

Monetary policy and collateral constraints since the European debt crisis¹

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Abstract

With the European debt crisis, the role of assets accepted by the Eurosystem as collateral for refinancing operations took on a new place in the public debate, as, against a backdrop of shifting demand for refinancing, movements in European bond prices led to significant fluctuations in the collateral constraints of credit institutions. This paper documents the change in and heterogeneity of these constraints. We assess the impact attributable to the downgrade of sovereign ratings and the decline in asset prices during the European debt crisis on the valuation of collateral available for refinancing. We also construct indicators that track the change in the quality and liquidity of posted collateral. Our findings suggest that the flexibility of the Eurosystem collateral framework enabled credit institutions to cushion the shock created by the European debt crisis by depositing assets that were less liquid than bonds without causing a relative deterioration in the average rating of assets posted as collateral compared with the average rating on the market, as measured by eligible marketable assets.

Key words: Collateral; Eurosystem; Transmission of monetary policy; European debt crisis.

JEL codes: E52 E58 G01 G21

1. Introduction

Recent financial crises have thrown the spotlight onto the instruments used by central banks to implement their monetary policy objective(s), see Chailloux et al. (2008) and Bindseil (2016). In the euro area, the Eurosystem² conducts refinancing operations, i.e. loans of central bank money to credit institutions.³ These operations are “secured” in the sense that assets must be pledged as collateral by the borrowing credit institutions.⁴ With the European sovereign debt crisis of 2010-2012, the collateral issue has been of interest as discussions mounted on how the collateral framework had influenced or not the monetary policy transmission.⁵

This paper inform on if and when the Eurosystem collateral framework may have impeded the transmission of monetary policy through binding collateral constraints. We study how the European

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² The Eurosystem comprises the European Central Bank (ECB) and all of the national central banks of the euro area.

³ See Drumetz et al. (2015) for a detailed description of Eurosystem monetary policy operations.

⁴ Pledging is legally distinct from repurchase agreements (repos). See for example Goffinet (2008).

⁵ The collateral framework determines which assets are eligible as collateral at the central bank, the price at which they are valued and the haircut applied to that value. Collateral shields the central bank against the consequences of a counterparty default while the haircut provides protection against price and liquidity variations in the event of a forced liquidation.

debt crisis and non-standard monetary policy measures affected the collateral posted with the Eurosystem. Specifically, we offer some quantitative answers to the following three questions: (1) How large were collateral constraints? (2) What were the determinants that shaped changes in the collateral available to credit institutions? (3) What changes were recorded in the credit risk of assets posted as collateral for refinancing operations? To answer those questions, we use a base of weekly exhaustive data giving eligible assets as well as refinancing operations and assets pledged by each individual counterparty, asset by asset, between 6 January 2011 and 26 May 2016.

Before the 2007 crisis, the issues linked to the central bank collateral framework were viewed as technical matters, as they related chiefly to operational risk management. What is more, credit institutions held eligible assets that far exceeded their demand for refinancing, since they also had access to an extremely active interbank market. The crisis unleashed in August 2007 thrust questions about collateral into the limelight, notably because they may complicate the transmission of monetary policy (Cheun et al., 2009). When the interbank market (particularly the unsecured segment) began drying up in August 2007, credit institutions started boosting their demand for Eurosystem refinancing. To accommodate this increased demand and alleviate pressure on money markets, the Eurosystem modified its operational framework by organising fixed rate full allotment tenders. With that, collateral became the only real limit on the increase in central bank refinancing in the euro area (Bindseil, 2014). But the European sovereign debt crisis of 2011-2012, which caused asset prices and ratings to plunge, decreased the value of the marketable assets that could be posted as collateral with the central bank. The degree of pro-cyclicality of the Eurosystem's collateral policy may hence be questioned (Gabor and Ban, 2016).

Our research shows that at the level of the euro area as a whole, the quantity of posted collateral continued to far exceed the amount of refinancing requested. But there were sizeable disparities between banks insofar as around 10% of them saturated their collateral constraint at one point in time of the entire 2011-2016 period. This can be linked to the asymmetric impact of the crisis on bond yields: in some countries, up to 80% of posted collateral was used as security for refinancing operations for a few months in 2012.

We also document a reduction of approximately EUR 200 billion on the valuation of eligible collateral due to the fall in sovereign bonds prices concomitant with the sovereign debt crisis. This shock was partly cushioned by collateral expansions, but also by greater use of provisions in place before the crisis, such as the ability to put up loans as collateral. The framework used to implement the Eurosystem monetary policy, characterised by acceptance of one of the broadest ranges of eligible assets of any central bank,⁶ thus proved highly resilient to these financial shocks.

⁶ See for example BIS, "Central bank collateral frameworks and practices. A report by a Study Group established by the Markets Committee", March 2013.

To document the changes in credit risk resulting from refinancing operations, we compare the average rating of posted assets with the average rating of eligible assets. Banks choose the composition of their collateral baskets from among the list of eligible securities, whose quality may vary depending, for example, on the business cycle and which thus constitute our control group. This statistic measures the distance between what was actually deposited as collateral and what could have been posted had credit institutions had a basket that was representative of all eligible assets, and thus provides insights for the current debate over the quality of collateral posted with the Eurosystem. Nyborg (2015), for one, criticises the eligibility policy as being overly generous relative to the market.⁷ We demonstrate that the weighted rating of collateral posted with the Eurosystem fell from to A+ from AA in early 2011, in line with deteriorations in individual sovereign ceilings. Drawing on data from the 2007-2011 period, Drechsler et al. (2014) reveal a deterioration in the quality of assets posted by stressed banks (measured using CDS). As bank stress was greater in some countries, this should have resulted in a larger deterioration in the quality of posted collateral relative to eligible assets in crisis-hit countries as compared with the relative quality of assets posted by banks in other countries. We show that these two statistics do not vary greatly between the two groups of countries, even at the height of the crisis. Eberl and Weber (2014) interpret expansions of eligibility as contrary to Bagehot's Rule, which states that the central bank should only accept good collateral. However, this interpretation ignores the remainder of the rule as written by Bagehot who goes on to say that the central bank should be "freely advancing on what in ordinary times is reckoned a good security".⁸ However, in keeping with Bagehot's Rule, we find that the quality of posted collateral improved markedly after winter 2012-2013, in parallel with the end of the sovereign debt crisis, which underlines the fact that the posted collateral was of good quality *in ordinary times*.

This article helps to further our understanding of the mechanisms at work during the European debt crisis, particularly as regards the manner in which banks were able to overcome their funding difficulties on interbank and money markets. The decrease in dollar financing for European banks has been studied by Correa et al. (2013), Ivashina et al. (2015) and Acharya and Steffen (2015) while Barthélemy et al. (2017), Garcia-de-Andoain et al. (2016) and Pérignon et al. (2016) describe funding pressures on European markets. Legroux et al. (2018) confirmed those finding using comprehensive indicators of liquidity mismatch of French banks during the 2011-16 period. Bindseil et al. (2017) propose a comprehensive overview of how the collateral framework of the Eurosystem adjusted in response to the increasing financial tensions. Barthélemy et al. (2017) have shown that the eligibility of credit claims and additional credit claims with the Eurosystem had contributed to smooth the

⁷ Nyborg (2015): "The collateral framework in the euro area promotes risky and illiquid collateral and, more generally, impairs market forces and discipline."

⁸ Lombard Street, Chapter 7, paragraphs 57-58: "The great majority, the majority to be protected, are the 'sound' people, the people who have good security to offer. If it is known that the Bank of England is freely advancing on what in ordinary times is reckoned a good security—on what is then commonly pledged and easily convertible—the alarm of the solvent merchants and bankers will be stayed. But if securities, really good and usually convertible, are refused by the Bank, the alarm will not abate, the other loans made will fail in obtaining their end, and the panic will become worse and worse."

adverse macroeconomic consequence of the funding loss on the financing of the European economies. We document the resilience of the Eurosystem collateral framework in situations of high demand for central bank refinancing and the resulting sources of potential stress.

Our article is linked to theoretical papers that explore the relationship between monetary policy, asset prices and collateral. Collateral is often analysed as an amplifier of shocks and monetary policy (Shleifer and Vishny, 1992; Kiyotaki and Moore, 1997, see Engler and Grosse Steffen (2016) for an application to the Eurosystem) or as a source of fluctuations if it modifies the incentive to screen the underlying quality of borrowers (Gorton and Ordóñez, 2014). Benmelech and Bergman (2012), Struyven and Koulischer (2014) and Gabor and Ban (2016) explain the mechanisms through which changes in the value of collateral affect the transmission of monetary policy. We document empirically how collateral impacted on the availability of central bank refinancing. In particular, our article is related to Singh and Stella (2012), who link the decrease in liquid assets as loan collateral to the ability of financial intermediaries to obtain refinancing during a crisis. Our data suggest that the collateral constraints of credit institutions were deeply impacted by the European debt crisis.

The article is in five sections. In section 2, we describe the various non-standard monetary policy measures implemented by the Eurosystem and their interactions with the collateral framework. We describe the collateral framework employed by the Eurosystem in section 3 and present the changes that had a meaningful impact on monetary policy implementation. In section 4, we discuss whether some local collateral constraints in the euro area appeared, whether the pool of eligible collateral was impacted by monetary policy measures and the financial crisis and compute statistics of the average quality of collateral posted. Section 5 concludes.

2. Collateral and Eurosystem monetary policy

In this section, we describe changes to the Eurosystem operational framework since the onset of the 2007 crisis and show why the issues related to collateral framework have become critical to the implementation and transmission of monetary policy.

a. The monetary policy framework

Before the 2007 financial crisis, monetary policy was implemented by means of one-week refinancing operations known as main refinancing operations (MROs) and one-month refinancing operations. Refinancing operations are secured by means of fixed income assets pledged with the central bank (the term collateralised loans is also used). Indeed like any creditor, the Eurosystem needs to protect itself against counterparty risk, i.e. the risk of losses linked to a default.

Counterparty risk may vary both over time and from one credit institution to another. For reasons of legal equality in terms of access to the central bank, i.e. regardless of place of residence,

and to safeguard its independence, the Eurosystem set up a policy based on collateral rather than on discriminating between counterparties. Accordingly, counterparties are treated equally provided they are solvent. Their ability to borrow from the central bank is limited by the security they can provide, in accordance with a single public list of eligible collateral.

The impact of a potential counterparty default is greatly reduced by the pledging process. If a counterparty defaults, the Eurosystem becomes the owner of the security posted as collateral. Although rare, this does happen occasionally. If it can sell the asset, and the price has not fallen by more than the haircut, the central bank loses nothing. However, it could be that there is a lack of liquidity for this asset. In the case of some non-marketable assets, resale is complicated by the absence of an organised secondary market. The central bank, which is not exposed to liquidity risk, needs to find a counterparty for an over-the-counter sale or wait to be reimbursed. In the event of a default by the issuer of the security, the central bank works alongside other investors in the insolvency proceedings. It could ultimately be forced to use its capital to absorb some losses, although there is very little risk of this in practice. As the Bundesbank points out, even the Lehman Brothers failure did not result in losses (see Bundesbank, 2015).

b. The monetary policy implementation framework in times of crises

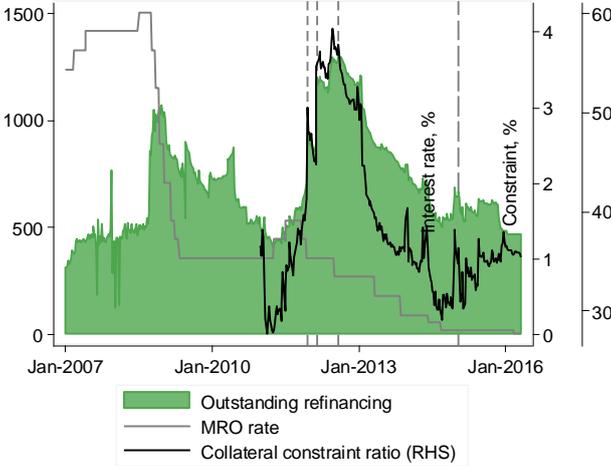
The Eurosystem takes steps to tackle the Great Financial crisis in August 2007. As the crisis deepened following the Lehman Brothers failure, the Eurosystem cut the policy rates on its MROs from 4.25% in October 2008 to 1% in May 2009, as shown by Figure 1. This active interest rate policy was supplemented from October 2008 mainly by changes in the characteristics of refinancing operations.⁹ The Eurosystem began offering loans of gradually increasing maturity through Longer Term Refinancing Operations (LTROs), starting with three and six months, followed by 12 months, three years and finally four years for the most recent Targeted Longer Term Refinancing Operations (TLTROs).

One notable decision that structurally changed the role of collateral in the implementation of monetary policy was taken in October 2008 to replace the limited-amount variable rate auction process by a demand-based fixed rate allocation system for all lending operations. In this new system, the Eurosystem continues to set the price (fixed policy rate) but no longer determines the quantity of reserves available in the economy and counterparties set it endogenously as a function of the interest rate and the quantity of assets eligible as collateral for refinancing operations. Accordingly, the question of the availability – and potential scarcity – of collateral has become crucial (Bindseil, 2014). From March 2015 onwards, the quantitative easing programme was added to bank refinancing

⁹ It was not before July 2009 that the Eurosystem launched its first programme of asset purchase for a total value of EUR 60 billion (the Covered Bond Purchase Programme), following this up in May 2010 with the EUR 200 billion Securities Markets Programme. Large scale asset purchases started in 2015, with an expected total size in 2018 of more than 2000 billion of public sector debt.

operations, and the quantity of reserves truly became the joint product of asset purchases and bank refinancing.

Fig.1 Eurosystem loans, interest rates and outstanding amounts, collateral constraints



Source: Authors’ calculations based on ECB and Eurosystem data.

Figure 1 shows the main changes in outstanding amounts of refinancing, the policy rate for refinancing operations and the share of posted collateral used as collateral for refinancing (what we refer to as the collateral constraint). The decline in interest rates and the three-fold increase in outstanding amounts of refinancing operations at the height of the euro area crisis in 2011-2012 were accompanied by a rise in the share of collateral used for monetary policy operations, which temporarily doubled from around 30% to just under 60%.

b. Crisis-time challenges for the collateral framework

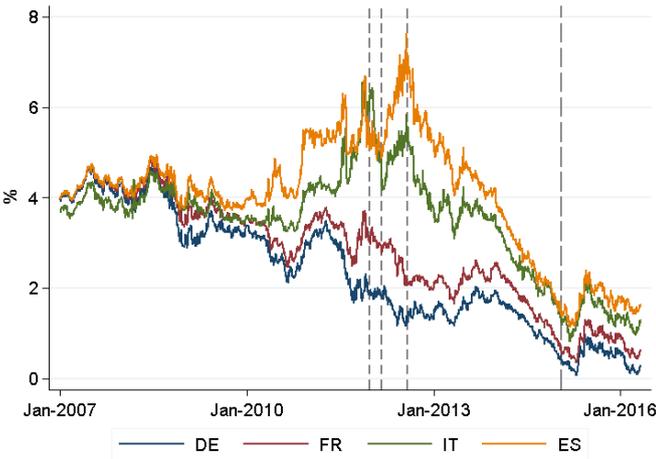
Collateral was a major issue for the implementation of refinancing operations between October 2008 and March 2015, as strain on its availability may have weighted on access to central bank money and hindered the transmission of monetary policy. One commonly used measure of collateral availability is the nominal value outstanding of eligible marketable assets,¹⁰ which has been around EUR 13 trillion to EUR 14 trillion since 2011, compared with less than EUR 10 trillion in 2007.¹¹ Compared against the maximum outstanding amount of Eurosystem refinancing operations during the crisis, which stood at EUR 1.265 billion in June 2012, the nominal value of eligible collateral is high. But credit institutions do not hold all of these eligible assets, since non-residents and other domestic investors own a large portion. Just 20% of outstanding eligible assets was held by the counterparties to Eurosystem refinancing operations at end-2014, i.e. a nominal value of EUR 2.800 billion, and was used to secure not only Eurosystem refinancing but also secured interbank

¹⁰ See for example “The Eurosystem collateral framework throughout the crisis”, in the ECB’s July 2013 Monthly Bulletin, p. 71.
¹¹ This measure varies based on outstanding amounts of the main categories of eligible debt – and hence government debt, for example, but also private sector generation of good collateral – and also, to a lesser extent, on collateral expansions.

transactions. However, as discussed in Part 3.a, the stock of eligible assets extends beyond that of marketable assets alone.

Valuing collateral at market prices rather than nominal value is a way to capture changes in default risk associated with the assets.¹² It protects the central bank in the event that the counterparty defaults and the assets posted as collateral are liquidated. Applying a haircut to the market price covers the risks associated with potential difficulties in selling the assets, such as the absence of an organised market or a fall in market prices. Valuing collateral at market prices and using ratings to determine haircuts may have a procyclical impact. This is the collateral channel. Financial accelerator theories (Kiyotaki and Moore 1997, Bernanke et al. 1999) suggest that the transmission of monetary policy may be complicated by the fact that a reduction in collateral value increases financing constraints. This problem is particularly acute when market prices are below their fundamental value, as for example in a cash-in-the-market pricing situation (Allen and Gale, 1994). In these settings, collateral that is not valued at market prices is less exposed to the issue of procyclicality.

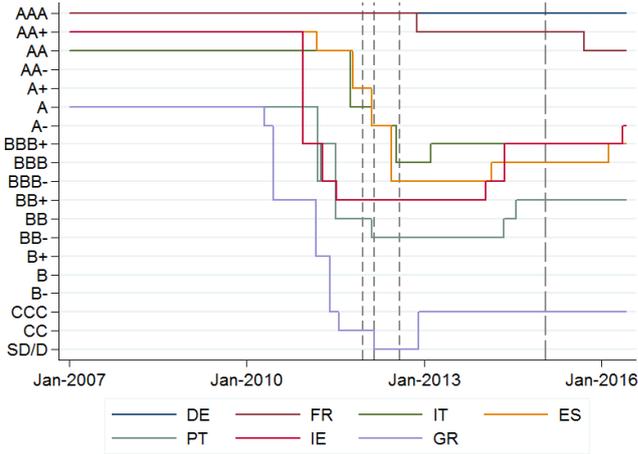
Figure 2: Ten-year sovereign bond yields of four large euro area countries



Source: Bloomberg

Note: The vertical lines show (1) the first three-year LTRO of 21 December 2011, (2) the second three-year LTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015.

Figure 3: Long-term ratings of euro area sovereigns



Source: Thomson Reuters/Standard and Poor's

The European sovereign debt crisis, which was characterised by a fall in bond prices, particularly in 2011-2012 (Figure 2) and a sharp deterioration in sovereign ratings over the same period (Figure 3), may have reduced counterparties' refinancing capacities because of the reduction of bond prices and because of the increase in haircuts caused by the degradation of the rating. At the

¹² See on this topic the report prepared by a BIS working group in 2013.

same time, this effect may have been counteracted by ECB Governing Council decisions to extend the scope of eligible collateral in two ways:

(i) By extending eligibility to include new assets: in October 2008, the minimum credit rating threshold for securities was lowered from A- to BBB- (excluding ABS), with attendant changes to the table of haircuts, for example. Eligibility was also expanded to debt instruments issued in the euro area by credit institutions and denominated in certain foreign currencies. However, the main expansion to new types of assets occurred in February 2012 with the inclusion of additional credit claims.

(ii) By allowing assets that were scheduled to become ineligible to remain eligible: this was the case for the suspensions of rating criteria for the debt instruments of certain crisis-struck countries, whose ratings were cut during the crisis to below the BBB- threshold.

Collateral constraints may also have been affected by asset purchase programmes through two channels. Such programmes may have the effect of increasing constraints due to a reduction in outstanding high quality assets. But they also push up prices, automatically easing the constraints (since most assets are valued at market prices).

3. Data and descriptive statistics on the collateral framework

We describe the legal framework for collateral, before presenting the data that we use.

a. Eligible assets

The “General documentation on Eurosystem monetary policy instruments and procedures” lists all Governing Council decisions on refinancing operations.¹³ Chapter 6 gives the criteria used to determine the eligibility of assets accepted as collateral. To be eligible as collateral in monetary policy operations, an asset must be a fixed income debt security, such as a debt or a security representative of a debt – or an ABS. The asset must be denominated in euros and meet a minimum quality requirement corresponding to a maximum probability of default of 0.4% within the meaning of the Basel rules. It is unacceptable to post the debt of an issuer that is not resident in the euro area. The Governing Council may authorise temporary exemptions to these requirements.

It is standard practice to distinguish two main categories of assets accepted as collateral:

- **marketable assets**, which are identified by a single ISIN number and which may be traded on regulated markets. They include bonds issued by sovereign nations and sub-sovereign entities

¹³ This document may be consulted here: <https://www.ecb.europa.eu/ecb/legal/pdf/02011o0014-20130103-en.pdf>

such as local authorities, bonds issued by banks and non-financial companies, covered bonds¹⁴ and ABS.

- **non-marketable assets**, which are mainly credit claims held by banks, such as mortgage and business loans. This category also includes debt securities representative of term deposits issued by the Eurosystem under the SMP sterilisation framework until June 2014, when sterilisation was suspended.

Eligible assets may be posted by any solvent credit institution that applies to the Eurosystem to do so.¹⁵ Once their account of pledged financial instruments is open, counterparties have a free hand to choose which assets to pledge from the list of eligible securities. They may take an asset out of this “collateral basket” whenever they like as long as the basket’s value covers current operations. Posted collateral creates a “basket” because it is not allocated to specific operations, with a few exceptions (see Tamura and Tabakis, 2013). When the collateral constraint is not satiated, this basket approach limits the operational risk associated with collateral management and mitigates the Eurosystem exposure to the risk of default on securities posted as collateral because the entire set of securities provides the guarantee.

The general rule for valuing collateral is to apply market prices to marketable assets when they exist. Market prices are reckoned to provide a value that captures the issuer’s probability of default. In the case of assets for which market prices are not available, such as ABS, the Eurosystem uses model prices set by the Common Eurosystem Pricing Hub (CEPH). For loans, each NCB accepts them as collateral at the nominal value of the residual principal, i.e. after taking account of repayments by the borrower. Collateral assets are valued daily, and margin calls are issued to counterparties if the new amount of the basket no longer covers the loans extended.

A haircut is applied to the market or model price and is intended to protect the Eurosystem against the risk of loss in the event of liquidation. The percentage of the haircut applied is determined based on residual maturity (assets with a shorter residual maturity are subject to a smaller haircut), asset type (bonds are subject to a smaller haircut than ABS), issuer (sovereign, sub-sovereign, bank or non-financial company) and liquidity class (less liquid assets are subject to a bigger haircut). Other factors taken into account include the coupon type (fixed or zero) and the quality of the asset or issuer according to the rules of the Eurosystem European Credit Assessment Framework (ECAF). The credit assessment may draw on assessments by the major credit rating agencies recognised by the

¹⁴ Chiefly issued by financial institutions, covered bonds are “bonds whose redemption and interest payments are secured by income flows generated by a portfolio of high quality assets, often mortgage loans, which acts as a guarantee. The transferor often manages investor payment flows”, see Banque de France glossary (2012, p. 111).

¹⁵ In the European Union, credit institutions are the subject of a clear and binding definition as being any institution that is subject to the minimum reserve system, i.e. any bank authorised by a banking supervisor and taking deposits and making loans, cf. Chapters 2.1. and 7 of the Eurosystem general documentation.

Eurosystem (Standard & Poor's, Moody's, Fitch and DBRS) but may also rely, particularly in the case of credit claims, on internal credit risk assessment systems.

In practice, the minimum haircut of 0.5% is applied to sovereign bonds with a residual maturity of less than one year and a rating of at least A-. Given a comparable maturity and rating, ABS get a haircut of 6.5%. An increase in residual maturity and a lower rating have a marked impact on haircuts. A ten-year sovereign security rated below BBB- would be subject to a haircut of 10.5% while an equivalent ABS would get a 39.5% haircut. Haircuts are larger for credit claims because of the lack of a secondary market. Where residual maturity is less than one year, haircuts for credit claims are higher than those applied to ABS, at 9% when the claim is rated above BBB+. Loans rated below BBB+ get a haircut of up to 46%.¹⁶

b. Database and descriptive statistics

We merged three databases to construct time series for the collateral posted by counterparties with Eurosystem NCBs.

- (i) The first contains the list of eligible marketable assets, which is published daily by the ECB. For each security identified by its ISIN, the list provides 24 characteristics, including date of issue and maturity, reference market and the haircut applied by the Eurosystem. This “eligible” base includes 48 million observations for our period, or between 31,000 and 55,000 securities per date. On average, 38,600 different assets were eligible per day over our period from January 2011 to May 2016.
- (ii) The second contains the marketable and non-marketable securities posted by each credit institution that was a Eurosystem counterparty. The base of marketable securities contains 9,700,880 “bank-ISIN” observations, or 35,456 “bank-ISIN” observations per week. The base of credit claims contains 13,029,425 loans posted as collateral, or 54,344 loans per week posted by some 300 counterparties that provided credit claims.
- (iii) The third base includes all refinancing operations carried out by counterparties with one of the Eurosystem's NCBs, which we use to construct the total amount of refinancing on a bank-by-bank basis. The base contains 1,218,477 observations, or 2,356 items on average per week.

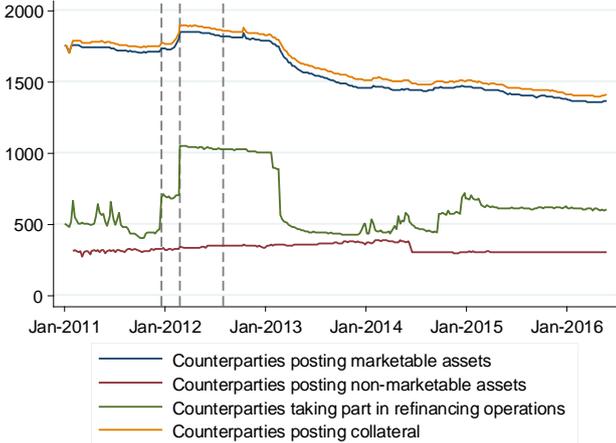
The database has a weekly frequency and covers the entire euro area for the period from 5 January 2011 to 26 May 2016.

On average, the number of credit institutions posting collateral with the Eurosystem has declined since 2011, falling from 1,750 in January 2011 to 1,362 in May 2016, as shown by Figure 4. This is in line with the decline in the number of euro area credit institutions, which shrank from 6,327 to 5,269 over the same period. As a result, between 25% and 30% of eligible credit institutions posted collateral

¹⁶ See “Guideline (EU) 2016/65 of the ECB of 18 November 2015 on the valuation haircuts” of the Official Journal of the European Union dated 21/1/2016 https://www.ecb.europa.eu/ecb/legal/pdf/oj_jol_2016_014_r_0006_en_txt.pdf

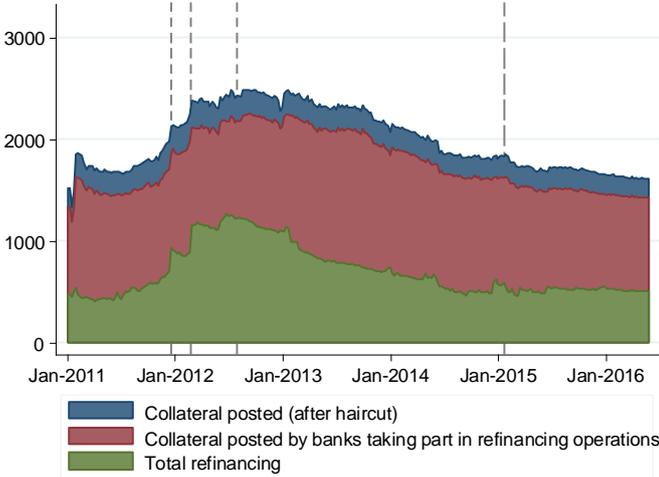
with the Eurosystem. The proportion of credit institutions taking part in monetary policy operations varied between 8% and 10% of eligible counterparties. It temporarily varied substantially following the introduction of three-year LTROs in December 2011 and February 2012. Between December 2011 and March 2013, which was the first month in which the funds raised through three-year LTROs could be repaid, the number of banks capped at 1,046.

Figure 4: Number of Eurosystem counterparties



Note: The vertical lines show (1) the first three-year LTRO of 21 December 2011, (2) the second three-year LTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012.

Fig. 5: Total aggregate refinancing and collateral posted by credit institutions

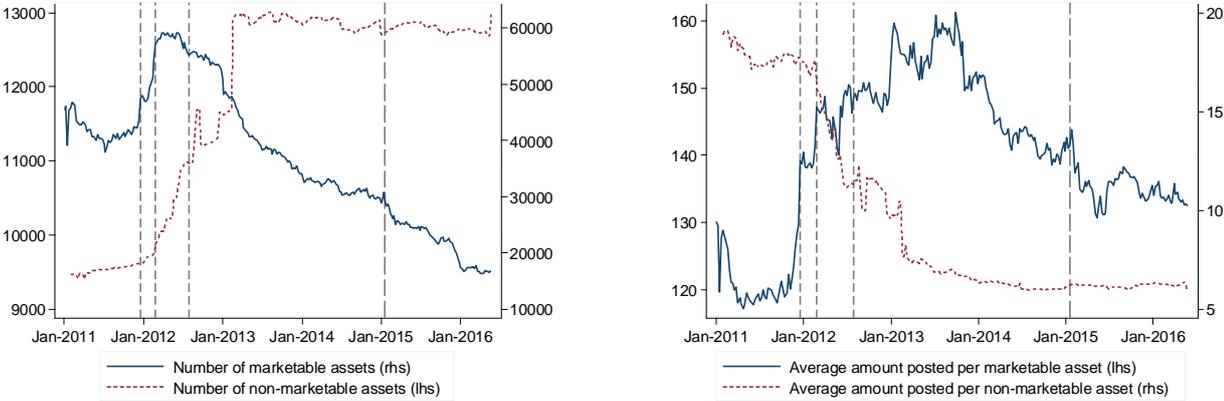


Note: The vertical lines show (1) the first three-year LTRO of 21 December 2011, (2) the second three-year LTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015

However, despite the wide gap between the number of banks that posted collateral and the number that took part in refinancing operations, most of the collateral posted was put up by banks that requested refinancing. Figure 5 shows that, on average, banks that requested refinancing posted 89% of the total collateral. Posted collateral fluctuates with demand for refinancing. Each major

non-standard monetary policy operation had an impact on aggregate amounts of collateral, with the three-year LTROs increasing both margin and refinancing volumes, while the announcement of the quantitative easing programme had a slight downside effect. The peak was reached on 26 June 2012.

Fig. 6: Number and average amount in EUR million of assets posted as collateral by credit institutions



Note: The vertical lines show (1) the first 3-year LTRO of 21 December 2011, (2) the second 3-year LTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015

Our data also provide information about changes in the types of collateral posted by banks. These variations may arise because new assets are posted (extensive margin) or because of an increase in the amount of assets already posted (intensive margin). The left-hand panel of Figure 6 shows the average number of marketable securities and loans posted by counterparties (extensive margin). The right-hand panel shows the average amount posted per asset (intensive margin). In January 2011, each bank posted an average of 11,500 different debt securities worth an average post-haircut amount of EUR 120 million. This number and the average amount of marketable assets, rose significantly from December 2011 to spring 2012, before decreasing steadily. The average number and amount of non-marketable assets posted moved in opposite directions. The average amount fell by EUR 20 million to approximately EUR 6 million in May 2016. Meanwhile, the average number of non-marketable assets rose from around 15,000 in January 2011 to over 60,000 in January 2013.

4. The European debt crisis and collateral

We now turn to study how the European debt crisis and non-standard measures affected collateral posted with the Eurosystem. To do this, we answer three questions: (1) Was there a local collateral shortage in the euro area? (2) How did net volumes of available collateral change, and to what extent did eligibility expansions ease the constraints? (3) How did the average quality of collateral posted by counterparties change?

a. Heterogeneity of collateral constraints between banks and across countries

To inform on the evolution of the collateral constraint, we calculate two: an aggregate ratio and an unweighted average of individual constraints. The aggregate ratio C_t , is defined as follows:

$$C_t = \frac{Refi_t}{\sum_{j=1}^k N_{j,t} * P_{j,t} * (1 - H_{j,t})}$$

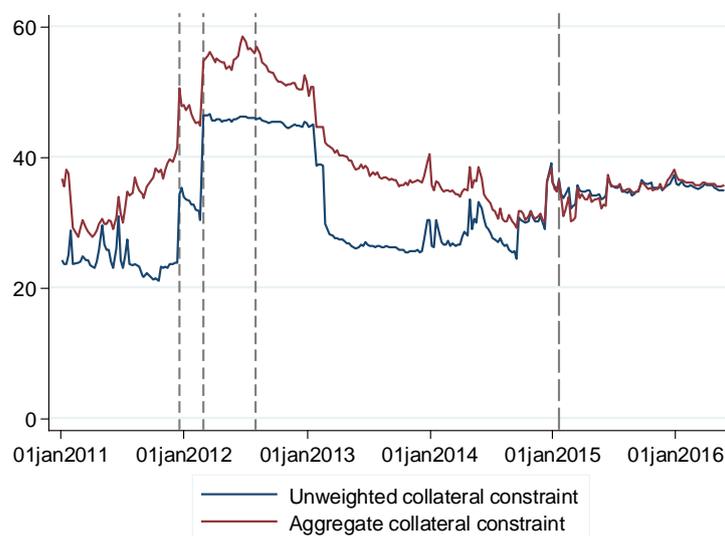
where $Refi_t$ is the total amount loaned by the central bank through its monetary policy operations, $N_{j,t}$ is the nominal total value of assets j posted with the central bank as security at date t , $P_{j,t}$ is the price of the asset while $H_{j,t}$ denotes its haircut.

The second statistic corresponds to the unweighted average of individual collateral constraints. The collateral constraint ratio for bank i , $C_{i,t}$ is defined as follows:

$$C_{i,t} = \frac{Refi_{i,t}}{\sum_{j=1}^k N_{i,j,t} * P_{j,t} * (1 - H_{j,t})}$$

where $N_{i,j,t}$ is the nominal holding of counterparty i in asset j at date t in its basket of posted collateral.

Because this collateral is used both to secure the payment made through TARGET 2 – the payment system operated by the Eurosystem – and to secure the refinancing operations, it is usually not the goal of a counterparty to satiate the collateral constraint. The inability to pay intraday in due time because of a lack of collateral may trigger the default of the bank. Therefore, banks of the Euro area are usually over-collateralized, in order to build a buffer allowing to proceed to (sometimes) large and unexpected interbank payment. Fig. 7 Collateral constraints

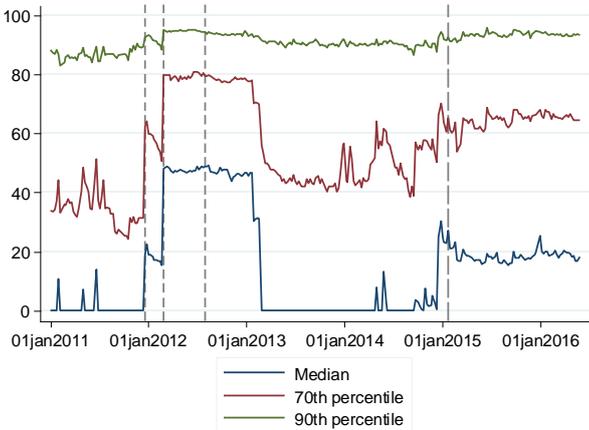


Note: The vertical lines show (1) the first three-year VLTRO of 21 December 2011, (2) the second three-year VLTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015.

Figure 7 shows the change in those two measures of collateral. On aggregate, refinancing represents between 30% and 60% of posted collateral. Between mid-2011 and early 2014, the aggregate constraint ratio is always higher than the unweighted average, suggesting that the

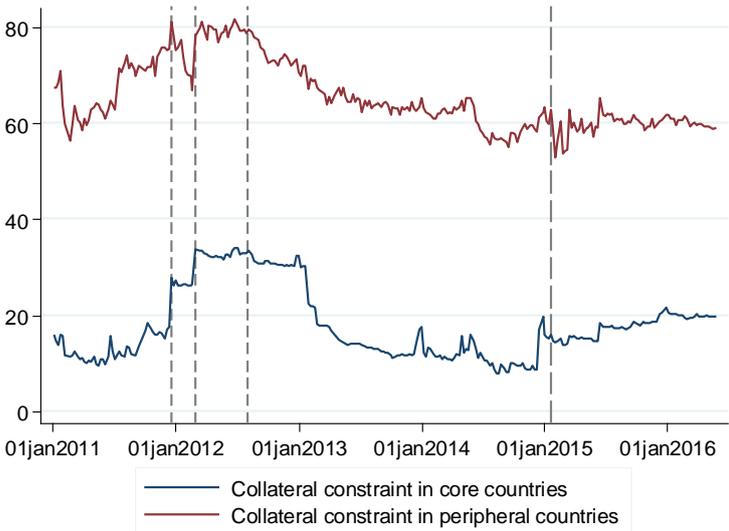
counterparties that posted the most collateral saw their constraint ratios go up. To check this hypothesis, Figure 8 draws the median and the 70th and 90th distribution percentiles for collateral constraints. This reveals that a median bank posting collateral did not take part in monetary policy operations in January 2011. With the introduction of the three-year long-term refinancing operations in January 2011. With the introduction of the three-year long-term refinancing operations in December 2011 and February 2012, the median ratio spiked first to 20% and then to 50%. Conversely, the 10% of banks experiencing the most severe constraints always used over 80% of posted collateral for refinancing operations. This level was reached by the 70th percentile only during the period between the three-year VLTRO in February 2012 and the start of 2013.

Fig.8 Distribution of collateral constraints



Note: The vertical lines show (1) the first 3-year VLTRO of 21 December 2011, (2) the second 3-year VLTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015.

Fig. 9: Collateral constraints in core vs. peripheral countries



Note: The vertical lines show (1) the first three-year VLTRO of 21 December 2011, (2) the second three-year VLTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015.

Figure 9 plots the change in the collateral constraints of banks according to their residence (or not) in a country experiencing a sovereign debt crisis (sometimes referred to as “peripheral” countries below). At the height of the crisis, the collateral constraint of banks of crisis-hit countries (defined as Spain, Greece, Ireland, Italy and Portugal) reached 80% of the post-haircut value of posted collateral. These banks were thus already heavily constrained at the start of our study period in early 2011. Furthermore, in January 2012, two-thirds of the 10% of banks suffering the most severe collateral constraints were residents of one of the peripheral countries. The binding collateral constraints may have locally impeded the transmission of the accommodative monetary policy in the countries that were the most hit by the sovereign debt crisis.

Conversely, the collateral constraints of banks in other countries temporarily increased with the three-year very long-term refinancing operations (VLTROs). This heterogeneity may be linked to the following two things. The banks of the countries in crisis either found it harder to access market financing or had to pay a higher cost. They also saw their collateral lose value (see below) owing to imperfect diversification of their bond portfolios, as suggested by Acharya and Steffen (2014) and documented by Koijen et al. (2017).

b. Sources of fluctuations in collateral constraints

Collateral constraints fluctuate according to demand for reserves on the basis of the quantity of posted collateral. A change in the total value of posted collateral may itself have four different sources: (i) a change in the market price of a security as illustrated in Figure 2, (ii) a change in haircut linked to a central bank decision or a change in one of the properties of a security (chiefly the rating of credit risk, see Figure 3), (iii) the new issuance of eligible debt, (iv) assets that become eligible thanks to collateral expansions.¹⁷

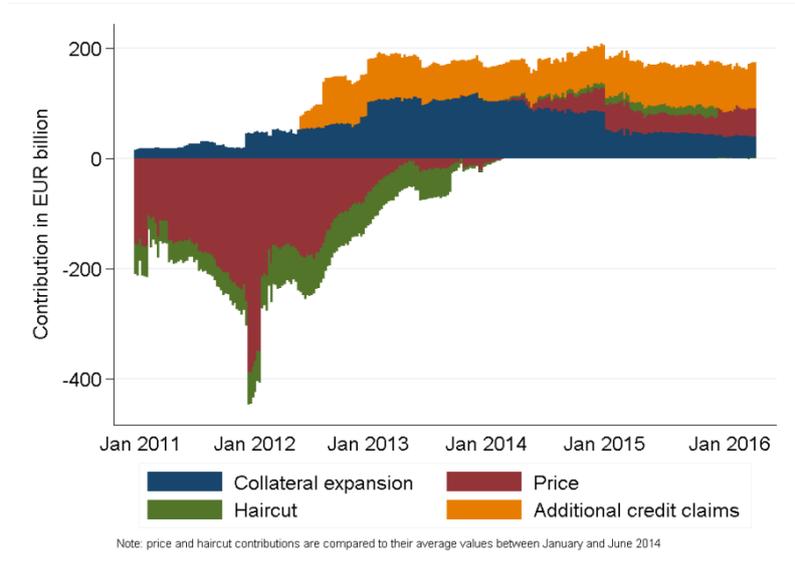
Figure 10 plots the contribution in EUR billion of price fluctuations, haircut changes, main collateral expansions since 2011 resulting in the acceptance of new eligible assets as listed in box 2, and separately the acceptance of additional credit claims by some national central banks of the Eurosystem, see Bignon et al. (2016) for their use in France. Price and haircut contributions are compared to their average values between January and June 2014, a period that we selected for its distance from the European crisis, which ended in 2013, and the 2015 asset purchase decisions. Price appears to be the major determinant of the quantity of collateral actually available. Substantial increases in yields on some government debts in 2012 translated into a loss of around EUR billion 200 in collateral. All in all, collateral expansions covering marketable assets made a positive EUR 70 billion contribution to posted collateral. Haircuts were relatively unchanged over the period

¹⁷ For a detailed list of all collateral framework expansions and the use of collateral eligible thanks to all collateral expansions since 2008, see Bindseil et al (2017), <http://www.ecb.europa.eu/pub/pdf/scpops/ecb.op189.en.pdf>

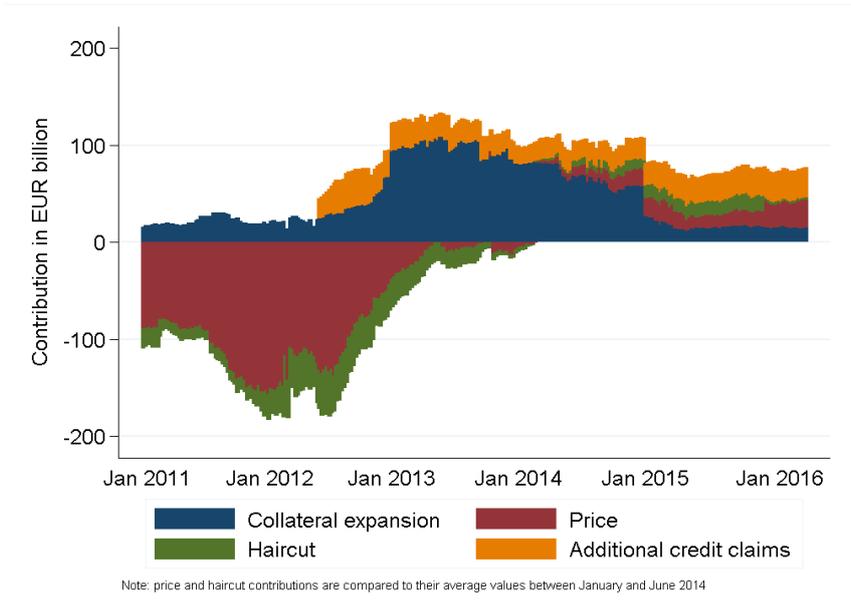
compared with 2014, and actually seemed to have a positive impact towards the end of the period, suggesting either a composition effect or improved ratings for some collateral.

Fig.10: Shocks on the outstanding amount of collateral

Panel A: Euro area



Panel B: Peripheral countries only



Relative to euro area refinancing, the price shock was equivalent to 16% of the EUR 1.265 billion refinancing peak reached in June 2012. For stressed countries, the maximum price variation corresponded to a EUR 150 billion reduction in posted collateral, equivalent to 40% of the total refinancing of peripheral countries or 27% of total post-haircut collateral posted by the banks of these countries.

Additional credit claims, which were allowed by the collateral expansion of December 2011, improved banks access to central bank money and amounted to EUR 85 billion, including EUR 38 billion in peripheral countries. Moreover, additional use was also made of credit claims that were already eligible, rising from a total of EUR 310 billion at end-November 2011 to EUR 390 billion during spring 2013. Credit claims as a whole accounted for 26.7% of total post-haircut collateral posted in May 2013. This suggests that it was not only the new expansion measures that made it possible to cushion the price shock, but also and especially the flexibility of the existing operational framework (i.e. most illiquid assets eligible as collateral for Eurosystem refinancing).

Finally, the asset purchase programmes deployed from 2015 onwards may have changed the quantity of available collateral. On the one hand, a reduction of available collateral may have resulted from the withdrawal of good quality, generally eligible assets from the market. On the other hand, the programmes may have exerted a rise in bond prices relaxing the collateral constraint of Eurosystem counterparties. Kojien et al. (2017) show that the monetary policy counterparties were not the main sellers of government bonds to the Eurosystem indicating that the aforementioned negative effect of the asset purchase programmes on the outstanding amount of available collateral is likely to be dominated by the positive effect due to rise in bonds prices.

c. Quality and liquidity of collateral posted since the beginning of the crisis

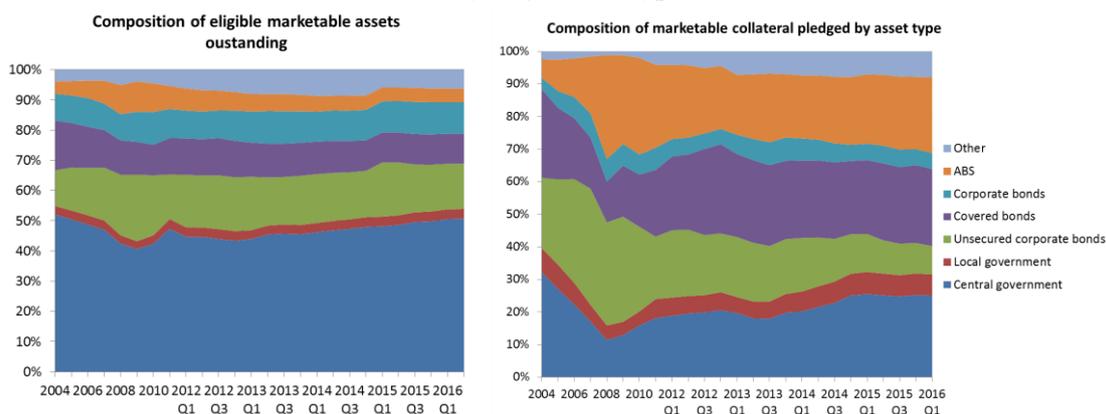
Did the Eurosystem accept low quality assets during the crisis? Drechsler et al. (2014) and Nyborg (2015) suggest that the Eurosystem rules encouraged struggling banks to borrow against poor quality collateral. Bindseil et al (2017) offer a summary of this debate, and show these claims are widely exaggerated.

We consider this question by looking at the structure of the collateral pool by asset type, average haircut and average rating. Keeping in mind the fact that the central bank is not subject to the same liquidity risk as normal credit institutions, we pay special attention to the difference between credit risk and liquidity risk.

Least liquid assets played a cushioning role

Figure 11 shows the change in the distribution of eligible and posted collateral for the main asset types. The left-hand panel, which shows eligible collateral, plots the change in volumes in circulation of the main investment grade assets issued in euro by euro area residents. The second panel shows the change in the securities that credit institutions chose to deposit with the Eurosystem. The left-hand panel reveals that sovereign bonds make up over 50% of eligible marketable assets. Debt issued or guaranteed by banks accounts for approximately 30% of total eligible securities while debt issued by non-financial companies makes up 10%. ABS account for a small share of the nominal value of eligible assets.

Fig.11: Composition of the nominal value of eligible collateral and posted collateral (after haircut) by major asset type



Source: ECB data (<http://www.ecb.europa.eu/paym/coll/charts/html/index.en.html>)

Note: The ECB reports eligible assets at nominal value while posted assets are shown after their haircut.

Comparing the two charts provides insight into counterparties' collateral strategies. For instance, counterparties post fewer sovereign assets relative to the share of such securities in eligible assets. This is consistent with the fact that sovereigns are most often used as collateral in secured interbank market transactions or in dealings with central counterparties. However, the share of sovereign bonds posted as collateral grew in particular from end-2012 as stress diminished on the sovereign debt market. Covered bonds and ABS account for about 50% of posted collateral, reflecting the intermediated nature of financing for European economies, as these assets are backed by portfolios of loans granted by banks.

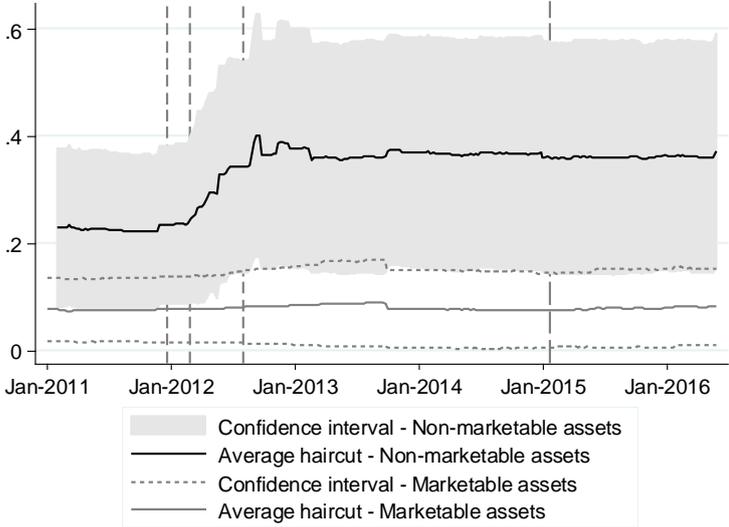
Non-marketable assets were used more extensively during the crisis, accounting for over 25% of posted collateral in 2012. This increase partly resulted from the expansion of eligibility to include additional credit claims. In addition, more banks did use the ability to pledge more credit claims. Barthelemy et al. (2017) have shown that the increasing pledge of non-marketable assets by banks did increase their credit activity during the European sovereign debt crisis. However banks that lost the most wholesale funding were not those increasing the most their credit activity. This suggests that, at the bank level, the pledge of credit claims was not mostly associated with a strategy to substitute private funding with public funding guaranteed by non-negotiable assets.

Counterparties also chose to post more illiquid marketable collateral, i.e. collateral that can be easily traded on the markets, such as ABS, or, more rarely, on over-the-counter markets. This is consistent with differences in collateral valuation methods. The methods used to value ABS (model prices) and non-marketable assets (nominal residual value) are less procyclical than that used for marketable assets and hence less prone to sharp price swings during financial crises. The Eurosystem broad collateral framework thus enabled counterparties to smooth the valuation shock to marketable

assets caused by the European sovereign debt crisis, a point also made in Bindseil et al. (2017) and Legroux et al. (2018).

The impact of this change in the composition of collateral was a decrease in the liquidity of assets posted as collateral, explaining the larger haircuts applied to these assets. To verify this, we plot in Figure 12 the change in the average haircut applied to posted collateral according to marketability. The increase in the number of marketable assets posted in 2011-2012 was accompanied by a slight upward trend in the average haircuts of marketable assets. The newfound eligibility of additional credit claims in late 2011 caused the average haircut for this asset category to jump from 20% to 40%. This increase reflects the weaker liquidity of these assets, which have a smaller residual value on average – as illustrated by Figure 6 – and are harder to sell when the need arises.

Fig.12: Average haircut (unweighted) and one standard deviation intervals for posted assets



Note: The vertical lines show (1) the first three-year LTRO of 21 December 2011, (2) the second three-year LTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015

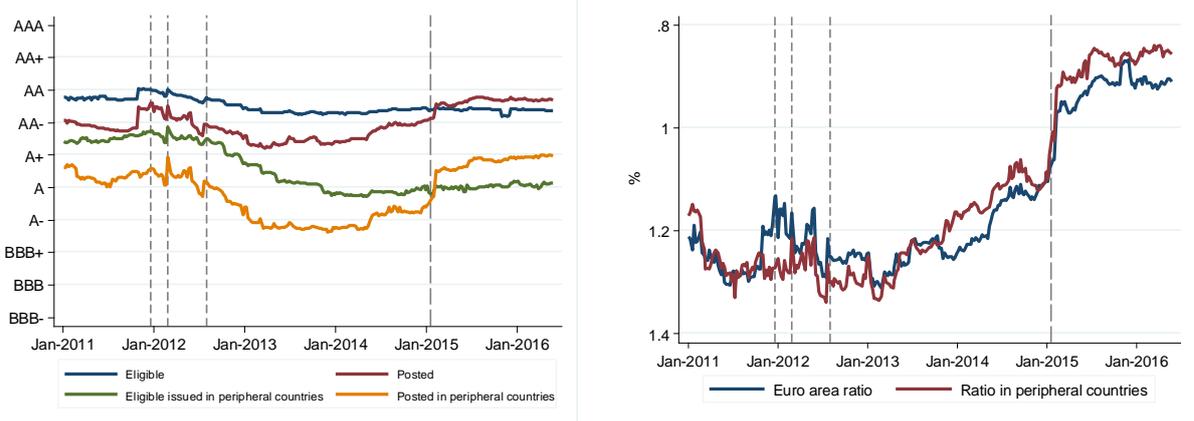
Variations in the quality of posted collateral

An asset’s quality is usually measured by the credit risk associated with that asset. But credit risk varies over time, and the central bank has a neutral collateral framework relative to the economy if the collateral posted with it follows the same path as average credit risk on the market. Because any financial crisis is characterised by a deterioration in the credit risk of assets, it is important to compare the quality of assets posted with the central bank against the average quality of assets on the market. To have a single scale for assets available on the market and those posted as collateral with the central bank, we measure credit risk using the rating assigned to each marketable asset by credit rating agencies. We also calculate the average ratings of securities traded on the market but only for eligible

securities. This means that we exclude all sub-investment grade assets (which implies that we use a conservative comparison base for average credit risk on the market because speculative grade assets are excluded). All the averages are calculated by weighting the rating by the nominal outstanding of each marketable asset.

The left-hand panel of Figure 13 shows the change in average ratings for posted marketable collateral across the entire Eurosystem and for countries hit by the sovereign debt crisis. It also plots the average rating of marketable assets. The baskets of posted collateral stayed above the lowest investment grade rating of A-. The average rating of posted collateral declined by one notch on average, and by two notches for peripheral countries. At the same time, the average market rating for marketable assets fell by slightly less than one notch for the euro area as a whole and by approximately two notches for countries affected by the crisis, which suggest that the decrease of the average rating may only reflect the deterioration of the average market quality of European assets.

Fig.13 Average weighted rating of eligible marketable assets and posted assets



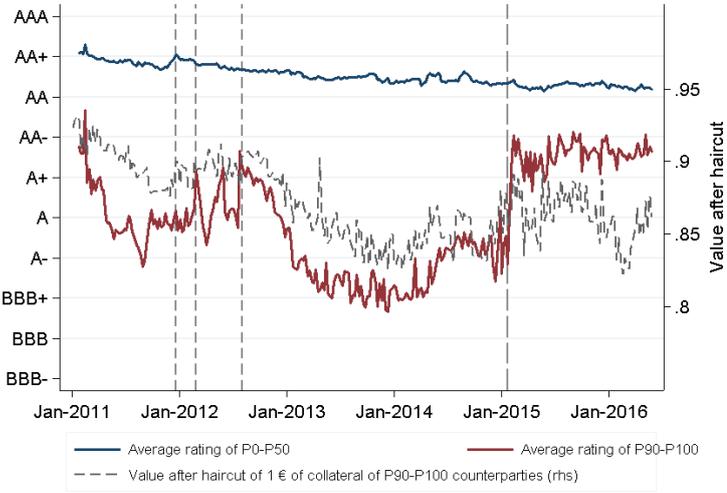
Note: The vertical lines show (1) the first three-year LTRO of 21 December 2011, (2) the second three-year LTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015

The right-hand panel of Figure 13 plots the ratio of the average rating of posted to eligible assets for the five countries that were the most hit by the European sovereign debt crisis and for the Euro area as a whole. This ratio shows the change in the relative ratings of posted collateral correcting for changes of the ratings that were caused by the European debt crisis. This criterion is the most appropriate to judge if banks changed the average quality of negotiable assets because the ratings were degraded or because they had an interest to do so. Relative ratings are calculated as the ratio of the average rating of posted assets to the average rating of assets on the market. For peripheral countries, we compare the average rating of collateral posted by banks in crisis-struck peripheral countries against the average rating of marketable assets issued in the same countries. Changes can be interpreted as follows: a ratio of more than 1 indicates that, on average, posted collateral is rated lower than eligible collateral, and vice-versa.

On average, the average basket of posted collateral was rated below eligible assets until the launch of the quantitative easing programme in January 2015. The average quality of posted collateral began to improve from winter 2012-2013 onwards, or shortly after the end of the sovereign debt crisis, marked by the introduction of the OMT programme. After January 2015, the quality of assets posted was higher on average than the quality of the overall population of investment grade assets. A comparison between the euro area average ratio and that of crisis-affected peripheral countries does not point to differences in bank behaviour. Furthermore, when the European sovereign debt crisis was at its worst between mid-2011 and mid-2012, the relative rating was stable, i.e. there was no deterioration in the quality of posted collateral relative to that of eligible assets.

Overall the two panels of figure13 suggest two conclusions. First counterparties of the Eurosystem did not use the full scope of the scale of eligible ratings as the average quality of the collateral basket is not far from the average quality on the market. Second the period is characterized by some variation of the average quality both across counterparties and over time, which suggest that counterparties have found useful the size of the scale of eligible collateral. These two remarks suggest that counterparties do not pledge the collateral of the worst quality.

Fig.14 The rating of marketable assets posted by counterparties and the value after haircut of the collateral posted depending on the intensity of the collateral constraint



Note: The vertical lines show (1) the first three-year LTRO of 21 December 2011, (2) the second three-year LTRO of 28 February 2012, (3) the announcement of the OMT programme on 2 August 2012, (4) the decision to launch the PSPP on 22 January 2015

To check whether the pledging behaviour of the counterparties varies with the collateral constraint, we compute the average quality of the basket of collateral for all the counterparties that have a constraint lower than the median constraint ratio and for those with a collateral in the last decile at each date. Figure 14 plots the evolution of these two statistics together with the quantity of refinancing that the most constrained banks (P90-P100) get in exchange for their collateral baskets.

The evolution suggests the three following observations.

First it confirms that the counterparties had not pledged the collateral of the worst quality. This is especially true for the 50% of banks the least constrained in terms of collateral who had pledged a basket of rating AA+ and AA during the 5 years under study. This is also true for the most constrained banks as their average basket is two notches above the investment grade frontier of BBB-.

Second some counterparties have temporarily used the quality scale of the collateral framework. The rating of the baskets of the most constrained banks had decreased from AA- in 2011 to BBB+ in 2014 before increasing again to AA- from January 2015 onwards. It is however hard to link the variation of the average rating with financial tension as most of the decrease occurred after the cooling of financial tensions during the summer of 2012. Moreover the increase of the average rating is coincident with the start of the Quantitative Easing program, which suggests the possibility of positive feedback between the various tools used to implement the monetary policy.

Third any reduction of the average rating is associated with a reduction of the volume of refinancing. The effect is sizable as the average refinancing that the most constrained banks get in exchange for 1 euro of collateral was reduced from 0.92 to 0.84 euro during the period of study.

To conclude, a *temporary* reduction in the quality of assets posted with the central bank is not inconsistent with Bagehot's Rule, which states that the central bank should accept collateral that is good quality *in ordinary times*. The average quality of posted assets was at the same level (or sometimes even greater) in 2016 than it was in January 2011. This reversion to the mean shows that the counterparties of the Eurosystem posted good collateral of normal times. The comparison of this quality relative to the market average of eligible assets even suggests a marked increase of the relative quality. This suggests that if the relative quality of posted collateral has deteriorated, it did so before January 2011 and so was unrelated with the intensity of the European debt crisis, something that is at odds with the idea that the collateral framework had loaded the central bank with more credit risk.

5. Conclusions

Our study offers two main findings.

First, the considerable flexibility of the Eurosystem operational framework played a big part in absorbing the shocks that emerged during Europe's 2011-2012 crisis (Coeuré, 2016). We documented how the negative impact on collateral constraints of increased credit risk and lower prices for assets that were previously deemed risk-free was partly offset by the use of more illiquid collateral and by expansions of collateral to include new assets. We showed that one of the main sources of the increase in collateral constraints was the fall in asset prices, especially in countries hardest hit by the European debt crisis. The price decline may have curbed access to refinancing. Neither the eligibility expansions

nor changes to the haircuts decided by the Eurosystem were able to completely absorb the decrease in the post-haircut value of collateral over the 2011-2012 period. Conversely, banks stepped up their use of credit claims as collateral with the central bank, indicating that it was not so much new decisions on the monetary policy framework but rather the considerable flexibility of the existing framework that made it possible to cushion the shock caused by the decline in asset prices. The collateral framework thus partly played the role of countercyclical buffer, without which collateral constraints and hence constraints on the transmission of monetary policy would have been more problematic.

Second, our study does not bear out the view that the Eurosystem had to take on significant risks in order to do this. At the height of the crisis, the quality of posted collateral, as determined by the average rating of posted assets, fell by just two notches, in line with credit rating agencies' cuts to the average rating of eligible assets. What is more, between 2012 and 2016, Eurosystem counterparties posted collateral whose quality drew gradually closer to the average quality of eligible assets before exceeding it after the launch of the quantitative easing programme. When the absolute quality of safe assets declines, it is not unusual for assets posted as collateral for loans on the market or with the central bank to move in step with the average quality of debt issued on the markets. In other words, it is important to measure relative changes.

Box 2: Main measures to expand eligible collateral between October 2008 and May 2016

Date	Measure
15/10/2008	Credit threshold for eligible securities lowered from A- to BBB- (excl. ABS) Debt instruments issued in the euro area by credit institutions and denominated in US dollars, Japanese yen or British pounds become eligible until 1 January 2011 https://www.ecb.europa.eu/press/pr/date/2008/html/pr081015.en.html
03/05/2010	Suspension of BBB- minimum credit rating threshold for Greek government debt https://www.ecb.europa.eu/press/pr/date/2010/html/pr100503.en.html
31/03/2011	Suspension of BBB- minimum credit rating threshold for Irish government debt https://www.ecb.europa.eu/press/pr/date/2011/html/pr110331.en.html
07/07/2011	Suspension of BBB- minimum credit rating threshold for Portuguese government debt https://www.ecb.europa.eu/press/pr/date/2011/html/pr110707.en.html
08/12/2011	Expansion to include A-rated ABS (second-best rating) https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208.en.html
08/12/2011	Expansion to include additional credit claims https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208.en.html
08/03/2012	Suspension of BBB- minimum credit rating threshold for Greek government debt https://www.ecb.europa.eu/press/pr/date/2012/html/pr120308_1.en.html
22/06/2012	Expansion to include CMBS and RMBS https://www.ecb.europa.eu/press/pr/date/2012/html/pr120622.en.html
06/09/2012	Renewed eligibility for debt instruments issued in the euro area by credit institutions and denominated in US dollars, Japanese yen or British pounds https://www.ecb.europa.eu/press/pr/date/2012/html/pr120906_2.en.html
06/09/2012	Suspension of rating criteria for government debt https://www.ecb.europa.eu/press/pr/date/2012/html/pr120906_2.en.html
02/05/2013	Suspension of BBB- minimum credit rating threshold for Cypriot government debt https://www.ecb.europa.eu/press/pr/date/2013/html/pr130502_3.en.html

Source: ECB.

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