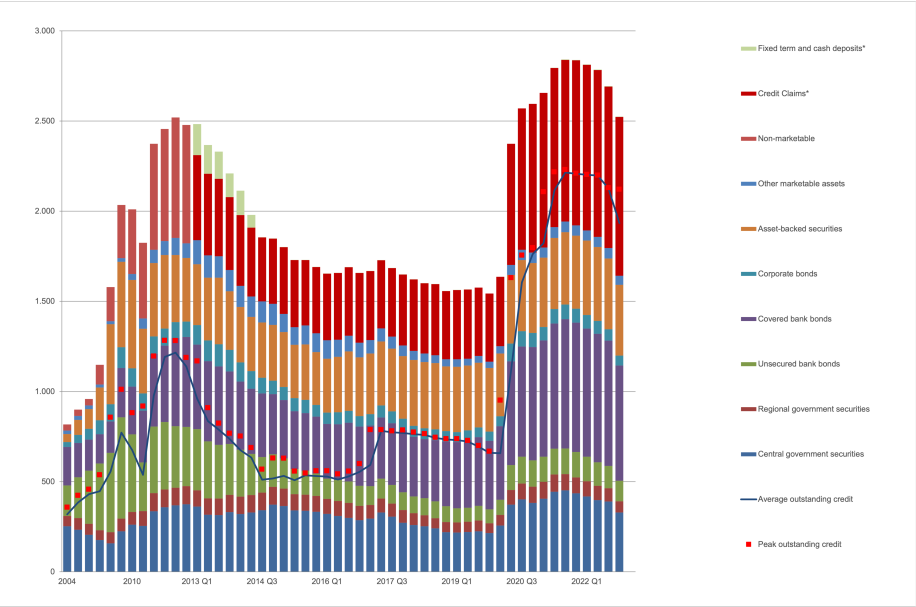

Figure 2: Amount of collateral used by asset type.

a means of risk mitigation and implementation of proper rule setting, the remaining risk of the eligible assets can be levelled to the risk profile of the central bank followed by utilisation of the potential asset as collateral to be reduced to a cost–benefit analysis. In the same paper, they study the impact of the implementation of such a framework on the financial markets by measuring the spread between assets that can be used as collateral and the ones not. The difference in the spread or as they call it "eligibility premium". Their assumption of eligibility producing premium did not hold.

On the topic, Kaldorf and Wicking (2021) state the opposite. Banks pay a premium for assets eligible as collateral and there is a positive effect on the corporate bond yields abiding by all ECB requirements to be used as collateral. Since 2008, ECB started accepting corporate bonds which incentivised companies to move to frequent bond issues. Since corporate bonds become eligible firms change their borrowing decision and work on eligible debt capacity. Reaching the maximum capacity leads to the loss of eligibility because of overindebtedness and credit downgrading. The safer the company the more intensely issues new bonds taking excessive risk and the less safe the company the higher its deleverage to obtain eligibility grade from the central bank. This a market discipline phenomenon. Risk-taking from new issuance leads to an increased rollover risk which may be initiated by older bonds outstanding in a scenario of revenue shock. This adverse scenario leads to market value loss of the assets and as a result, the eligibility is also lost leading to further rollover problems.

About the effect of the frameworks on the banking sector of the economies that are applied, Jasova et al. (2023) discuss the effect of the Lender of Last resort in bank interconnectedness. Haircut-gap is defined as the haircut variation between private markets and central banks. They deduct that central bank haircut policies nudge banks to hold and pledge higher collateral-gap assets from banks of their country, especially systemically significant. They focus on Eurozone as the banking sector is fundamental for the financial system, and ECB expanded its liquidity provision considerably. The increased demand creates new issuance of bank corporate debt with longer maturities and lower spreads. The high–gap banks change their debt profiles towards bonds abandoning links in repo markets thus elevating leverage in balance sheets. The cross-holding of these bonds leads to a correlation to the banking sector threatening the total health of the system.

On the collateral framework interaction with markets and the wider economy, Nyborg (2017) examines how a framework could create distortive effects. Central bank money is not provided based on market valuation but on collateral held by the institution but that structure does not avoid the framework to touch financial markets. The outcome is that ECB's collateral framework undermines market discipline. The different interventions of central banks around the world have made it difficult to establish correct prices for assets to achieve a more efficient distribution of resources. The design of a collateral framework has a direct impact on these inefficient resources distribution leading to the market. The disconnection of haircuts from market information is proven inconsistent with reality. This misconception leads to reduced issuance of new collateral which is tied with lower quality generation as well. This is a serious externality of the ECB, indirectly supporting lower-quality collateral.

Important work by Bindseil (2013) is a model in which the liquidity of the assets, in conjunction with the current collateral and regulatory framework can provide the necessary stability in the Eurosystem. Under certain conditions, the model explains the collateral pledging behaviour of banks and the effects of the abrupt change in liquidity of the assets. It proves that a broader collateral framework helps the banking system to perform its role as a maturity transformer and reveals the policy aspect of the collateral framework and as a potential antidote in periods that the zero low bound is reached.

A theoretical approach to collateral and the impact of pledging the highest quality of assets for Central Bank operations negatively affecting the financial market is produced by Choi, Santos and Yorulmazer (2021). Central banks can lend against lower-quality assets they provide evidence that even though high-quality collateralised liquidity provision helps the economic activity, there is a possibility that a freeze of the economic activity could still unfold. Lending with lower quality collateral allows the market to jump–start.

Uhlig, De Fiore and Hoerova (2018), develop a complex model studying a general equilibrium which includes heterogeneous banks as market players, an interbank market for collateralised and uncollateralised liquidity and the existence of a central bank. They assume that banks can be liquidity or leverage-constrained. The results are that these frictions lead the banks to dedicate funds

to non-performing but highly liquid assets. Another potential way of facing this friction is through deleveraging. Both reactions lead to a negative outcome.

Vestergaard and Gabor (2022), examine the role of haircuts and how their implementation on different asset classes affects the effectiveness of the framework. They support that the proposal of Nyborg of a more extensive and decisive central bank would be pro-cyclical and destabilizing but agree that market liquidity should be the primal target of the OMO of the ECB and credit risk secondary. Du (2022), adds that in periods of market stress central banks should reduce rates and haircut levels which makes monetary policy much more efficient than just lowering the rates.

Hilberg and Hollmayr (2011), model an interbank market for short-term liquidity. The outcomes are that the existence of the interbank market lead to a reduction of economic deviation and the presence of the bubble has the opposite effect. In such cases, the interbank market fails to provide the necessary liquidity and the central bank steps in with reduced interest rates and haircuts. They agree that asset prices should be considered only for the setting of the haircut policy.

Koulisher and Struyver (2014) consider that part of the collateral valuation comes from the cost of transferring the assets due to imperfect collateral quality. Similar to Tsomokos and Voliotis, (2016) they prove that the fall in quality and quantity of collateral pool during turmoil leads to higher interest rates. During a credit crunch, the interbank market starts to require collateral which becomes the driving factor of the loans disbursed. The collateral shortage leads to higher interest spread and central banks should loosen the collateral policy, so the banking system does not dry up. To avoid moral hazard, they propose a minimum collateral holding measure, similar to Basel III provisions as of January 2023.

Cassola and Koulisher (2016) specify the tactic the banks pledge assets. Using country-level data for collateral pledged in ECB for the timeframe of 2009 - 2011, the model quantifies the implications of changing collateral policies in the collateral pool of the market and the funding costs of banks. They answer two fundamental concerns of the collateral framework design of central banks, which are credit risk and the uninterrupted implementation of monetary policy. Regarding the heterogeneity of the collateral assets in the collateral pool of the Eurosystem, a direct implication is the weak convergence between the countries in the North and the Periphery, the model predicts the links between collateral, investment and interbank access choice in the simultaneous existence of credit constraints for the banking institutions. Higher flexibility of collateral frameworks leads to more efficient monetary policy, always considering the counterparty risk undertaken by the Central Bank. They prove also that due to the sovereign debt crisis, the general downgrading of the government bonds presented difficulties to the banks of the most highly impacted regions to participate in central bank operations. This led to a significant change in the collateral pool of each country, especially the so call 'high-yield' countries [3] were

[3]Spain, Greece, Italy, Ireland, Portugal

more affected by the raised haircut levels to government bonds. These results hold when they test for the access of regional banks in the interbank markets.

Corradin et al. (2017) work on the role of collateral as a mechanism of monetary policy. The paper studies the factors that drive the market of collateral, both private and public, and how the interaction of the market infrastructure is represented by Central Clearing Counterparties (CCPs). They conclude that collateral does not automatically bring financial stability in collateralised markets but it is necessary to ensure it with micro and macroprudential legislation and with safe government-backed assets. They conclude that typical collateral techniques in the private collateral market are pro-cyclical and that even large institutions such as CCPs, and their rule-based tactics on collateral could lead to demand distortions on assets.

A special academic discussion has been going on about the relationship between corporate bonds and collateral frameworks. Pelizzon et al. (2023) have shown that upon eligibility of corporate bonds, there is a trinity of positive effects. First, there is a boom in the corporate securities lending market, second that lowers the eligible bonds' yields and finally, affects bond liquidity. The results are that when eligibility is relaxed it acts as a remedy to market segmentation. As a common result, eligible firms shift from bank loans to debt issuance with longer maturities. These shifts provide the market also with additional collateral and cheaper funding, allowing for more risky bank loans to start-ups enhancing also balance sheet diversification as well.

Lengwiler and Orphanidis (2021) study the impact of the ECB collateral framework in sovereign debt. They highlight that in contrast with Western central banks' collateral policy structure, ECB does not accept all sovereign debt in its operation as collateral no matter the quality and the maturity. Instead, they depend on external sources such as credit rating agencies to assign ratings and if the ratings are below the minimum rating set as a limit, ECB will not accept the assets as eligible collateral. Different ratings are accompanied by different levels of haircuts and liquidity premiums as a consequence. The result of studying this differentiation is that this selection of debt can lead to multiple equilibria and leave governments exposed to shocks feeding the creation of sovereign debt crises. The inability of governments to include the bonds as eligible collateral puts upward pressure on their yields leading to exposure to sovereign debt crises, given that with a more relaxed framework, the potential default could be avoided. Diving deeper into the government exposure on collateral and haircuts, relevant work is done by van Bekkum, Gabarro and Irani (2018), who study the 2008 framework change of ECB to the minimum threshold for ratings of residential mortgage back securities and the effect on bank lending and risk-taking. Contrary to Kaldorf and Wicking this is a study on the asset side of institutions. What they find is that the renewed policy allows for new credit supply with lower interest rates which then are turned into a fresh pool of new RMBS collateral of lower quality than the original used for obtaining liquidity. Most importantly they expose a mechanism through which these new credits which are guaranteed by the government present lower-than-average quality and as a consequence there is a potential risk spill-over to the

sovereign. The confidence that the newly originated loans will be kept briefly in the balance sheet until pledged as collateral reduces the quality of the new credits transferred directly to the Treasury. Similar work to the securitisation issues is done by Gorton and Metrick (2012), who try to discover the mechanism between the subprime mortgages crisis and their association with the systemic failure that occurred in 2008. They argue that this dry-up was a modern-day bank run rising from the opacity of the subprime repo market so the flight to quality gave birth to fear of collateral scarcity. Interestingly enough, the fear was for the dry-up of good quality collateral. The predicted volatility led to a rise in repo haircuts – a mirror effect of bank runs.

Richter's paper (2022) observes the phenomenon of liquidity commonality in bond markets. More specifically he shows that common liquidity in sovereign bond markets has a common factor of source which is the market liquidity the bonds are traded in. He continues to show that the market liquidity is much more sensitive compared to equity markets. This remark in conjunction with the findings of Nyborg (2017) and Lengwiller and Orphanidis (2021) show that the correct structure of the collateral frameworks is vital so they don't push economies into recession and monetary policy exclusion. The results of these papers leave open the question on the subject of whether the monetary policy of the ECB and its collateral Framework design is broad and predictive for all heterogeneous economies in the Eurosystem.

Ballensiefen, Ranaldo and Winterberg (2023) focus their work on collateral in Money Market Disconnections. They show that the money market is segmented when the collateral instincts reign. This disconnection derives from two factors of the collateral framework. The access of a bank to the central bank's deposit facility and the availability of the asset for purchase in QE. The disconnection in the money market and the subsequent segmentation can create rate dispersion diminishing market quality. When General Collateral rates [4] drop below the rate of deposit facility rate banks store their liquidity in the central bank and don't offer it in the interbank repo market. The second factor is the eligibility of assets to be included in a QE program. The smaller basket of QE-eligible assets leads to a special repo segment and collateral scarcity as a repo of these collaterals becomes scarcer. As a result, repos secured by these assets become collateral motivated disconnecting them from funding-based money market segments. There is a smaller sensitivity between EONIA rates and the valuation of these special assets. Further from the real effects on the economy, the dispersion of repo rates is an efficient indicator for monetary policy and transmission effectiveness.

Boissel et al. (2017) work on an inquiry for the systemic stress in clearing houses in the European repo market during the debt crisis in eurozone. They reveal Clearing House stress by measuring the rates sensitivity to CDS spreads – an indicator for default. This quantification gives information on the effectiveness of the haircut policy. The reaction of rates in the countries that in my

[4]Rates that respond to standard liquidity operations under the established Eurosystem Collateral Framework

paper are considered as Periphery are treated as if the conditional probability of CCP default was material. Sensitivity is very high even for the CCP cleared repos that are protected against default risk. During the 2010-2011 period the sensitivity remains low, due to the presence of CCPs but in 2011 when haircuts started to increase the was no effect even though the main bank storm was past. Given that main collateral asset is sovereign bonds, CCP clearing in imperative and given the discount in 2011 that they were considered failed indicate the need for contingency frameworks. Central banks have the power to reduce the pressure by non-traditional monetary policy like LTROs[5] in 2011 which resulted in drop of rates-to-CDS sensitivity.

Finally, as the collateral pool is marketable assets and they are valued in market terms, there is information on these assets. Berthonnaud et al. (2021), study the encumbrance ratios of assets in banks' balance sheets in an empirical model about how this ratio can be used as an Early Warning Indicator for Crisis. They find that encumbrance ratios increase right before the development of a crisis, concentrating on institutions that have been through a crisis. The liquidity drought in 2007 turned banks to collateralised funding, subsequently changing the way that assets are treated by banks. They infer that banks with riskier assets (NPLs) have more encumbered assets, a positive relationship between the Central Bank's eligible collateral and encumbrance and a material effect of the bank's nationality to the encumbrance as the most usual asset pledged in Refinancing Operations are government bonds. (Grund, Nomm, & Walch, 2020).

Following this literature, I will study an empirical model, which considers the haircuts apply to the assets pledged to the ECB Main Refinancing Operations between 2011 and 2019, between European North - Germany, France, the Netherlands, Austria and Belgium - and the European Periphery – Greece, Ireland, Italy, Spain and Portugal. The dependent variable will be the average haircut of collateral per operation and if there is a regional differentiation through a dummy variable for the North and Periphery. In all of the previously presented literature, only a few papers focused on the issue of framework efficiency for all different economies in the Eurosystem. Only Schmidt (2019), Boissel et al. (2017) and Cassola and Koulisher, (2016) introduce the regional characteristics of their data set. It is a real gap in the literature, that this paper intends to fill. According to Berthonnouad et al. (2021) encumbrance ratio is related to nationality as well so this ratio will be included in my dataset along with Non-performing loans, to test and confirm or reject their findings.

4 Data & Methodology

4.1 Data

I have compiled two datasets, using as a source the database of the European Central Bank and OECD. The two datasets are different in terms of periods.

[5]Long Term Refinancing Operations

For that matter, I have designed two different models to analyse which one is complementary to the other. The basic dataset that I have compiled expands from 01/01/2011 to 31/12/2019. The dependent variable in both models is the average haircut on pledged collateral per country on each of the weekly operations that the Main Refinance Operations take place. The haircut is in percentage points applied to the assets pledged as collateral. This model includes 4670 observations. For Haircut, though some observations are missing as for a period in 2015 due to capital controls and political turmoil in the country the Greek Banking system did not participate in the liquidity mechanisms. The two periods that the Greek Banking system did not participate in the operations span from 25/07/2012 to 19/12/2012 and from 11/02/2015 to 22/06/2016.

All the variables are percentages and are used in their level values. The only exceptions are EONIA Volume and Allotment Amount which are measured in millions and for scale proximity they are logged. Additionally, I include the credit ratings of Standard and Poors for the countries in the dataset. According to the rating scale of S&P, there are 24 scales of credit ratings ranging from default spectrum signalled as D-NR up to Prime assigned to AAA. To model the credit rating score I have allocated each rating a 4% score. Starting from 4% for the D-NR of the scale for every upgrade in the rating scale 4% is added to the score. For a score change from AA+ to AAA because of the scarcity and the difficulty of acquiring an AAA rating a score change of 8% is assigned. Furthermore, the rating agency except for the ratings, gives additionally to the rating a secondary signal for each level of rating by assigning a positive/negative outlook. This is not a standard procedure for every review and it is employed in cases when a full upgrade or downgrade is not necessary. To include this signal I assign a half-leap upwards of 2% when a positive outlook accompanies the rating and a half-leap downwards when a negative outlook accompanies the rating.

Table 2: Summary Statistics Base Model by Region

Region	Mean Haircut	Hairctut St. Dev	Min	Max
North	0.095	0.030	0.041	0.173
Periphery	0.143	0.089	0.075	0.433

The summary statistics for the dataset in question are presented in Table7 where an average haircut applied of 11.9% with a standard deviation of 7% is observed. To put these amounts into context the maximum haircut that was observed in the period was approximately 43% and the minimum as low as 4%. The maximum haircut was towards Greek collateral and the minimum was towards assets from Belgium. Diving a little deeper into the haircut distribution I present in Table 2 the descriptive statistics sorted by region. In this version, there is an obvious difference in the average haircut applied to assets. Periphery countries during this period were charged an extra 5 per cent on their assets. It is indicative that the average collateral for the Periphery cluster the average

haircut is close to the maximum of the Northern region. According to Table 8, the haircut applied in this period by diminishing order Greece, the Netherlands, Italy, Ireland, Austria, Portugal, Spain, Germany, France, and Belgium. This classification is particularly interesting because even though the countries of the Periphery were considered to be the ones that were under stress during this period are not leading the board on haircuts, indicating sudden and intense stress during the decade. This stress could also be a signal for a 'flight to quality' that can negatively affect efficient monetary policy as the central banks in not eager to take on subprime assets as collateral. The development of the collateral haircut for all countries can be found graphically in Figure 3. An interesting statistic is that EONIA Rate on average this period is negative. This is somehow contradictory to the established economic theory of positive lending interest rates. Although the Asset Purchase Programs of the EU to implement Quantitative Easing provided an abundance of liquidity in the market. The problem is that to participate in these programs high-quality collateral was demanded. Another explanation for the negative lending interest rate is the fact that there was a stall in economic activity and subsequently a reduction in new credits leaving some banks in a pile of cash that could not deposit in the Deposit Facility of the ECB due to the negative deposit rate.

For the second model, I have retrieved a more extensive set of variables which relate to the banking sector of the European countries in question. These data are quarterly and span for a period from Q2 of 2015 with a few exceptions starting end of 2016. In Appendix A there is a detailed presentation of all variables and their definitions, without considering the model structure they are going to form.

This second data frame is important for two main reasons. The first reason is that it represents the second half of the 2010 decade. Considering that the European debt crisis unfolded at the beginning of the decade, and mainly between 2009 to 2011, the dataset that focuses on the second half of the decade should present a more stable economic environment. With Greece being the only exception, there is an apparent regularity in the haircut levels. Furthermore, the economic stability in the region is visible also in Figure 4. As expected the yields climb dramatically starting middle of 2009 and peaked in 2012. After 2012 they settle for all the countries except Greece for which like haircuts, rates accelerate again in 2015.

According to these two trends, I expect that data after 2015 will not carry information and will not be affected by the negative events at the beginning of the decade. In that case, the potentially inflated haircuts should drop. Otherwise, that will be an indicator that haircut policy is affected by other factors. Looking to the summary statistics presented in Table 10 it is contrary to the hypothesis of settlement of haircut levels, the average haircut is higher than in the longer period that includes the sovereign debt crisis.

Analysing in more depth the characteristic of the descriptive characteristics

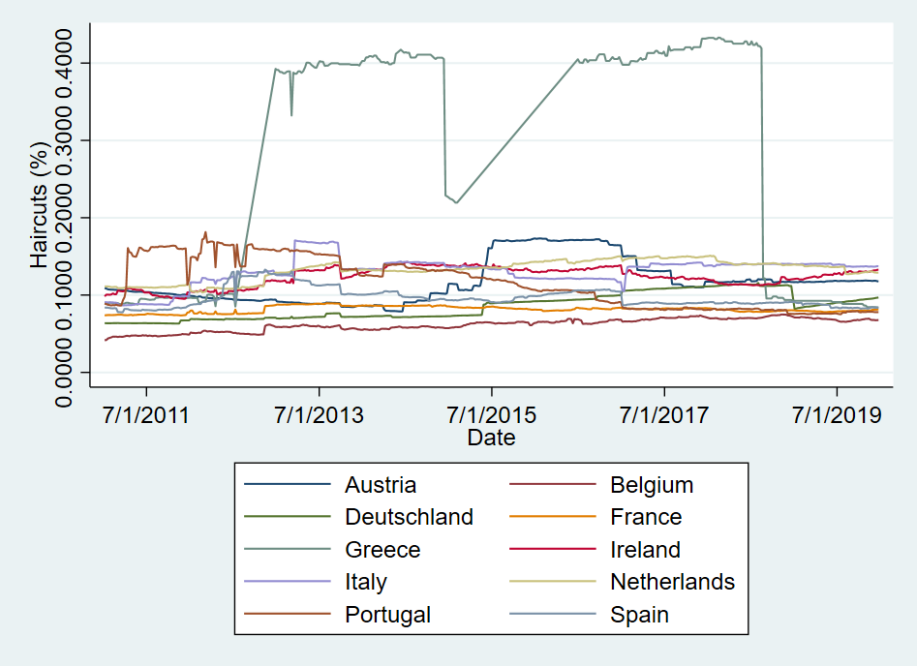

Figure 3: Average collateral haircut by country.

of the data set I deduce that the average haircut is 20 basis units higher but the standard deviation remains stable at 7%. EONIA Rate is again negative in this period and is even lower than in the longer period data. According to the assumption that after 2015 economic stability has returned in the period after 2015 and onwards, it is observed that CISS and CLIFS which measure the economic stress in the sovereign and the financial market respectively, are lower than in the extended period dataset. Comparing the two periods we can also point out that the average allotment per operation and the standard deviation of the variable are also considerably lower if I focus on the second phase of the decade. This is important if I consider the fact that the Loans to Deposits ratio drops as well in the second dataset. This drop could derive from fewer credits or higher deposits which is not clear, but supposing that a value over 1 (or 100%) means more borrowing from external sources for the banks and lower liquidity, I see that the banking sector stress is decompressed. On the Country level Debt to GDP is almost steady but the standard deviation is increased by 4% which means that there is increased volatility on country level.

The second reason for studying the extra dataset is because it includes variables that represent the health of the banking sector of the countries in question. The basic indicators are Liquidity Coverage Ratio, Common Equity Tier 1 capital, Tier 1 Capital, Leverage Ratio, Encumbrance Ratio and Solvency Ratio. Also, for the economy level, it is included the Return on Equity indicator.

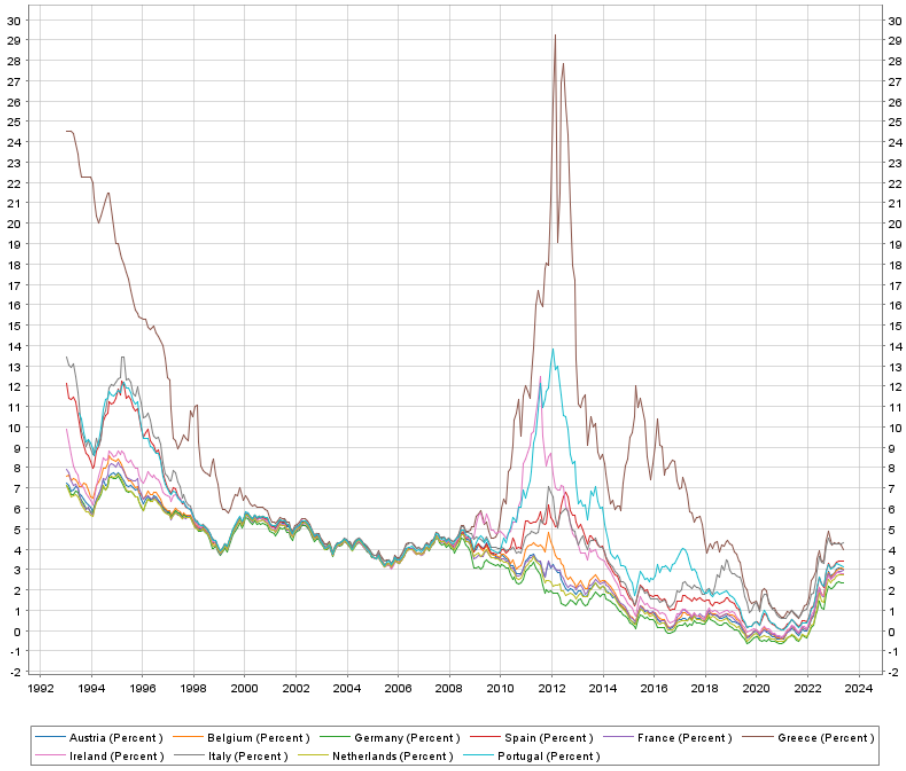

Figure 4: 10-year Bond Yields

The inclusion of these indicators aims to introduce the impact of the banking sector. The design of these liquidity provision operations are focusing on maintaining the necessary liquidity in the banking system and subsequently in the economy. A strong economy without a strong banking system could paralyse the economic activity.

A qualitative characteristic of the dataset is that it refers to national banking sectors that fall under the direct supervision of the ECB and fully adopt the Basel directives. By setting the general regulations as uniform and the supervision to one super-national institution, the residual risk for the haircut premium can be interpreted to country and region-specific characteristics.

4.2 Methodology

The two models are based on panel data. According to that, I aim to present three different models. The two models are already briefly mentioned in the data section above. A third model, which could be considered as an extension is a model that will test the variables only related to the banking sector. I formulate a model to fill a literature gap related to the effect of the banking sector and its effect on the haircut policy. Considering that banks hold the great majority of the highest quality of collateral (i.e. government bonds) and are the fundamentally interested party in the operations for liquidity for microeconomic purposes. Taking into consideration that all banks in the countries in question operate under the Bank of International Settlement "Basel" prudential framework but also under the European Banking Authority and European Central Bank. This particularity will be important to the discovery of potential regionality issues in haircuts.

For the three models regressions results using Pooled OLS, Fixed Effects and Random Effects estimators are presented. To test for potential problems with autocorrelation, Breusch - Godfrey test is performed and if spotted, clustered Standard errors will be employed. For pooled OLS which is always accompanied by autocorrelation, I use clustered standard errors directly. Clustered standard errors solve automatically the issue of heteroskedasticity, and any issue will be treated automatically.

For testing issues with exogeneity and selecting the correct statistical estimator between Random or Fixed Effects estimators, Hausman Tests are performed.

5 Results & Interpretation

5.1 Base Model

Equation 1 mathematically presents the base model that I test to explore potential factors that drive the haircuts applied in the assets that are pledged as collateral.

Model 1: Base Model

$$\begin{aligned} Haircut_{it} = \alpha_0 &+ \beta_1 logAllotment_{it} + \beta_2 LoansToDeposits_{it} \\ &+ \beta_3 DebtToGDP_{it} + \beta_4 EONIARate_t \\ &+ \beta_5 logEONIAVol_t + \beta_6 CLIFS_{it} + \beta_7 CISS_{it} \\ &+ \beta_8 Region_i + \alpha_t + \epsilon_{it} \end{aligned} \tag{1}$$

The model includes the log amount of the average amount that is auctioned on every operation by the European Central Bank. This amount is calculated by the ECB accounting for the current and future liquidity needs of the Eurosystem. After testing for exogeneity with Hausman I find X^2 of 0.02 which indicates that between Fixed and Random Effects estimators more reliable estimator is Random Effects.

In the model, I also include the EONIA Rate and the amounts that were cleared on the same days of the operations. EONIA Rate is important to be studied in conjunction with haircut level as it represents the rate at which banks lend to each other in the secondary market and which does not require collateral for providing liquidity. Even though these operations are for shorter lending periods it is this very market that is most commonly used daily by banks to look for short-term funding, and it is this very market that froze during the 2008 global financial crisis and Central Banks had to fill in the gap in liquidity that this secondary market did not cover any more. In this model, it is considered a competitive or alternative market for liquidity. EONIA is equivalent to the LIBOR rate. Their difference is that EONIA Rate refers to overnight lending limited in the European Union.

As an indicator of the banking sector quality I use the Loans to deposits ratio and as a proxy for the sovereign economic health I use the Debt to GDP ratio. Debt to GDP is significant because it is one of the main driving factors for the credit rating of the country and the debt that it issues. The higher the debt the higher lower the rating and the higher the haircut applied.

Finally, the CISS and CLIFS indicators are used to include the stress of the financial markets in the country and the way they participate in International Markets.

Table 3: Basic Model Regression Results

Haircut	Pooled OLS	Random Effects	Fixed Effects
Constant	-0.128	-0.106	-0.101
	(0.128)	(0.110)	(0.119)
EONIA Rate	-5.259**	-5.000***	-5.053**
	(1.747)	(1.903)	(1.955)
LTD	0.107*	0.111***	0.115**
	(0.048)	(0.039)	(0.042)
Debt/GDP	0.100	0.043	0.038
	(0.070)	(0.048)	(0.047)
CISS	0.069	0.031	0.028
	(0.054)	(0.037)	(0.036)
CLIFS	-0.141	-0.189	-0.189
	(0.109)	(0.143)	(0.144)
log(EONIA Vol.)	0.005	0.006	0.006
	(0.007)	(0.008)	(0.008)
log(Allotment)	-0.005	0.002	0.001
	(0.004)	(0.029)	(0.002)
Region	-0.019	0.015	0
	(0.037)	(0.028)	(omitted)
Observations	4446	4446	4446
R^2	0.34	-	-
R^2 (Between)	-	0.32	0.29
R^2 (Within)	-	0.22	0.22
R^2 (Overall)	-	0.27	0.26

$^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$.

Clustered standard errors in parentheses.

The regression results are presented in detail in Table 3. According to these results, I find statistical significance in two of the independent variables. EONIA Rate and loans to deposits are significant after the application of the three estimators. As I hypothesized earlier in the paper EONIA Rate negatively affects the Haircuts applied to the assets. The unsecured market rates fall as the haircuts increase. This mechanism is important as it describes the condition that due to higher haircuts applied and potential exclusion from the central bank's liquidity operations, the excluded institutions are directed to the unsecured market to secure funding.

The deflated ratings that followed the sovereign debt crisis for many states in the European periphery lead to that exclusion. Despite the fact that ECB drops the base rating for eligible collateral in its operations. A similar result has been shown by Choi, Santos and Yorulmazer,(2021) who prove that a lower quality of collateral can help participants to provide better quality assets in the market so economic activity restarts. Also Vestergaard and Gabor, (2022) claim that the haircut levels should be reduced in times of turmoil prioritising the liquidity provision over risk management.

Regarding the statistical significance of the loans to deposits, I find that a unit of increase of the indicator results in an increase of 11% increase in the haircut applied. This finding can be interpreted in line with the work of van Bekkum, Gabarro and Irani, (2018). In their work, they discuss the mechanism through which relaxed collateral frameworks lead to new credits that are of lower quality and as a result, they are not eligible to be provided as new collateral. Furthermore, from a financial point of view, an extensive Loans to deposits ratio is an indicator of excessive leverage. In a case of a sudden dry-up, or a negative shock in the market the need to de-leverage fast. In such occasions where there is a trade-off between liquidity and leverage, Central Banks should intervene with open market operations and expand their balance sheets (Uhlig et al., 2018).

In this model, there is no signal of regionality. In all three applied estimators, I cannot spot any significance in the constant term or most importantly, to the coefficient of the dummy variable. In other words, there are no regional residuals in the haircut formation.

5.2 Credit Ratings

According to the Collateral framework guidelines for specifying the liquidity categories and the eligibility identification of an asset, credit rating is a fundamental parameter. For that reason, I consider that I should include in the basic model the credit ratings of the countries during the decade. The model is presented by Equation 2

I specifically apply the credit rating to the base model and not to the extent and the banking effect model for three reasons. The first reason is that credit ratings can be very volatile for countries under stress and very stable for countries that have a solid economic background. For that matter, I chose to use the decade-long time frame to allow for all countries to present variations in their ratings. For example Germany, the highest-rated country in the data set moved from AAA to AAA - Negative Outlook in December 2011 and a month later regained its solid AAA rating until today. This volatility would not be included in the shorter period data set.

Model 2: Credit Ratings Influence

$$\begin{aligned} Haircut_{it} = \alpha_0 &+ \beta_1 logAllotment_{it} + \beta_2 LoansToDeposits_{it} \\ &+ \beta_3 DebtToGDP_{it} + \beta_4 EONIARate_t \\ &+ \beta_5 logEONIAVol_t + \beta_6 CLIFS_{it} + \beta_7 CISS_{it} \\ &+ \beta_8 Rating_{it} + \beta_9 Region_i + \alpha_t + \epsilon_{it} \end{aligned} \tag{2}$$

Furthermore, since the Sovereign Debt crisis unfolded at the beginning of the decade and after 2016 there was a slow recovery of the euro system economies, there was a continuous upgrade wave for all countries without taking into consideration the plunge at the beginning of the decade. I distinguish the economic recovery from the lower haircuts and long-term bond yields in Figure 3 and Figure 4.

Finally, given that government rating is given by analysing the country's economy, I consider that a less sensitive to the banking sector model would reflect better the actual importance of the country-specific characteristics. The results of the regression are presented below in Table 4.

For this model, the Hausman test indicates that Random Effects Estimator is the more appropriate estimator between the two with X^2 =0.11 $p\text{-}value = 1.000$. According to the results, there is a very limited difference in the estimators and the statistically significant variables. Again EONIA Rate negatively affects haircut levels and Loans to Deposits ratio has a positive effect. These results support the results of the basic regression in Table 3.

Relative to the newly introduced credit ratings I find no evidence for the significance of the variable in the level of haircut. For pooled OLS there is a strong indication that there is a negative effect at 1% but according to the characteristics of the estimator, there is no provision of individual-specific effects. The dummy for the region is again not significant at any level for Random effects but with Pooled OLS estimator the same dummy is statistically significant at 10%. The unexpected result is that there is a negative relationship between haircuts and regionality. This contradictory result is in line with the work of Cassola and Koulsiher (2017) that the collateral policy of the ECB has an impact on the funding cost of banks in the open market operations. They argue that the broader collateral basket provides a more efficient economic policy and that the debt-downgrade stressed countries, adapt to the new haircut increases with a differentiated national collateral pool.

Table 4: Basic Model Regression Results with Ratings

Haircut	Pooled OLS	**Random Effects**	Fixed Effects
Constant	0.275*	-0.159	-0.157
	(0.124)	(0.144)	(0.149)
EONIA Rate	-3.530**	-5.248**	-5.337**
	(1.749)	(2.027)	(2.092)
LTD	0.116**	0.109***	0.111**
	(0.048)	(0.039)	(0.041)
Debt/GDP	0.009	0.048	0.046
	(0.064)	(0.046)	(0.045)
CISS	0.026	0.034	0.033
	(0.036)	(0.038)	(0.038)
CLIFS	-0.209	-0.185	-0.184
	(0.125)	(0.140)	(0.140)
log(EONIA Vol.)	0.003	0.007	0.007
	(0,006)	(0.008)	(0.008)
log(Allotment)	-0.005	-0.0006	-0.0003
	(0.004)	(0.002)	(0.002)
Credit Rating	-0.310***	0.044	0.053
	(0.063)	(0.054)	(0.058)
Region	-0.078*	0.027	0
	(0.037)	(0.41)	(omitted)
Observations	4446	4446	4446
R^2	0.41	-	-
R^2 (Between)	-	0.25	0.16
R^2 (Within)	-	0.22	0.22
R^2 (Overall)	-	0.24	0.19

$^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$.

Clustered standard errors in parentheses.

5.3 Extended Model

The second model that I have assembled in this paper introduces more variables and a time frame that focuses on the second part of the decade. Additionally to

the previous model described with Equation 1, in this model, I incude a variety of banking indicators that will be used to provide estimations of the factors that drive the formation of the haircuts.

Model 3: Extended Form Model

$$\begin{aligned} Haircut_{it} = \alpha_0 &+ \beta_1 logAllotment_{it} + \beta_2 Loans/Deposits_{it} \\ &+ \beta_3 Debt/GDP_{it} + \beta_4 EONIARate_t + \beta_5 SolvencyRatio_{it} \\ &+ \beta_6 NPL_{it} + \beta_7 Tier1_{it} + \beta_8 LeverageRatio_{it} \\ &+ \beta_9 CET1_{it} + \beta_{10} LCR_{it} + \beta_{11} AER_{it} \\ &+ \beta_{12} RoE_{it} + \beta_{13} logEONIAVol_t + \beta_{14} CISS_{it} + \beta_{15} CLIFS_{it} \\ &+ \beta_{16} Region_i + \alpha_t + \epsilon_{it} \end{aligned} \tag{3}$$

The research in this model is again focused on the discovery of regionality impact on the level of applied haircuts. This model does not signify a regional implication in the data. In the results from the regression of the model though in Table 5 various other variables are proven to be statistically significant. By performing Hausman Test, the test dictates that Fixed Effects is the more reliable estimator with a *p-value* = 0.000.

Starting from the constant term even though it is statistically significant for Pooled OLS and Random effects estimator and thus I focus only on the Fixed Effects coefficients. According to the output, there is no indication of the regionality of country-specific effects on the level of haircuts. Furthermore, due to collinearity issues the Regionality Dummy is omitted.

Proceeding the analysis Debt is significant to GDP (significant at 5%), Non-Performing Loans (significant at 5%), Asset Encumbrance Ratio, CISS and CLIFS. Even though there is no regional effect on the government indicators are turning out to be the driving forces for explaining the haircuts.

Starting with Debt to GDP a positive relationship is found. That is evident from the literature and the empirical knowledge of the Sovereign Debt Crisis. The inability of countries to service their debt was the starting point for the crisis to unfold in the European Union. According to the statistics for the period, only 4 out of 10 countries had a debt ratio lower than 100%. This is a strong indicator of expansionary policies and over-leverage of the sovereigns.

A basic interpretation of this positive effect is that the higher the debt of a country the higher the probability of default. The fact that Greece has an average Debt ratio almost 3 times in magnitude the lowest observed by the Netherlands, is the country that defaulted on its debt according to the credit ratings as well. Connecting the result with the existing literature, Lengewiler and Orphanidis, (2021) prove that the interaction between sovereign debt and collateral framework leaves the sovereign economy exposed to a debt crisis. The selection of bonds is according to the external credit ratings and not the defacto acceptance. This cherry-picking procedure pushes yields higher and squeezes the country's debt to a lower rating. Furthermore, the downgrade of sovereign debt

and the potential exclusion of the bonds from the eligibility basket takes away any eligibility premium on the assets according to works of Heider and Hoerova, (2009), De Roure, (2016) and Koulisher and Struyven (2014). Furthermore, due to the liquidity correlation of bonds and the market where they are traded, this result confirms the findings of Richter, (2022), Nyborg, (2017) and Lengwiller and Orphanidis,(2021) that inefficient collateral frameworks leave economies exposed to recessions and monetary policy exclusions, also being thoughtful about the efficiency and predictiveness of the ECB policies for all heterogeneous economies under supervision.

Statistical significance is spotted in Non-Performing loans, the results can be interpreted to the work of Gorton and Metrick, (2012) and van Bekkum, Gabarro and Irani, (2018), that in periods of loose liquidity and broader collateral pool, there is a surge in risk as the newly created assets - soon to be pledged as new collateral - is a vicious cycle that will keep on dropping the quality and increasing the haircut levels. A final result will be the scarcity of high-quality collateral.

Return on Equity shows also statistical significance but unexpectedly, at first thought the relationship is positive. Assuming that higher Return on Equity in an economy is reflected also in the corporate bond yields and therefore the credit ratings of these bonds, a negative impact would be expected. The positive impact of corporate bond eligibility is discussed and proven by Pelizzon, (2023). If the assumption of higher Return on Equity is translated to lower yields partly because of the collateral eligibility premia holds, there could be a financial interest to transform debt from bank loans to debt issuance for cheaper funding. If excessive issuance breaches the maximum debt capacity of the issuer, then eligibility is retrieved due to credit downgrading according to Kaldorf and Wicking, (2021). Excessive issuance increases the rollover risk and the following market discipline and as a result a negative effect on the collateral quality.

Table 5: Extended Model Regression Results

Haircut	Pooled OLS	Random Effects	**Fixed Effects**
Constant	0.215**	0.215**	0.011
	(0.085)	(0.085)	(0.028)
EONIA Rate	0.345	0.345	2.703
	(5.919)	(5.919)	(2.844)
Loans to Deposits	-0.0003***	-0.0003***	-0.0001
	(0.0000)	(0.0000)	(0.0001)
Debt/GDP	-0.079***	-0.079***	0.068**
	(0.016)	(0.016)	(0.024)
Non-Performing Loans	0.235**	0.235**	0.137**
	(0.095)	(0.095)	(0.043)
Tier1	1.364*	1.364**	0.033
	(0.651)	(0.651)	(0.220)
Leverage Ratio	0.060	0.060 0	-0.030
	(0.213)	(0.213)	(0.058)
CET 1	-1.640**	-1.640**	0.226
	(0.665)	(0.665)	(0.218)
Liquidity Coverage Ratio	-0.005	-0.005	0.008
	(0.022)	(0.022)	(0.006)
Asset Encumbrance Ratio	0.024	0.024	-0.106*
	(0.101)	(0.101)	(0.047)
Return on Equity	0.098**	0.098***	0.013**
	(0.037)	(0.037)	(0.004)
Solvency Ratio	0.0000	0.0000	-0.0002
	(0.0005)	(0.0005)	(0.0001)
CISS	0.103***	0.103***	0.022***
	(0.020)	(0.020)	(0.004)
CLIFS	-0.030	-0.030	-0.019
	(0.031)	(0.031)	(0.010)
log(EONIA Vol.)	0.0005	0.0005	0.0005
	(0.002)	(0.002)	(0.0006)
log(Allotment)	0.0001	0.0001	0.0000
	(0.001)	(0.001)	(0.001)
Region	0.011	0.011	0
	(0.011)	(0.011)	(omitted)
Observations	1437	1437	1437
R^2	0.63	-	-
R^2 (Between)	-	0.88	0.11
R^2 (Within)	-	0.07	0.32
R^2 (Overall)	-	0.63	0.08

$^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$.

Clustered standard errors in parentheses.

Furthermore, the resulting output shows that Asset Encumbrance Ratio has statistical importance and a negative effect on the haircut valuation. This find-

ing does not align with or confirm the results of Berthonaud et al. (2021) that highlight the Asset Encumbrance Ratio as an Early Warnings Indicator for future crises. The expected result would be that the increase in Asset Encumbrance is positive. Although their finding shows that there is an increase in Encumbrance has predictive power before the unfolding of a crisis, the data set includes observations from 2015 onwards when encumbrance ratios recede. Furthermore, these results should be in the context that the collateral eligibility framework was broader as a second driving factor for the ratio recessions and the negative effect on the haircut. In contrast with Pooled OLS, AER presents a marginally positive effect on collateral but there is no country effect on the results.

Finally, I find strong statistical significance between haircut levels and the CISS indicator. This indicator is positive under all estimators and supports that sovereign financial stress is detrimental to the haircut valuation. This finding has special importance as the indicator is country-specific. Despite the country's relevance, there is not a country-specific factor that I could interpret. It is a good confirmation though that economic robustness is critical for efficient liquidity absorption.

5.4 Banking Sector Effect

For this model, I make use of the second dataset that contains a large variety of variables related to the Banking Sector. The reason I study this specific model is two-pronged.

Model 4: Banking Sector Model

$$\begin{aligned} Haircut_{it} = \alpha_0 &+ \beta_1 Loans/Deposits_{it} + \beta_2 SolvencyRatio_{it} \\ &+ \beta_3 NPL_{it} + \beta_4 Tier1_{it} + \beta_5 LeverageRatio_{it} \\ &+ \beta_6 CET1_{it} + \beta_7 LCR_{it} + \beta_8 Region_i \\ &+ \alpha_t + \epsilon_{it} \end{aligned} \tag{4}$$

Firstly, banks are the main vehicle of the monetary policy and the actual entity that participate in the liquidity operations. The whole theory of central banking is based on the axiom that these institutions act as lenders of last resort. This role demands from the Central bank to provide theoretically infinite liquidity to the banking system as long as this need is not deriving from solvency issues. The distinction between liquidity issues and solvency issues is very thin. Recent examples in the USA with banks failing to secure liquidity.

The idea of combatting sudden bank runs has been a constant headache for the regulatory authorities and central banks. Milestones in the combat for deterring and withstanding bank runs have been the 1933 Bank Act that introduced

the Federal Deposit Insurance Corporation and many decades later the regulatory framework of Bank of International Settlement with Basel Regulatory Frameworks.

These Frameworks are based on maintaining minimum Capital Requirements according to the weighted average of the risky assets of each institution's balance sheet. According to this average, each banking institution should keep minimum amounts on their balance sheet in case an unexpected bank run occurs. In that way, the risk of a bank run turning into a systemic pressure episode or even a failure is mitigated.

Current banking models around the world follow the same design incorporating the steps that have proven efficient. The countries that comprise my dataset, have the common characteristic. They are all regulated under the same central bank and as modern institutions, they abide by the prudential regulations of BIS, currently Basel III.5. ALready, Corradin et al. (2017) highlight the importance of the existence of micro and macroprudential regulation to limit the impact of the collateral framework in the collateral market as the highly complex demand and supply forces can create characteristics of procyclicality.

In this extension, I separate the variables related to the variables that relate only to the banking sector and exclude the ones that are related to government and markets. In that way, I want to test if there is an effect of the banking sector on haircuts. I do not include the Country-Level Index of Financial Stress or Composite Indicator of Sovereign Stress because they are based on market indicators that are relevant to the banking sector itself. I consider that as long as the banking sector of these countries on the bank sector and international level can have very small gaps for differentiation, the potential significance should derive from national regulation and the banking sector in general. As in the previous models, I start with regressing the model as presented in Equation 4 using the region dummy whose results are included in Table 6.

Using the three estimators it is evident that with the simple linear regression to the basic model, there is no indication that the ratios regarding the banking liquidity and health are not affecting the haircuts applied to the collateral. In contrast to the results in the Pooled OLS, Random effects and Fixed effects estimators present some relationship. According to Hausman, with a X^2 of 0.24 and a *p-value* of 0.997, Random Effects estimators are the more robust for interpreting the results. More specifically, the level of non-performing loans is and shows a positive effect on haircuts. For every one-point increase in the non-performing loans in the banking sector, there is a 0.10 increase in the haircut levels of the country's assets. This result comes in line with the notion that the bad quality of credits incommodes the creation of new securitised collateral to be provided as collateral in the repo market as Gorton and Metrick, (2012) argue in their paper. The result also abides by the basic risk theory that as long as the underlying asset of the collateral deteriorates, it becomes more illiquid and as a result premiums rise. There is also the indication that there is a standard premium of 0.098 based on the regression results but the most important is that there is no regionality effect.

Table 6: Banking Sector Extension Regression Results

Haircut	Pooled OLS	**Random Effects**	Fixed Effects
Constant	0.160	0.098**	0.096***
	(0.090)	(0.040)	(0.029)
Loans to Deposits	-0.0001	-0.0001	-0.0001
	(0.0002)	(0.0001)	(0.0001)
Non-Performing Loans	-0.109	0.106**	0.107 *
	(0.129)	(0.052)	(0.052)
Tier1	2.007	-0.112	-0.114
	(1.162)	(0.299)	(0.298)
Leverage Ratio	0.308	-0.008	-0.008
	(0.515)	(0.095)	(0.095)
CET1	-2.194	0.211	0.214
	(1.203)	(0.283)	(0.282)
Liquidity Coverage Ratio	-0.035	0.002	0.002
	(0.026)	(0.004)	(0.004)
Solvency Ratio	0.0007	-0.0002	-0.0002
	(0.001)	(0.0002)	(0.0002)
Region	0.017	-0.008	0
	(0.021)	(0.021)	(omitted)
Observations	1567	1567	1567
R^2	0.19	-	-
R^2 (Between)	-	0.08	0.06
R^2 (Within)	-	0.16	0.16
R^2 (Overall)	-	0.03	0.02

$^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$.

Clustered standard errors in parentheses.

The most important finding in this model specification is that despite the statistical insignificance of the dummy variable for regionality is not statistically significant the constant in Random Effects estimator is statistically significant. This result signifies that there is a positive haircut increase across all countries during the period I work. More specifically there is a 9.8% average increase in all countries from an unobserved country effect.

This finding partially supports the ground hypothesis that international banking sectors supervised by the same Central Bank and under the same international regulating institutions affect the collateral haircut in open market operations from country-specific particularities. These particularities could represent political stability, additional or relaxed legislation, the characteristics of the economy or the reputation of each country on the market. The research for more indications of reputation residuals in the formation of the haircut will look at in the next session.

6 Discussion & Conclusion

6.1 Discussion

Starting point for this Thesis has been the liquidity discussions and the recent discussion around the monetary policy implementation by Central banks. The depth of the liquidity provision of the central banks extends to greater depths than just the money circulation in an economy. The central bank's liquidity operations are also the basic transmission mechanism of the interest rates in the economy.

A distinctive characteristic of these transactions is that they are always collateralised. From the very beginning of economic theory, Walter Bagehot (1873) in 1873 already describes Central Banks as Lenders of Last Resort and that they should be willing to provide unlimited liquidity to solvent banking institutions. Today this blueprint remains the backbone of these operations but the collateral frameworks employed to cover the liquidity needs have been central for the regular operation of the economy. European Central Bank's Collateral Framework is one of the most discussed because compared to others, it applies to a strongly heterogenous and inconvergent monetary union and that is the reason for being in the spotlight of this paper.

The extensive literature and research on the subject are revealing the gravitas of the topic. The current literature focuses on 4 main aspects of the collateral framework.

Asset eligibility has been central in a series of works from Kaldorf and Wicking, (2021), Bindseil and Papadia, (2006). Both works focus on the impact of the framework when the eligibility basket expands and how this affects the valuation and characteristics of these assets. Bindseil, (2013) argues that expanded collateral frameworks help the revitalisation of the economies when zero lower bound is reached.

A critical part of the collateral framework play the haircuts applied. Despite their stable nature, policy optimisation remains open. Uhlig, de Fiore and Hoerova, (2018), Vestergaard and Gabor, (2022), Du, (2022), all concur that haircut application is imperative to the efficiency of the monetary policy and support that during crisis periods haircuts should lower to facilitate countries under stress to participate without limitations.

Substantial work has been done also on the direct effect of the collateral framework on the states that participate in these collateralised operations as the most common asset class pledged is government bonds. Lengwiller and Orphanidis, (2021), prove that the selective nature of government debt according to credit ratings can create weak points for sovereigns for debt crises. Cassola and Koulisher, (2016) on the other hand show that amendments in the collateral framework have a direct impact on the national collateral pool, especially on the high-yield European economies. Finally, van Bekkum, Gabarro and Irani, (2018), describe the mechanism by which the extended collateral frameworks lead through lower quality credits transfer the burden of the collateralisation to the sovereign.

Current literature covers most of the spectrum relative to the collateral frameworks but very limited research has been conducted to examine the efficiency of the monetary policy across the different regions of the Eurosystem, if there is indeed no counterparty consideration when applying the haircuts to assets as collateral and if these haircuts are formed with a negative reputation premium. The only works that consider the regional factor is the work on Schmidt (2019) and Boissel, (2017).

This paper does not come without limitations. The basic limitation that I faced for this work is mainly data-driven. As an initial target for data, I was planning to acquire data on bank-level collateral pledged for each operation and the cost of funding for each of the operations. My request for these data from the ECB was rejected due to privacy issues.

Additionally, in terms of data, there was no data on the amounts that banks receive from these operations. The data that I could retrieve were the total allotment amount for each operation. To be able to use these data I made the simple assumption that all countries receive the same amount of liquidity, for their institutions.

Furthermore, I consider that the modelling of credit ratings in my data has been reasonable but not 100% representative. When I quantified each rating scale the simple assumption was made that all rating steps have an equal probability of being awarded. Only for the last step in the rating ladder, I made a more significant allocation score. Also, I assigned the same score for the intermediate signals of positive and negative outlook that accompany the ratings without examining the true implication of these signals in the real world.

6.2 Conclusion

The results of this paper do not support the aforementioned hypothesis. Under my two basic models, there is no indication of countries from the European periphery are charged with additional haircut amounts to their assets. Under some model specifications, I discover some regionality residuals but the results are not robust enough to claim a reputation effect as Nikolov, (2012) did with his theoretical framework on commercial banking.

The results give a signal that European Central Bank has a very robust and cohesive policy design on collateral haircuts. The policy architecture does not allow for any regionality and reputational effect on the haircut levels. I test this by using two datasets that I compiled for the needs of this paper.

The first data set has the characteristic that spans the 2010 decade starting from 2011 up to 2019. This dataset has the form of panel data for 10 countries. Five of them are countries from the European North representing the strong economic backbone of the Eurosystem and the rest are countries of the European periphery that went through a lot of stress during the Sovereign debt crisis. The dependent variable is the average haircut per operation and the independent variables are the EONIA Rate, the volume transacted to this rate, Loans to Deposits Ratio, allotment amount per operation and indicators of sovereign market stress. The results show a negative relationship between EONIA Rate

and haircut levels as these two markets are competitive with collateralisation being the main difference. Loans to Deposits were also significant in a positive trend.

To this model, I later include an additional variable to attempt and capture the reputational aspect of the haircuts applied by introducing credit ratings of the country. The results from this extension were similar to the base model without any indication from the random effects estimator of rating significance. Pooled OLS though, revealed a negative significant relationship as would someone expect based on the collateral design.

The second data set includes multiple additional variables but covers only the second half of the decade. The additional variables refer mainly to the banking sector of the countries in the dataset. In the extended model Non-Performing loans, Debt/GDP, Asset Encumbrance Ratio, Return on Equity and CISS indicator are the driving factors in explaining the haircut level. All coefficients respond to the existing literature with only Encumbrance presenting opposite results and are open to interpretation.

In the end, an extension based on this second dataset is formulated in which I only use banking sector ratios relative to the health of the sector. Under this specification, there is a proven indication that there is a country effect on the haircut level. This follows my assumption that as long as the banking sector of the countries studied is under the same legislative umbrella, regional characteristics should be the driving factor in any haircut inconsistencies. Non Performing Loans are also significant in that model.

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A Appendix

A.1 Variables List

Below I provide a detailed presentation of the variables that constitute the dataset.

- ***Haircut*** - The percentage difference between an asset's market value and the amount that can be used as collateral for a loan.
- ***Allotment*** - The amount in an auction on weekly Main Refinancing Operations by the ECB. The amount is specified according to ECB's calculation to achieve Liquidity Neutrality. The allocation to the dataset is done by the assumption that each country demands the same amount of liquidity to combat the lack of more specific data that are proprietary.
- ***EONIA Rate*** - Euro Overnight Index Average. the reference rate for which European banks lend to one another in euros. The EONIA is the interest rate for one-day loans between European banks and is considered an interbank rate.
- ***EONIA Volume*** - The amount of repo traded in the same period based on the EONIA Rate in the unsecured European market.
- ***Loans To Deposits*** - It is a percentage ratio. A higher percentage indicates more borrowing for expanding credits and liquidity is necessary for
- ***CLIFS*** - Country-Level Index of Financial Stress. Includes six, mainly market-based, financial stress measures that capture three financial market segments: equity markets, bond markets and foreign exchange markets.
- ***CISS*** - Composite Indicator of Sovereign Stress. It includes 15 raw, mainly market-based financial stress measures that are split equally into five categories, namely the financial intermediaries sector, money markets, equity markets, bond markets and foreign exchange markets.
- ***Region*** - A dummy variable grouping the countries in the model between countries of the North (Netherlands, Germany, Belgium, Austria, France) and of the Periphery (Portugal, Ireland, Italy, Greece, Spain).
- ***Debt to GDP*** - Indebtedness ratio of General government debt as a percentage of the Gross Domestic Product.
- ***Asset Encumbrance Ratio*** - Assets that have been pledged or subject to the arrangement to secure, collateralise or credit enhance any transaction as a percentage of total assets and collateral.

- ***Liquidity Coverage Ratio*** - Proportion of highly liquid assets held by financial institutions, to ensure their ability to meet short-term obligations.
- ***Solvency Ratio*** - Metric used to measure an institution's ability to meet its long-term debt obligations and is used often by prospective business lenders.
- ***Non-Performing Loans*** - Percentage of loans disbursed in arrears over 90 days to the total loan amount disbursed.
- ***Loans to Deposits*** - Ratio used to assess a bank's liquidity by comparing its total loans with its total deposits for the same period.
- ***Common Equity Tier 1*** - Component of Tier 1 capital that is primarily common stock held by a bank or other financial institution.
- ***Tier 1 Capital*** - Tier 1 capital refers to the core capital held in a bank's reserves and is used to fund business activities for the bank's clients.
- ***Return on Equity*** - Ratio of financial performance calculated by dividing net income by shareholders' equity.

A.2 Tables

Table 7: Summary Statistics Base Model

Variable	Mean	St. Dev	Min	Max	Observ.
Haircut	0.119	0.070	0.042	0.433	4576
EONIA Rate	-0.0002	0.004	-0.004	0.014	4670
DEBT/GDP	1.163	0.333	0.622	2.007	4670
LTD	1.144	0.228	0.605	1.754	4670
CISS	0.230	0.263	0.011	0.986	4670
CLIFS	0.106	0.082	0.019	0.597	4670
EONIA Vol	9.429	0.926	6.190	10.941	4670
ALLOTMENT	6.114	0.996	3.560	7.508	4670

Table 8: Summary Statistics Base Model by Country

Country	Mean Haircut	Haircut St. Dev	Min	Max
Austria	0.117	0.027	0.078	0.173
Belgium	0.061	0.008	0.041	0.075
France	0.081	0.004	0.073	0.089
Germany	0.085	0.016	0.063	0.115
Greece	0.277	0.154	0.084	0.433
Ireland	0.123	0.012	0.095	0.142
Italy	0.130	0.018	0.086	0.170
Netherlands	0.132	0.014	0.103	0.151
Portugal	0.115	0.032	0.075	0.181
Spain	0.096	0.012	0.077	0.133

Table 9: Correlation Matrix Base Model

	Haircut	EONIA %	LTD	DebtGDP	CISS	CLIFS	EONIA	ALTMT
Haircut	1.00							
EONIA Rate	-0.12*	1.00						
LTD	0.25*	0.38*	1.00					
Debt to GDP	0.44*	-0.11*	0.02	1.00				
CISS	0.21*	0.55*	0.51*	0.31*	1.00			
CLIFS	-0.01	0.42*	0.33*	0.13*	0.69*	1.00		
EONIA Volume	-0.03*	0.69*	0.32*	-0.00	0.39*	0.30*	1.00	
Allotment	-0.01	0.56*	0.31*	0.02	0.37*	0.30*	0.76*	1.00

Table 10: Summary Statistics Extended Model

Variable	Mean	St. Dev	Min	Max	Observ.
HAIRCUT	0.121	0.070	0.061	0.433	2395
EONIA Rate	-0.003	0.001	-0.004	-0.001	2460
LTD	0.997	0.302	0.101	1.431	2460
DEBT/GDP	1.170	0.375	0.622	2.007	2460
NPL	0.089	0.116	0.011	0.471	2460
TIER 1	0.153	0.025	0.102	0.206	2330
LEVERAGE RATIO	0.062	0.019	0.000	0.114	1670
CET 1	0.244	1.34	0.10	18.07	2330
LCR	1.445	0.247	0.332	2.263	1567
AER	0.221	0.069	0.113	0.485	2460
ROE	0.054	0.085	-0.437	0.812	2291
SOLVENCY	0.275	1.319	0.104	17.880	2330
CISS	0.113	0.131	0.013	0.840	2460
CLIFS	0.078	0..049	0.022	0.552	2460
EONIA VOLUME	8.745	0.792	6.190	10.252	2460
ALLOTMENT	5.443	0.896	3.560	6.679	2460

Table 11: Correlation Matrix Extended Model

	HRCT	EONIA%	LTD	DGDP	NPL	TR1	LR	CET1	LCR	AER	RoE	SR	CISS	CLIFS	EONIA	ALTMT
Haircut	1.00															
EONIA%	-0.03	1.00														
LTD	0.17*	-0.00	1.00													
D/GDP	0.33*	0.05*	0.06*	1.00												
NPL	0.72*	0.16*	0.29*	0.75*	1.00											
Tier1	0.11*	-0.27*	0.16*	-0.37*	-0.11*	1.00										
Leverage	0.52*	-0.03	0.27*	0.34*	0.65*	0.24*	1.00									
CET 1	0.30*	-0.02	0.09*	0.14*	0.23*	0.09*	0.20*	1.00								
LCR	0.09*	-0.07*	-0.20*	-0.04	-0.40*	-0.31*	-0.18*	-0.33*	1.00							
AER	0.50*	0.15*	0.42*	0.51*	0.69*	-0.29*	0.18*	0.22*	-0.01	1.00						
RoE	-0.04*	-0.13*	-0.10*	-0.29*	-0.47*	0.19*	-0.10*	0.12*	0.03	-0.36*	1.00					
Solvency	-0.005	-0.04	0.02	-0.06*	-0.05*	0.00	0.03	-0.01	-0.01	-0.05*	0.05*	1.00				
CISS	0.39*	0.12*	0.24*	0.52*	0.62*	-0.22*	0.10*	0.09*	-0.10*	0.6216*	-0.4408*	0.0168	1.00			
CLIFS	-0.01	0.22*	0.16*	0.146*	0.31*	-0.16*	0.02	-0.02	0.03	0.39*	-0.31*	-0.02	0.47*	1.00		
EONIA	0.05*	0.58*	-0.08*	0.05*	0.16*	-0.22*	-0.02	0.03	-0.04	0.17*	-0.09*	-0.07*	0.09*	0.04*	1.00	
ALMT	-0.004	0.64*	-0.11*	0.06*	0.16*	-0.26*	-0.08*	0.06*	-0.12*	0.19*	-0.17*	-0.01	0.14*	0.11*	0.62*	1.00