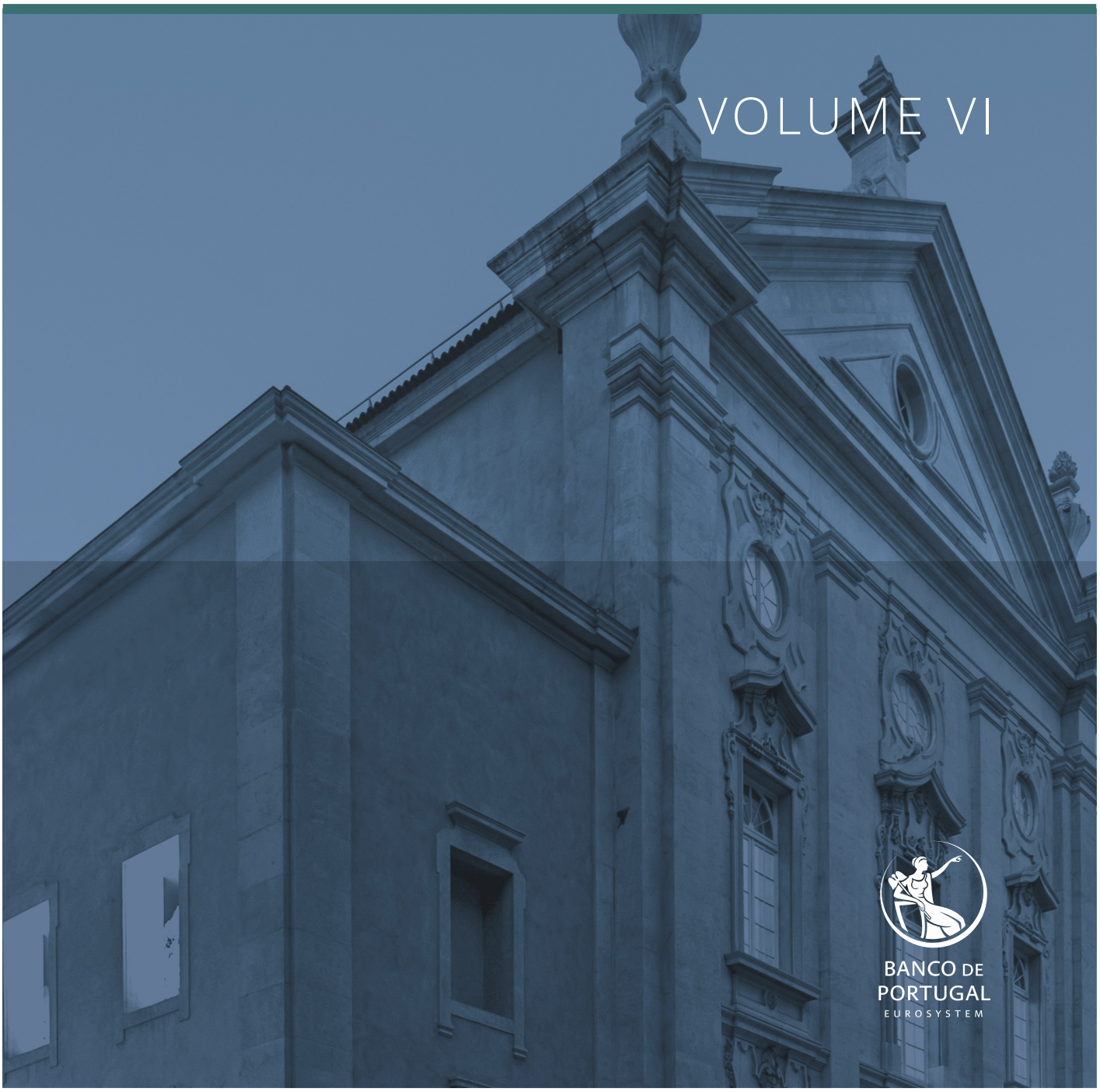
3

BANCO DE PORTUGAL ECONOMIC STUDIES



VOLUME VI

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3

Banco de Portugal Economic Studies

Volume VI

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Content

Editor's note[1]

Pedro Duarte Neves

July 2020

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1. This issue of the *Banco de Portugal Economic Studies* contains four studies, covering monetary policy in the euro area and financial stability. The opening study analyses the results of the CSPP, one of the constituents of the Eurosystem's asset purchase programmes. The second article is a conceptual study on the modelling of credit risk, which will be included in this editorial within the Basel III finalisation process under way. The third article is a descriptive and analytical study of a prudential measure of the Banco de Portugal – motivated by financial stability concerns – which was developed in 2011, at the beginning of the financial crisis, and constitutes an extraordinarily interesting case study for applying a prudential penalty to excessive rates of return on deposits that were being applied by some institutions. Finally, the summary that closes this issue of Banco de Portugal Economic Studies reviews the existing literature on the same topic, that is, maximum limits on deposit rates. The four studies contribute to a better understanding of the results obtained through economic policy measures – in the areas of monetary policy and prudential policy – using the econometric methods consolidated in the literature and which, in this way, contribute to the understanding and discussion of economic policy.

2. On 10 March 2016 the Governing Council of the European Central Bank announced the Corporate Sector Purchase Programme (CSPP), thus broadening the Asset Purchase Programme (APP) to the acquisition of debt securities issued by non-financial corporations in the euro area. The CSPP, despite having a relatively small weight in the APP, is of particular importance in the euro area considering that the relative weight of bank financing is greater than that in other economic areas such as the US and United Kingdom. The evidence to date points to various positive results of this programme[2]: there was a direct increase in debt securities issued by non-financial corporations and a reduction in such securities' remuneration; in terms of effects on other debt markets, financing conditions improved in general terms and the CSPP may have released capacity for bank loans to enterprises considered not eligible under this programme.

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1. The analyses, opinions and conclusions expressed in this work are entirely those of the editor and do not necessarily coincide with those of Banco de Portugal or the Eurosystem.

2. See, for instance, "The impact of the corporate sector purchase programme on corporate bond markets and the financing of euro area non-financial corporations", by Roberto De Santis, André Geis, Aiste Juskaite and Lia Cruz, ECB *Economic Bulletin*, No 3/2018, pp 66-84.

The Bonfim and Capela study focuses on an analysis of the CSPP effects on remuneration of the bonds eligible for the programme[3] (*the direct effect*) and the bond yields not eligible for this programme (*the indirect effect*), using an econometric analysis based on the difference-in-differences method. In terms of the direct effect, the authors found that (i) there was a reduction in these yields following the announcement of the CSPP and that (ii) there was an additional fall when the Eurosystem actually started to purchase these securities, indicating that the programme had the desired results. Furthermore, the authors also demonstrated that there were, on average in the euro area, steeper falls in bonds not eligible for the CSPP: that is, the *indirect effect* was greater than the *direct effect*. This result probably translates into a reallocation of asset portfolios of these markets' investors, towards a greater appetite for risk – that is, an increase in relative terms in investment in higher-risk bonds – as a way of attenuating the effects on average portfolio yield.

Although the *indirect effect* was greater than the *direct effect*, in average European terms, the authors noted that this did not happen in a group of EU countries (Greece, Ireland, Italy, Portugal and Spain), as these two effects had close magnitudes in general terms. In the specific case of Portugal, the *direct effect* was indeed greater than the *indirect effect*, which seems to show that – as suggested by the authors – the portfolio reallocation transactions did not bring about visible changes in demand for bonds from Portuguese enterprises that are not eligible for the CSPP. It is nevertheless an issue that should be explored in future studies in order to better understand the reality.

3. The second study included in this issue of Banco de Portugal Economic Studies needs a background note. The Basel Committee on Banking Supervision, henceforth Basel Committee, in December 2017 concluded the review process of the regulatory framework[4] that began as a result of the international financial crisis. Its main objective was to create the conditions for a more resilient banking system that was in a better position to support the real economy. The final part of this process (known as *Basel III finalisation*) was made public on 7 December 2017, aiming to reduce excessive variability in calculating risk-weighted assets (RWAs). As the Committee itself stated: "At the peak of the global financial crisis, a wide range of stakeholders – including academics, analysts and market participants – lost faith in banks' reported risk-weighted capital ratios. The Committee's own empirical analysis highlighted a worrying degree of variability in the calculation of RWAs in banks."

The revisions defined in December 2017 by the Basel Committee to restore credibility to the calculation were as follows: (i) enhancing the robustness and risk sensitivity of

3. The study included in this issue of Banco de Portugal Economic Studies presents the full eligibility criteria for this programme. In case are bonds that can be used as collateral for monetary policy operations and with a minimum rating of BBB-.

4. "Basel III: Finalising post-crisis reforms", Basel Committee on Banking Supervision, December 2017.

the standardised approach for calculating credit risk and operational risk to improve the comparability of banks' capital ratios; (ii) further limiting the use of internal model approaches, and (iii) complementing the use of risk-weighted capital ratios with the leverage ratio[5] – finalised with the creation of the leverage ratio buffer applicable to global systemically important banks (G-SIBs) – and the introduction of a revised output floor which determines that the RWAs to calculate the CET1[6] (and other risk-weighted capital measures), may not be, at the end of the implementation period,[7] less than 72.5% of the total risk-weighted assets calculated using only the standardised approaches.

The use of more than one solvency metric is extremely important to reinforce the resilience of the banking institutions and the banking system. The capital adequacy assessment benefits to a large extent from the use of measures that are complementary between themselves, such as the leverage ratio and risk-weighted solvency measures (like the CET1). The CET1 ratio benefits from the granularity of risk assessment at the level of each exposure, mitigates the incentives for excessive risk taking (by distinguishing high-risk and low-risk assets), and provides incentives for better risk management by banking institutions. However, when non-standard methodologies are applied, it has the inconvenience of possibly leading to greater variability in the calculation of banks' portfolio risks resulting from the flexibility in the calibration and use of their internal models. The leverage ratio presents a number of benefits: it is simple and direct to calculate, it is easily comparable across institutions and jurisdictions, it is not affected by zero risk weights, it tends to be less pro-cyclical than the CET1 ratio, and in general terms, it prevents unjustified reductions in the risk weights. The use of an output floor allows some of the inconveniences of the CET1 ratio to be overcome, for example in terms of excessive variability of RWAs for similar exposures, excessively low RWAs or a horizontal imbalance that may exist when calculating capital requirements using the standardised approach versus internal models. It is therefore very important that the banking system's capital adequacy assessment is based on the complementary use of the leverage ratio and CET1 ratio, in line with the Basel III finalisation.

5. The leverage ratio corresponds to the ratio of Tier 1 capital (T1) to the measure of total exposure, including balance sheet assets and off-balance sheet items not weighted by risk.

6. The CET1 ratio is the Common Equity Tier 1 ratio; the Tier 1 ratio, as defined in the previous footnote, is the Additional Tier 1 ratio (thus including Additional Tier 1 capital, or AT1, in addition to the aforementioned Common Equity Tier 1). For a more complete definition, see for example, the special issue entitled "Interaction between minimum regulatory requirements and capital buffers", *Financial Stability Report*, Banco de Portugal, June 2020.

7. The December 2017 agreement defined 1 January 2022 as the implementation date for most of the changes set out in the Basel III finalisation. The only relevant exception is the implementation period for the output floor which would increase regularly from 50% on 1 January 2022 to 72.5% on 1 January 2027. More recently, on 27 March of this year, the Group of Central Bank Governors and Heads of Supervision (GHOS) postponed these dates for one year, in order to increase the banks' and supervisors' operational capacity to respond to the most immediate financial stability priorities resulting from the impact of the COVID-19 pandemic on the global banking system.

The European banking system is particularly sensitive to this review of the regulatory framework, that is, the *Basel III finalisation*. A recent study by the Basel Committee[8] suggests that, based on data as of June 2019, the Tier 1 capital requirements for European banks were expected to increase by about 17.3-18.2%, as a result of the full implementation of the Basel III finalisation compared to a small decrease in the Americas (-0.5%) and a moderate decrease in the rest of the world (-5.4%). The same study shows that at the end of June 2019 the leverage ratios were lower in Europe (5.1%) than in the Americas and the rest of the world (6.2% and 6.6%, respectively). In another recent study,[9] the European Banking Authority estimates that the average increase in minimum Tier 1 capital requirements is 23.6%[10], reaching 27.2% for the largest European institutions, the so-called G-SIIs (global systemically important institutions). The expected effect on the CET1 ratio is of a 2.8 p.p. decline in average terms (2.9 p.p. on average for the Tier 1 ratio and 3.5 p.p. for the total capital ratio).

The Portuguese banking system is one of the least sensitive to this additional requirement,[11] with an impact on minimum capital requirements of approximately 6-7%, thus below the estimates for Belgium, Spain and Italy (between 15% and 20%), for France, Ireland and the Netherlands (close to 25%), for Germany and Denmark (approximately 35%-40%) and for Sweden (about 50%). In practical terms, this result expresses the level of demand required by the Banco de Portugal to approve internal models as a result of the beginning of the implementation of Basel II in 2007[12]. This translates into a proportion of loans modelled by advanced models being clearly lower than in average European terms. The average risk weight (i.e. the ratio of the average density of risk-weighted assets to total assets) remained therefore above the European Union and euro area averages over the past fifteen years[13]. In this context, and contrary to the CET1 and Tier 1 ratios, in December 2019[14] the leverage ratios of the Portuguese banking system were higher (corresponding to greater solvency levels) than the European averages (7.7% versus 5.5%) and thus higher than in Austria, Belgium (6.5% and 7%), United Kingdom, France, Spain and Italy (5% to 6%), Germany,

8. BCBS (2020), "*Basel III Monitoring Report*", *Basel Committee on Banking Supervision*, April 2020. 174 banks were considered, including 30 G-SIBs (Global systemically important banks).

9. "*Basel III reforms – Impact study and key recommendations – macroeconomic assessment, credit valuation adjustment and market risk*", EBA, December 2019. 189 banks from 19 European Union countries were considered. For Portugal, 79% of total domestic assets were covered.

10. The sample distribution of this result is very informative: the 25th percentile is 0.0%, the median is +10.6%, the 75th percentile is +21.5%, the 95th percentile is +49.9%.

11. See chart 17, page 68 of the documents referred to in the footnote number 9.

12. The implementation in Portugal of Basel II began in 2007 with the transposition of CRD1.

13. See, for example, *Financial Stability Report*, Banco de Portugal, June 2020, and "Understanding the Basel III Leverage Ratio Requirement", Dina Batista and Sudipto Karmakar, Banco de Portugal Economic Studies, 2017.

14. See "*Spring 2020 EU-wide transparency exercise – Key statistics*", European Banking Authority, June 2020. 127 banks from 27 European Union countries were considered. Five Portuguese banks were included in this Study, covering 63% of country's total assets.

Denmark, Netherlands and Sweden (from 4.5% to 6%)[15].

4. The study by Santos, the second included in this issue of Banco de Portugal Economic Studies, provides a useful result in the context of using internal models. For the 2006-19 period, the author uses information from the Central Credit Register (CCR) referring to credit to non-financial corporations[16] and the in-house credit assessment system (Portuguese acronym: SIAC) developed by the Banco de Portugal to provide individual credit risk ratings to enterprises,[17] thus benefiting from an extremely rich combination of statistics. Explicitly taking advantage of the correlation between PD (probability of default) and LGD (loss given default), this study is a conceptual exercise that aims to determine the value that should be applied for downturn LGD (that is, LGD at a moment of economic recession), by calculating an add-on to be applied to forecast LGD. Despite the differences between the concepts employed in this study, which the author identifies, the value obtained for this add-on may be used as a reference in the context of the advanced IRB approach. The result of this conceptual study for this add-on – approximately 15 percentage points – corresponds precisely to the value defined by the European Banking Authority[18] as the minimum margin of 'conservatism' for the exceptional situation in which an institution that uses the advanced IRB does not have the conditions to model the aforementioned downturn LGD in any other way[19]. The study also presents estimates for alternative credit risk measures that assume similar values at end-points (2006 and 2019) and which assume the highest values in 2013, being therefore perfectly aligned with the economic cycle.

5. The third study in this issue of Banco de Portugal Economic Studies also requires some background. On 26 October 2011 a few months after the beginning of the financial assistance programme, the Banco de Portugal issued a press release stating the

15. The size of the Portuguese banking sector, expressed as a percentage of GDP, is well below the average one registered in the euro area, as it already happened at the moment of the implementation of Basel II. See, for instance, Financial Stability Report, Banco de Portugal, june 2020, and Séries Longas Setor Bancário Português 1990-2018, Esteves et all (2019), Banco de Portugal.

16. The Central Credit Register of the Banco de Portugal contains information on actual credit liabilities of natural or legal persons with the registered entities, as well as potential credit liabilities taking the form of irrevocable commitments. The CCR's main purpose is to provide a back-up service for the registered entities in their assessment of the risks attached to credit granting.

17. SIAC is a credit rating instrument made available by the Banco de Portugal that may be used by financial institutions that are eligible as counterparties for monetary policy operations and which select this system as a source of credit quality assessment for the Eurosystem's assets eligible as collateral. This system was approved by the Governing Council of the European Central Bank on 5 February 2016. SIAC may also be used for benchmarking banks' IRBs, to assess the credit risk of each financial institution's portfolio and, in general terms, to analyse financial stability.

18. See *Guidelines for the estimation of LGD appropriate for an economic downturn ('Downturn LGD estimation')*, European Banking Authority, 2019. These guidelines set out three types of downturn LGD calibration.

19. The guidelines of the European Banking Authority (see previous footnote) present three possible types of downturn LGD calibration: Type 1 - Downturn LGD calibration based on the impact observed; Type 2 - Downturn LGD calibration based on estimated impact; Type 3 - Downturn LGD calibration in the event of unavailability of the impact observed or estimated.

following: "Over the last few months, the rates of return offered by banks for deposits have been increasing gradually, particularly in some market segments. The Board of Directors of the Banco de Portugal believes that this movement in deposit rates entails increased risks for the institutions and ultimately for the financial system as a whole, and so has approved measures to reflect such practices in stricter own funds requirements for the institutions involved." This press release publicly presented the Banco de Portugal's action[20] to counter the possible undesired effects to the institutions and financial system as a whole, of excessively high rates of return that were being applied by some institutions. This measure, which consisted of a direct penalty applied to basic own funds based on the difference between the deposit rates practised and certain reference values, was subsequently adjusted and reinforced in April 2012, remaining in force until 31 December 2013.

The motivation for this prudential supervision measure of the Banco de Portugal was based on (i) the direct effect of high interest rates on the profitability of each institution and subsequent effects on solvency, and (ii) the indirect effect of this externality on overall profitability and solvency of the banking system and therefore, financial stability. This second reason, possibly the most interesting and innovative of this prudential measure, requires some background information from the time.

The profitability of the system was negative for the first time in 2011,[21] in a context of very unfavourable developments in the real economy and a directly ensuing increase in credit impairments. In parallel, the system was undergoing a necessary process of reinforcement of capital ratios that began in 2008 with the recommendation of a Tier 1 ratio greater than 8%[22] (from 30 September 2009), continued with the determination of a CET1 ratio greater than 9% (from 31 December 2011) and a CET1 ratio greater than 10% (from 31 December 2012). Thus, the principal motivation of the Banco de Portugal – the preservation of financial stability – was to discourage the practice of excessively high returns on deposits at individual level because they could unleash a large-scale increase in interest rates with potentially serious repercussions the financial system in an environment in which all efforts were concentrated on prioritising the reinforcement of institutions' solvency.

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20. The press release also stated: "Amendments to Notices of the Banco de Portugal No 6/2010 of 31 December 2010 and No 3/2011 of 17 May 2011 set forth a deduction from own funds relevant for the Core Tier 1 ratio calculation, regarding deposits with a rate of return above a certain threshold. The conditions for applying the deduction have been set out in Instruction 28/2011 of the Banco de Portugal, which will enter into force on 1 November 2011."

21. *The Long Series – Portuguese Banking Sector 1990-2018* documents this: net income for the system went from a surplus of €2.5 billion in 2010 to almost -€2 billion in 2011, thus beginning a relatively prolonged period of losses to the banking system.

22. This recommendation, issued in November 2008, was one of the first at European level of "more and better capital" which would be explicitly considered in the Larosière Report, presented in February 2009.

The Banco de Portugal's motivation was also naturally justified by microprudential considerations. The measure also aimed to prevent an additional fall in banks' profitability, through a contraction of net interest income as a result of an uncontrolled increase in the cost of deposits, in a context in which banks needed to create a stable base of resources and were unable to easily access the wholesale market. There was also the possibility that an excessive increase in rates of return on deposits might translate into an incentive for banks to invest in assets with greater return and therefore with a higher risk, with potentially negative effects on future solvency positions. Finally this measure contributed to a more stable deposit base for banks, by attenuating the movement of funds between institutions (with potentially destabilising effects in cases of large deposits).

The study by Esteves and Pinheiro has the merit of presenting a very comprehensive technical analysis of this measure – which will thus be registered for the future as a relatively original prudential policy case study – using the Banco de Portugal's database that was created to design and subsequently monitor the measure itself. As well as a very thorough description of its motivation, the authors provide the prevailing macroeconomic framework at the time, analyse it in comparison to other possible alternatives – namely that used, somewhat less successfully, in Spain – and illustrate through the empirical evidence presented the relative success in containing high interest rates, as the average market rates in addition to the sums deposited and earning (excessively) high interest rates fell significantly.

The Esteves and Pinheiro study also presents very convincing analytical evidence of another extremely relevant aspect: the increase in deposit interest rates was passing through to new lending rates, which might have contributed to reduce the amount of available credit even more, and thus deepen the economic recession.

6. The last study published in this issue of *Banco de Portugal Economic Studies*, now written by Pinheiro and Esteves, is a timely review of the literature on setting maximum limits on interest rates on deposits. The article presents a review of the economic literature on this topic and is thus related, albeit indirectly, with the application by the same authors to Portugal. The authors remind the readers that from 1953 there were maximum limits to interest rates on deposits in the United States, which became known as 'Regulation Q'. These limits were phased out between 1981 and 1986, except for the ban on the payment of interest on demand deposit accounts, which was surprisingly only revoked in 2010.

The authors present a very interesting review of the work of several economists including James Tobin and Milton Friedman, as much in terms of justifying 'Regulation Q' as in identifying the unintended indirect effects, on aspects such as the allocation of productive resources, the consequences for income distribution and the effects on monetary aggregates and therefore monetary policy and inflation. A second branch of the literature presented in the same review, yet perfectly autonomous from the first,

assesses the imposition of limits to interest rates on deposits as a prudential instrument.

Pinheiro and Esteves also present four problems, identified and discussed by those two currents of literature, which may result from the application of maximum limits to interest rates on deposits. In the first place, the imposition of maximum limits on rates of return on deposits may result in the allocation of savings to higher-risk financial products that generally lack a protection system similar to the deposit guarantee scheme; in the event of such a risk being underestimated, either because of unsuitable perception or incomplete information, it may lead them to making an inefficient decision on the allocation of agents' savings. In second place, the setting of maximum limits on rates of return on deposits may lead to a sort of 'cross-subsidisation' of these banking services at zero cost or low prices, with all the inherent risks of distorting competition and/or problems of informing bank customers. In third place, the disincentive to deposit money by the setting of maximum limits for return may condition or even limit loans granted for activities of economic value, should such a measure result in a shortage of funds that actively constrains credit granting. Finally, although no less important than the previous points, it may have an impact on income distribution, amplifying the effects that already exist due to the inequality in wealth distribution and the corresponding return on assets, by penalising more accessible savings options for small savers. These, due to their lower levels of financial sophistication and also the higher costs of access to alternative financial products, would have difficulty in directing their savings to assets with higher return.

The interest in Pinheiro and Esteves' review fully warrants, as I have tried to do through this editorial, an invitation to the *Banco de Portugal Economic Studies'* reader to explore this synopsis of the economic literature on the establishment of maximum limits to interest rates on deposits.

Non-technical summary

July 2020

The effect of corporate bond purchases by the ECB on firms' borrowing costs

Diana Bonfim, André Capela

Central banks have adopted a large set of unconventional monetary policy measures in the decade that followed the collapse of Lehman Brothers. Asset purchase programs, also known as quantitative easing, are among the most prominent. While the majority of assets purchased are sovereign bonds, the ECB also buys corporate euro area bonds through the Corporate Sector Purchase programme (CSPP).

In this article, we analyze the effect on corporate bond yields of the announcement of this program, in March 2016. Only bonds that meet a set of specific criteria defined by the ECB are eligible for the programme. This allows us to compare the evolution of corporate bond yields after the announcement of the programme for eligible and non-eligible issues.

The program might have had two simultaneous effects on bond yields. The *direct effect* is an expected decrease of the bond yields of the eligible securities, due to increased demand. At the same time, there could be an *indirect effect*, given that the yields of bonds that are not eligible might also have decreased. Given the relative small scale and lack of liquidity of the European corporate bond market, notably when compared to the US, investors might have increased their demand for non-eligible bonds, thus leading to this indirect effect.

To understand if these two effects were present and which of the two dominates, we collect data on European bonds for the period comprised between January 2016 and September 2017. This allows us to focus on the immediate effects of the announcement of the CSPP, but also to examine the behavior of bond yields for eligible and non-eligible issues in a longer horizon.

We find that bond yields generally decreased after the announcement of the CSPP, in March 2016. Once the Eurosystem actually started purchasing the bonds, in June, yields showed a further decrease.

This decrease was more pronounced for non-eligible bonds, what is consistent with a portfolio rebalancing effect towards riskier securities. This rebalancing was visible only for the countries at the core of the euro area sovereign debt crisis.

Corporate debt markets are heterogeneous within the euro area. Nevertheless, when we compare the effects for countries with large and small corporate debt markets, as a % of GDP, we find that this dimension is not relevant to determine the effects of the CSPP on corporate bond yields.

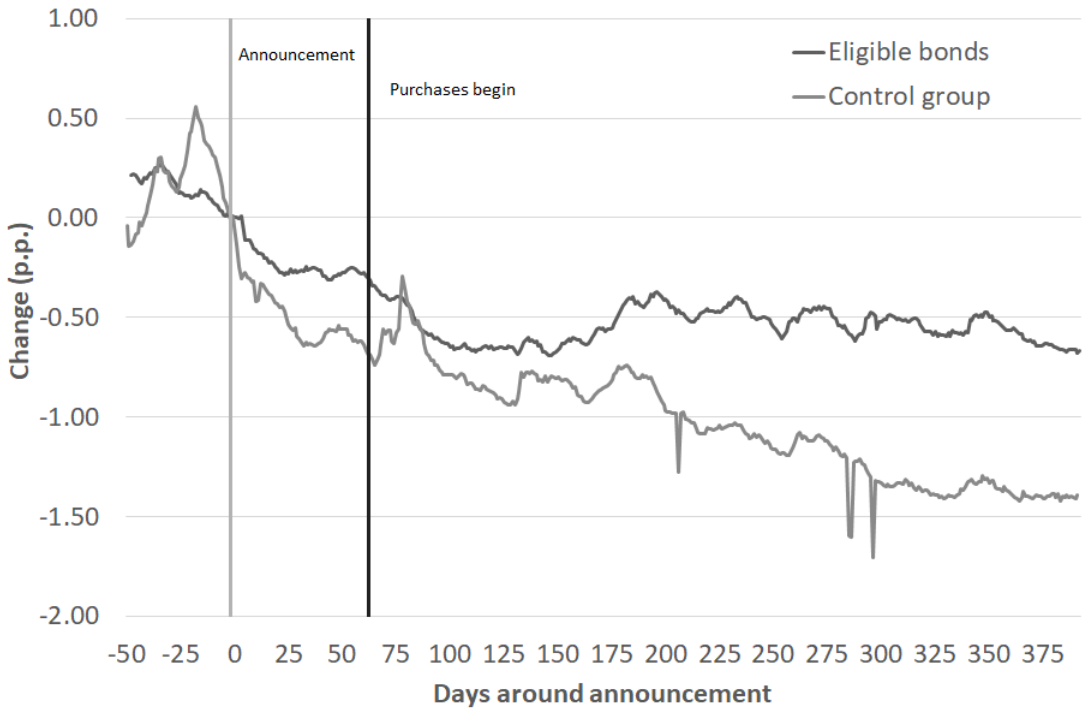

FIGURE 1: Change in bond yields

Notes: The figure depicts the cumulative change in corporate debt yields, with reference to the announcement date of the CSPP (10 March 2016). The purchases began on 8 June 2016. Eligible bonds are those that meet all the criteria defined by the Eurosystem. Bonds in the control group are those that meet all eligibility criteria except for the rating.

When we run the same exercise for Portuguese corporate bonds, the results are different. In this case, we find that the direct effect dominates, as the decrease of bond yields is steeper for the eligible bonds.

The effect of corporate bond purchases by the ECB on firms' borrowing costs

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July 2020

Abstract
One of the measures included in the quantitative easing policy adopted by the ECB was the purchase of corporate bonds. In this article, we analyze the announcement effects of the corporate sector purchase programme (CSPP). Only bonds that meet a set of criteria can be purchased by the Eurosystem. Using a difference-in-differences estimation, we compare the evolution of bond prices for eligible versus non-eligible corporate bonds. We confirm previous results for the euro area, showing that the decrease of the yields on non-eligible bonds was larger than on eligible ones. These results show that there were indirect effects stemming from the CSPP, which are consistent with a portfolio rebalancing mechanism. For the case of Portugal, the announcement had a more positive effect on CSPP-eligible securities. Despite the lower financing costs, eligible issuers in Portugal did not significantly change their issuance behavior. (JEL: E52, E58, G30)

1. Introduction

Throughout the decade that followed the collapse of Lehman Brothers, the European Central Bank (ECB) implemented a wide range of unconventional monetary policy measures to achieve its objectives. Quantitative easing measures were among the most prominent. By purchasing financial assets in the markets, central banks are able to promote price stability through mechanisms that do not rely only on the traditional transmission of monetary policy through banks. The purchase of sovereign bonds was possibly the most noteworthy (through the public sector purchase programme - PSPP), but the Eurosystem also purchased other financial assets, such as covered bonds (CBPP) or asset-backed securities (ABSPP).

In this article, we examine the announcement effects of one quantitative easing programme: the corporate sector purchase programme (CSPP). The CSPP – also known as the corporate Quantitative Easing (QE) – was designed to allow the ECB to lend money to corporations. The corporate QE, announced in March 2016, was a vehicle

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for the ECB to inject funds directly in the real economy through the purchase of non-financial corporate bonds. According to the Governing Council, the programme was designed to "provide further monetary policy accommodation and contribute to a return of inflation rates to levels below, but close to, 2% in the medium term".

Only bonds that meet a set of specific criteria defined by the ECB are eligible for the programme. This allows us to compare the evolution of corporate bond yields after the announcement of the programme for eligible and non-eligible issues. The programme might have had two simultaneous effects on bond yields. The *direct effect* is an expected decrease of the bond yields of the eligible securities (i.e., an increase in its price). Increased demand and enhanced liquidity both should contribute to this effect. But the programme might also have had an *indirect effect*. The yields of bonds that are not eligible might also have decreased. Given the relative small scale and lack of liquidity of the European corporate bond market, investors might have increased their demand for non-eligible bonds. This portfolio rebalancing behaviour may be reinforced due to the prevailing low interest rates and risk premia.

To understand if these two effects were present and which of the two dominates, we collect data on European bonds for the period comprised between January 2016 and September 2017. This allows us to focus on the immediate effects of the announcement of the CSPP, but also to examine the behavior of bond yields for eligible and non-eligible issues in a longer horizon. We follow an approach that is similar to recent papers on the same topic (Grosse-Rueschkamp, Steffen and Streitz, 2019, Arce, Gimeno and Mayordomo, 2017, and Abidi and Miquel-Flores, 2017), applying it also to the Portuguese corporate bond market.

The analysis is anchored on the comparison of bond yields for bonds that meet the eligibility criteria defined by the ECB (treatment group) and those that do not (control group). One important caveat of this comparison might be that bonds in the control group are very different from the eligible ones. To address this, we consider an alternative control group, where we include only bonds that meet all the criteria defined by the ECB with the exception of the credit rating.

We find that bond yields generally decreased after the announcement of the CSPP, in March 2016. Once the Eurosystem actually started purchasing the bonds, in June, yields showed a further decrease. When we compare the evolution of eligible and non-eligible bonds, we find that this decrease was more pronounced for the non-eligible bonds. This result holds for both definitions of the control group. The indirect effects of the programme thus seem to have been larger than the direct ones. This result can be explained by the portfolio rebalancing of investors. The accommodative monetary policy stance possibly encouraged investors to rebalance their portfolio asset allocation, in order to recapture the portfolio's original risk and return characteristics. To achieve that, investors need to purchase more risky assets (such as non-eligible CSPP securities). In this search for yield environment, investors try to compensate the lower returns they have on safer assets (which now include eligible CSPP securities) through risk-increasing portfolio shifts or through greater risk-taking on new investments.

When we run the same exercise for Portuguese corporate bonds, the results are substantially different. In this case, we find that the direct effect dominates. The decrease

of bond yields is steeper for the eligible bonds. Given the small size of the Portuguese corporate market, one possible explanation is that investors' portfolio rebalancing decisions are most likely not done within the portfolio of Portuguese corporate bonds, but within a larger pool of financial assets.

The remainder of study proceeds as follows. Section 2 describes the main features of the CSPP. In Section 3 we discuss the existing evidence on the literature on the corporate sector asset purchase programme. In Section 4 we proceed by describing the empirical strategy and the data used in the analysis. In Section 5 we present the results of our analysis for the euro area and, in Section 6, for Portugal. Section 7 summarizes our main findings.

2. The CSPP and the euro area corporate debt market

In the years following the failure of Lehman Brothers, central banks around the world adopted an unprecedented set of unconventional monetary policy measures to pursue their mandates. One of the measures adopted was the direct purchase of assets by the central banks, through quantitative easing programmes.

The Eurosystem started to purchase assets in specific categories during the euro area sovereign debt crisis, through the asset purchase programme (APP).[1] These included covered bonds (CBPP - covered bonds purchase programme) and asset-backed securities (ABSPP - asset-backed securities purchase programme). In March 2015 the Eurosystem started to buy euro-denominated investment-grade bonds issued by euro area governments, though only in secondary markets (PSPP - public sector purchase programme).

One year later, the ECB added another programme. In order to strengthen the transmission of monetary policy and the financing conditions of the real economy, on March 2016 the ECB announced the corporate sector purchase programme (CSPP).[2] This programme enables outright purchases of euro-denominated investment-grade bonds, in both primary and secondary markets, issued by euro area non-financial corporations. At the same time, the monthly purchases of EAPP were increased to 80 billion euros and a new set of targeted longer-term refinancing operations (TLTRO II) were announced.[3]

The bonds eligible for ECB purchases have to meet well-defined criteria:

1. For further details please see $https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html$.

2. The press release of this announcement may be found here $https://www.ecb.europa.eu/press/pr/date/2016/html/pr160310_2.en.html$

3. While these two announcements had significant effects on financial markets and, consequently, on corporate debt markets, they could only affect our results if eligible and non-eligible issuers are differentially affected by the EAPP or by the TLTRO II announcement. For the purchase of sovereign bonds, this hypothesis can be easily dismissed. In what concerns the TLTRO II, Arce, Gimeno and Mayordomo (2017) show that banks decrease lending to eligible firms, allowing them to lend more to non-eligible firms. However, these effects can only be assessed ex-post and should not have affected the relative evolution of bond yields of these two groups of firms immediately after the announcement.

- Eligible securities must be acceptable as collateral for monetary policy credit operations;
- Assets must be denominated in euros and purchases must be conducted at a yield-to-maturity (or yield-to-worst) above the deposit facility rate;[4]
- The location of incorporation of the issuer must be in the euro area. The issuer's ultimate parent location is not taken into consideration;
- The issuer or its parent company may not be a credit institution neither a public-undertaking;
- Bonds must have a minimum remaining maturity of 6 months and a maximum of 30 years and 364 days at the time of purchase;
- The issue must have a minimum credit rating assessment of BBB- or equivalent, provided by at least one of the four ECB recognized agencies, namely Fitch, Moody's Standard & Poor's and DBRS;
- There is no minimum issuance volume.[5]

The Eurosystem started to effectively purchase corporate securities on June 8, 2016. In order to help reduce market distortions and bond scarcity, from July 2016 onward all the bonds acquired by the Eurosystem were made available for securities lending purposes, thus contributing to an increase in market liquidity. From the inception of the programme until September 2017, the Eurosystem was holding 114,658 million of euros of the available universe of securities, 15% of which acquired in primary market purchases. By September 2017, the holdings of corporate debt securities under this programme represented 5% of all the assets purchased by the ECB under the APP.

The CSPP was designed to achieve the ECB's price stability goal. The transmission of monetary policy in the euro area was to some extent impaired during the euro area sovereign debt crisis and the purchase of corporate debt was a step towards ameliorating the workings of the transmission mechanisms. However, the programme might have played a broader role in shaping the financial system in the euro area. Banks play a much larger role than markets in the euro area. This is especially true when a comparison is made with the UK and, especially, with the US (Langfield and Pagano, 2016). The bank-biased structure is associated with greater systemic risk and worse growth performance and, although bank loans and bond financing are not perfect substitutes (Becker and Ivashina, 2014), the shift towards market funding could help reduce systemic consequences during times of crises. There is evidence that economic activity is more sensitive to asset price movements in bank-based systems than in market-based ones (Brunnermeier and Sannikov, 2012, Boissay, Colliard and Smets, 2016).

The CSPP, together with other initiatives at the European level (such as the Capital Markets Union), might have contributed to an increase in corporate bond financing in the euro area. The amount of net issues of corporate bonds in the euro area almost doubled between 2015 and 2017 (Figure 1). The countries where this increase was more

4. From September 2019 onward the deposit facility restriction does not apply;

5. These criteria can be found here: $https://eur-lex.europa.eu/eli/dec/2016/948/oj/eng$.

pronounced were at the core of the euro area sovereign debt crisis (Cyprus, Ireland, Greece and Spain). In Portugal, net issuances increased only slightly since the beginning of the CSPP.

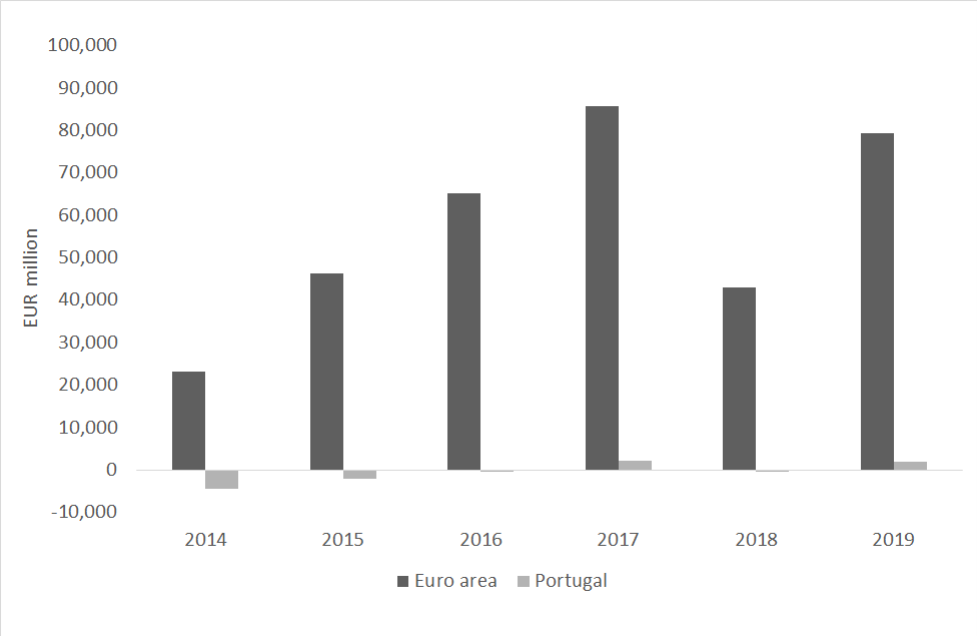

FIGURE 1: Net issues of corporate bonds
Source: ECB.

After the announcement of the CSPP, the increase in bond issuance documented in Figure 1 was accompanied by a significant decrease in bond yields. Figure 2 depicts the asset swap spread for the iBoxx Euro Non-Financials indices for several rating categories. The announcement of the CSPP on March 10, 2016 lead to a sizeable decrease in asset swap spreads.

The decrease was significant in all rating categories, suggesting that not only eligible bonds were affected. The spread between AAA and BBB indices tightened about 20 basis points (bps), from over 100 bps at the announcement date, to 80 bps at the effective starting date of CSPP (June 8, 2016). From this date onward, the spread tightened another 20 bps, to roughly 60 bps. The announcement effect on A-rated securities was not as impactful, as the spread between AAA and A-rated securities only decreased about 10 bps from the announcement date onward.

3. Related literature

The descriptive evidence presented above suggests that the CSPP might have been associated with more corporate bond issuance, at lower costs. These effects have been studied in depth in several recent papers. Grosse-Rueschkamp, Steffen and Streitz (2019) compare the eligible and non-eligible issuers and find that eligible firms move from loan to bond financing, reflecting the lower financing costs. Arce, Gimeno and

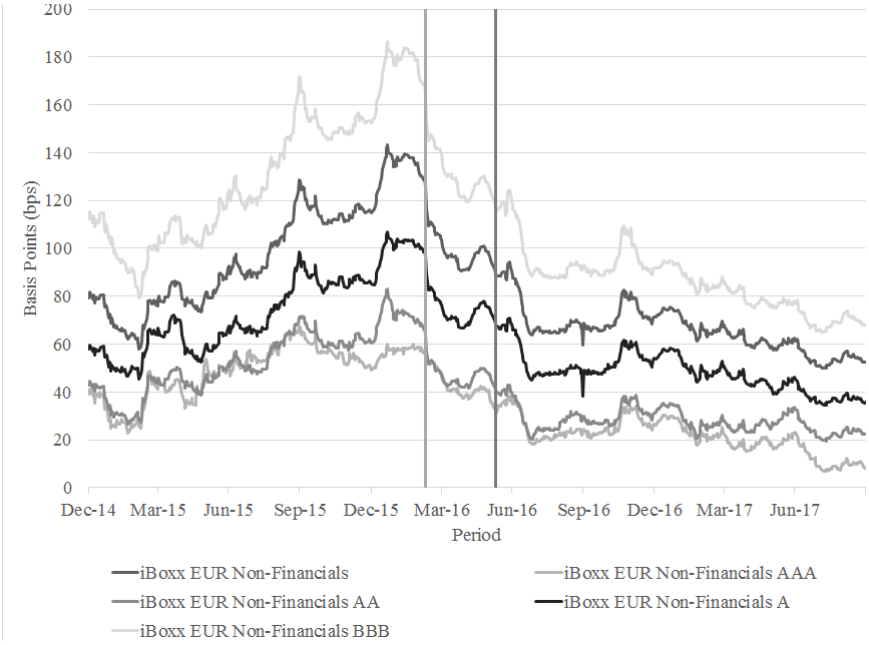

FIGURE 2: Asset swap spreads for euro area firms

Note: The figure shows the asset swap spread for the iBoxx indices. For each index, the asset swap spread is the weighted average of the asset swap spread of all constitutent bonds in the specific index. The asset swap spread of a bond is the difference between the yield of a bond and the Markit iBoxx swap curve. The two vertical lines represent the announcement date and the effective starting date of the programme.
Source: Refinitv.

Mayordomo (2017) analyze the combined effect of CSPP and Targeted Longer-Term Refinancing Operations (TLTROs) on Spanish non-financial firms and document a sizeable reallocation of credit towards smaller firms. They also find evidence that the CSPP announcement increased bond issuance by eligible firms. Abidi and Miquel-Flores (2017) find evidence of improved financial conditions for firms around the market eligibility thresholds. They consider that there might be a divergence between what is eligible for the ECB and market participants' risk assessment, especially around the investment grade threshold. Exploring this risk management divergence, they document a deterioration in CSPP-eligible bonds liquidity and, more importantly, larger drop in yields of non-eligible firms (which is consistent with the results we obtain in our analysis).

The effects of the CSPP may go beyond these direct and expected effects. One important issue to consider is that the CSPP might have lead to a liquidity squeeze in credit markets, due to bond scarcity. Even though the ECB tries to alleviate these concerns through securities lending, it cannot be ruled out that investors had incentives to shift to other (riskier) asset classes, in particular non-eligible non-financial corporate bonds (Vayanos and Villa, 2009; Hancock and Passmore, 2011; Arrata and Nguyen, 2017).

Another effect is that this scarcity possibly encouraged companies to issue more bonds, even if they are not eligible for the programme (Abidi and Miquel-Flores, 2017). This should contribute to an increase in liquidity in both primary and secondary

markets, with potential positive spillovers on firms' growth and performance through better financing conditions. Abidi and Miquel-Flores (2017) find that bond issuance is stronger for firms whose rating is close to the investment grade/non-investment grade frontier.

Finally, the CSPP might have improved access to bank loans. Given that the programme induces a shift from loan to bond financing by eligible firms, banks may redirect the funds that become available to other firms (Grosse-Rueschkamp, Steffen and Streitz, 2019). This means that small and medium enterprises (SMEs) and firms without access to the bond market might also have benefited indirectly from the CSPP (Arce, Gimeno and Mayordomo, 2017).

4. Empirical methodology and data

4.1. Methodology

To analyze the announcement effects of the CSPP, at the euro area level and in Portugal, we will compare the evolution of bond yields for eligible and non-eligible bonds after the announcement date. The eligible securities are defined as those that meet all the criteria outlined in Section 2. In general terms, all euro area bonds issued by non-financial corporations in euros that are accepted as collateral by the ECB, have a residual maturity of at least 6 months and have a rating of at least BBB- will belong to the treatment group.

The price reaction of these bonds will be compared with other euro area securities that do not meet the necessary criteria. The securities were selected from the universe of non-financial euro area securities available in Bloomberg, with a maturity date equal to or later than January 1, 2016.

We consider two control groups. The first one includes all the securities with price information downloaded from Bloomberg that do not meet at least one of the criteria defined by the ECB (control group 1). However, this broad control group includes bonds that may be too far from the eligibility threshold, undermining the comparability of the two groups. To mitigate these concerns, we consider a more restricted control group, where we include only bonds that fulfill all the criteria specified by the ECB with the exception of the rating (control group 2).

We estimate a difference-in-differences regression to capture the CSPP announcement effect on the yields of eligible bonds ($Eligible_{it}$), compared to those in the control group, after the announcement date ($Post_t$), such that:

$$Yield_{it} = \alpha_1 Eligible_{it} * Post_t + \alpha_2 Eligible_{it} + \alpha_3 Post_t + \beta X_{it} + \gamma j \quad (1)$$

$Eligible_{it}$ takes the value one for each bond i in the treatment group and $Post_t$ takes the value one from March 10, 2016 onward (and zero otherwise). We are interested in the coefficient α_1, which captures the differential behavior of eligible bonds after the announcement of the programme. X_{it} includes time-varying bond characteristics such as rating or tenor. We consider ratings as numerical values. We consider the best credit

rating awarded to a given security i by the four agencies approved by the ECB (S&P, Moody's, Fitch and DBRS) at time t. Tenor is defined as the days-to-maturity of security i at day t. Finally, γj refers to country fixed effects, that allow to control for time-invariant characteristics of the jurisdiction of the issuer.

4.2. Data and descriptive statistics

The data used in the analysis correspond to all non-financial European securities available in Bloomberg, with a maturity date equal to or later than January 1st, 2016. A total of 6,061 ISINs were extracted. The yields of the securities in the analysis were collected on a daily basis for a time frame between January 2016 and September 2017.

The yield-to-worst[6] and yield-to-maturity were both retrieved from Bloomberg and Refinitv databases. The sample was initially built with Bloomberg data, starting with the yield-to-worst. A few bonds bear some kind of optionality and the yield-to-maturity ignores these options and assumes that they will not be exercised. We prefer to use the yield-to-worst over the yield-to-maturity as it assumes the worst case scenario assumptions. Whenever yield-to-worst was missing, the yield-to-maturity for that bond was used. If there were any securities without any Bloomberg data for all sample days, Refinitv data was used also, giving preference to yield-to-worst over yield-to-maturity. Other bond characteristics such as credit rating, issuer, country of incorporation, maturity were retrieved from Bloomberg. Tenor was computed using the maturity date of each bond.

The dataset was created at the bond level rather than at the firm level, following the approach adopted by Abidi and Miquel-Flores (2017). We consider that the analysis at the bond level may deliver more accurate results on the announcement effects. Indeed, the eligibility criteria are defined at the bond rather than at the issuer level. For instance, firms without a rating may issue bonds that can still be eligible for the programme. [7] While previous papers have focused on firm eligibility to examine firm-level outcomes (Grosse-Rueschkamp, Steffen and Streitz, 2019, Arce, Gimeno and Mayordomo 2017), our focus on announcement effects on bond yields makes this bond-level analysis even more relevant.

For each ISIN we collected the credit rating assigned on each day by all the four agencies that the ECB considers eligible for criteria purposes (S&P, Moody's, Fitch and DBRS). On this issue we also depart from previous studies, which have relied on rating information only from one of the agencies. The only exception that we are aware of that considers the four rating agencies for all euro area bonds is again Abidi and Miquel-Flores (2017). Given that we collect daily ratings, we can define eligibility on a daily basis. A numerical scale was applied to ratings, ranging from 0 (not rated or missing) to 22 (AAA/Aaa). With these four rating vectors per ISIN for each day, a single rating

6. The yield-to-worst is defined as the lowest possible yield that can be received on a bond that does not default. This yield considers options associated to the bond, such as callability.

7. A firm that is not rated could still have bonds eligible for the programme if the bond is rated as investment grade or the issue is guaranteed by an eligible guarantor.

variable was created with the highest rating assigned on each day, as the ECB only requires that at least one agency-rating is investment grade.

To have a coherent sample, all securities that were registered outside the euro area were eliminated. All perpetual and convertible bonds were dropped from the sample, since the ECB does not accept these securities in the CSPP programme. From the initial 6,061 bonds, there are 4,765 left. This compares with 814 bonds used in Grosse-Rueschkamp, Steffen and Streitz (2019) and with 1,310 in Abidi and Miquel-Flores (2017).

To make sure that the results are not influenced by bonds with extreme prices, we winsorized bond yields. We considered that corporate bonds yields could not be lower than the historical minimum for German 10 year bonds (-0.86%) and we truncated the maximum at the 95th percentile.

Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	2.06	1.13	2.54	-0.86	16.57	1,203,095
Tenor	2,070	1,571	2,507	0	34,769	1,203,095
Credit Rating	B+/B1	BB+/Ba1	B-/B3	Not rated	AAA/Aaa	1,203,095

TABLE 1. Descriptive statistics of the full dataset

Note: This table reports the descriptive statistics for the key variables of the entire dataset for the period between January 2016 and September 2017. Tenor is reported in days.

Table 1 shows the descriptive statistics for the complete dataset. After the winsorization process described above, the average yield for corporate bonds is 2.06%. On average, bonds have a residual maturity of 5.7 years. The securities for which we collected information have, on average, a credit rating of B+/B1, which means that most of the rated bonds are below the investment grade threshold.

Eligible bonds						
Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	0.82	0.54	1.02	-0.40	15.04	547,700
Tenor	2,281	1,907	1,762	183	10,956	547,700
Credit rating	A-/A3	BBB+/Baa1	1.97	BBB-/Baa3	AAA/Aaa	547,700
Cum. yield change	-0.43	-0.50	0.23	-0.69	0.27	547,700

Control group 1 (all non-eligible bonds)						
Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	3.09	2.33	2.93	-0.86	16.57	655,395
Tenor	1,893	1,360	2,896	0	34,769	655,395
Credit rating	CCC-/Caa3	Not rated	5.40	Not rated	AAA/Aaa	655,395
Cum. yield change	-0.75	-0.79	0.42	-1.38	0.52	655,395

Control group 2 (bonds that meet all criteria except rating)						
Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	3.34	2.63	2.90	-0.40	16.57	566,707
Tenor	1,747	1,492	1,305	183	10,934	566,707
Credit rating	CC/Ca	Not rated	4.61	Not rated	BB+/Ba1	566,707
Cum. yield change	-0.84	-0.87	0.48	-1.71	0.56	566,707

TABLE 2. Descriptive statistics for the treatment and control bonds

Note: This table reports the descriptive statistics for the key variables of the eligible bonds and for the control groups for the period between January 2016 and September 2017. The first control group considers all non-eligible bonds. The second considers bonds that meet all eligibility criteria except for the credit rating.

Table 2 reports the descriptive statistics for the eligible bonds and for the two control groups used in the analysis. The yields on eligible bonds are, as expected, significantly lower than those of the bonds in the control groups. They are also less volatile. The higher creditworthiness of eligible bonds is also visible in their average rating. Actually, the median non-eligible bond does not have a rating. Eligible bonds also show longer average maturities. When we examine the cumulative change in bond yields since the announcement of the programme until September 2017, we find that the absolute decline in bond yields for eligible bonds was smaller than for bonds in the control groups. On average, eligible bonds showed a decrease in bond yields of 43 bps, which compares to an average decline of 75 bps for all the other bonds for which we have collected data. In the stricter control group, where we consider bonds that meet all the criteria except for the rating, bond yields decreased 84 bps. While the absolute decline was larger for non-eligible bonds, we should also note that these bonds have higher yields, on average. When we consider the relative change, we actually find that the yield on eligible bonds decreased 35.2%, compared to 35.1% in the broader control group and 32.6% in the stricter.

Figures 3 and 4 confirm that, in our sample, the indirect effects might have dominated the direct effects. The two figures show the change relative to the announcement date for a long window, starting 49 days before the announcement and going up to September 2017. Figure 3 shows the results for the broader control group, while Figure 4 considers the stricter control group. The main conclusion is the same: yields decreased more

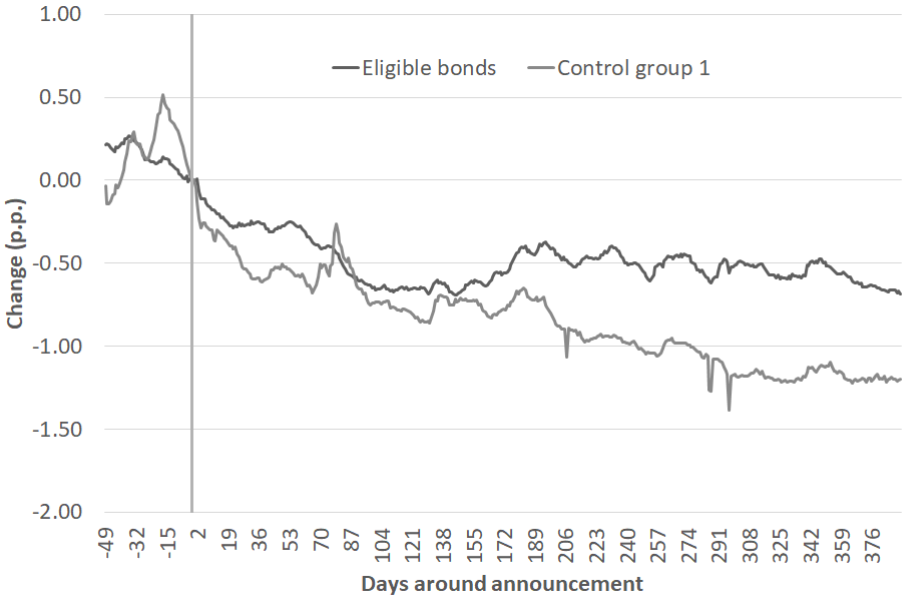

FIGURE 3: Change in bond yields

Note: Control group 1 refers to all non-eligible bonds in the sample.

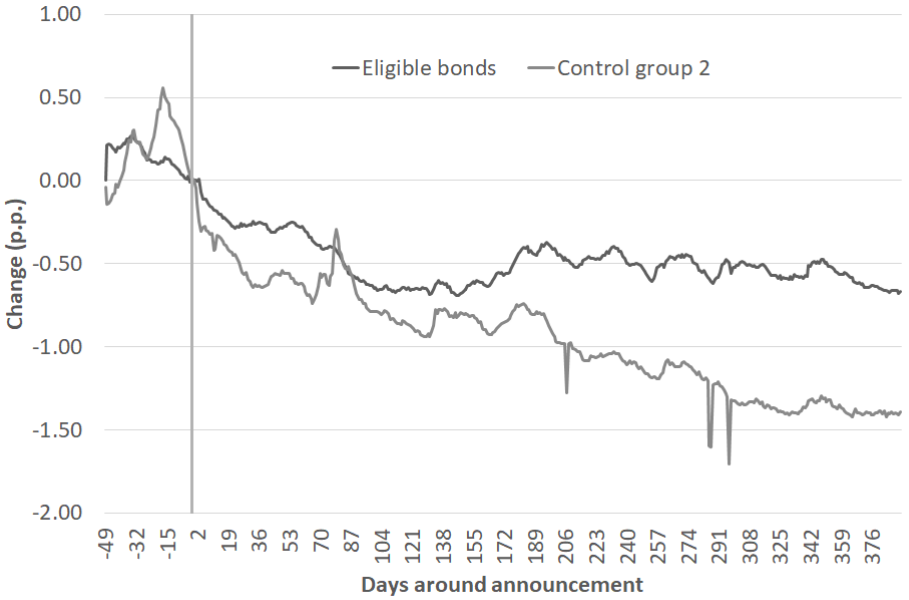

FIGURE 4: Change in bond yields

Note: Control group 2 refers to bonds that meet all the eligibility criteria except for the rating.

significantly for the bonds that are not eligible than for those that actually could be purchased by the Eurosystem. The effect is slightly more pronounced in the stricter control group.

The effect is visible immediately after the announcement and lasts until the end of the sample period. That said, it is important to mention that before the announcement of the CSPP programme, the bonds in the control group had shown a spike that was reversed in the days preceding the announcement.[8] This compromises the parallel trends assumption that is required for precise identification of treatment effects.

The change in bond yields was larger for the non-eligible bonds both immediately after the announcement as well as by the end of the sample period (September 2017). However, there is a period in between during which this difference is diluted. This happens roughly 60 trading days after the announcement and persists for a bit more than two weeks. This coincides with the effective start date of the programme. From June 8 onward, we see a steeper decline of bond yields that are eligible for the programme and, conversely, an increase of bond yields in the control group. This lasts until the end of June. This shows that once the Eurosystem starts purchasing bonds, the direct effect of programme dominates the indirect one, as the eligible bonds are the ones for which there are larger decrease in yields. However, that effect is not long-lasting and soon market participants begin to show again increased demand for non-eligible bonds.

It is also possible that this temporary change immediately after the purchases start reflects unmet demand of high quality corporate securities. Even though the programme was designed in a way that limited the purchases done by the Eurosystem so as to not affect market developments and ensure enough liquidity, the smaller scale and depth of the European corporate debt market might have challenged the stability of prices during a short period. Precisely to avoid the lack of high quality corporate bonds in the market, on July 18, 2016, the ECB added corporate bonds purchased through the CSPP to the securities lending initiative.[9]

5. Regression analysis

Using a difference-in-differences approach, we are able to provide further insights on the relative performance of eligible and non-eligible bonds after the announcement of the CSPP programme in March 2016. Table 3 reports the results of the estimation of equation 1.

8. This behavior could be related to some comments released by the press about which decisions the ECB would announce at its March 10, 2016 meeting, after in January of the same year, at an ECB meeting, Mario Draghi stated that "there are no technical limits" to the measures that could be used. On the days before the announcement date, there were a lot of jitters and presumptions from analyst and market commentators about the options that were on the table for the ECB and this could have been on the origin for the volatility seen in the yield change.

9. Through securities lending, the ECB temporarily transfers securities purchased in the APP to a borrower. In return, that borrower transfers other shares, bonds or cash to the ECB as collateral and pays a borrowing fee. The ECB does securities lending to make sure that financial markets continue to work smoothly, despite the large purchases being made. By lending securities to market participants, potential disruptions are avoided. Further details may be found here: *https* : *//www.ecb.europa.eu/mopo/implement/omt/lending/html/index.en.html*

Dependent variable: yield

	All bonds, full period				All bonds, [-30, 30]				Exclude non-rated, [-30, 30]				All bonds, without controls, [-30, 30]			
	Control group 1		Control group 2		Control group 1		Control group 2		Control group 1		Control group 2		Control group 1		Control group 2	
	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
Eligible*Post	0.59	***	0.60	***	0.20	***	0.25	***	0.62	***	0.79	***	0.21	***	0.25	***
	(16.08)		*(9.72)*		*(4.85)*		*(5.95)*		*(8.53)*		*(9.92)*		*(4.81)*		*(5.88)*	
Eligible	-2.00	***	-3.38	***	-2.51	***	-4.24	***	-1.14	***	-2.35	***	-2.84	***	-3.18	***
	-(15.98)		*-(20.25)*		*-(13.53)*		*-(19.66)*		*-(8.18)*		*-(12.12)*		*-(28.75)*		*-(30.73)*	
Post	-1.08	***	-1.09	***	-0.47	***	-0.51	***	-0.90	***	-1.06	***	-0.47	***	-0.52	***
	-(18.99)		*-(18.60)*		*-(11.79)*		*-(12.60)*		*-(12.65)*		*-(13.55)*		*-(11.74)*		*-(12.63)*	
Rating	-0.06	***	0.02		-0.03	**	0.08	***	-0.50	***	-0.40	***	-		-	
	-(7.54)		*(1.47)*		*-(2.24)*		*(4.98)*		*-(27.09)*		*-(18.34)*		-		-	
Tenor	0.0001	***	0.0003	***	0.0001	***	0.0003	***	0.0002	***	0.0004	***	-		-	
	(8.96)		*(13.79)*		*(5.95)*		*(9.82)*		*(7.75)*		*(18.38)*		-		-	
Constant	3.01	***	2.84	***	2.84	***	2.60	***	9.58	***	8.75	***	2.99	***	3.12	***
	(16.08)		*(14.30)*		*(13.21)*		*(11.45)*		*(32.01)*		*(30.64)*		*(14.32)*		*(14.31)*	
Country fixed effects	Y		Y		Y		Y		Y		Y		Y		Y	
Observations	1,203,095		1,114,407		155,731		146,795		104,942		99,034		155,731		146,795	

TABLE 3. Regression results for the euro area

Note: The table reports the results of the estimation of equation 1. All regressions include country fixed effects. T-statistics are reported in parenthesis. Columns 1 and 2 report the results for the entire sample period. Columns 3 and 4 report the results using the 30 days before and after the announcement of CSPP. Columns 5 and 6 exclude non-rated bonds from the control group. Columns 7 and 8 estimate the regression without controls. Control group 1 refers to all non-eligible bonds in the sample. Control group 2 includes bonds that meet all the criteria except for the rating. *** significant at 1%, ** significant at 5%, * significant at 10%

In the first column we report the results for the full sample period, using all available bonds in the control group. The results of the estimation confirm the graphical analysis: the yields on eligible bonds decreased less than those of non-eligible bonds after the announcement. After the announcement, the yields on eligible bonds decreased 59 bps less than those of non-eligible bonds, thus confirming that the indirect effects of the programme seem to dominate the direct ones. Even though eligible bonds have lower bond yields and all bonds showed a decrease after the announcement of the programme, this decrease was significantly more pronounced in the non-eligible bonds. This finding is aligned with the results of Abidi and Miquel-Flores (2017) and Gambetti and Musso (2017), who document the presence of the portfolio rebalancing effect and its importance for avoiding market distortions. Investors are pushed to "search for yield" after the CSPP announcement, increasing their demand for riskier, high-yield corporate bonds.[10]

We control for the rating and the maturity of each bond. Bonds with higher ratings have lower yields, which is consistent with the lower risk premia required by market participants on these bonds. Bonds with longer maturities have slightly larger yields, reflecting the positive slope of the yield curve. We also control for country fixed effects.

We consider several alternative specifications to challenge the validity of these results. In column 2 we run the same estimation, but now using the tighter definition of the control group. When we compare eligible bonds to bonds that meet all the necessary criteria except for the rating, we find that the effect is very similar (marginally larger in the tighter control group).

In the two regressions estimated so far we are using a relatively long period after the announcement, including data that goes until the end of September 2017. As shown in Figures 3 and 4, the relative evolution of yields of eligible and non-eligible bonds is not linear throughout the entire sample period. Furthermore, a long estimation window may bias the results due to confounding effects that may differentially affect eligible and non-eligible bonds throughout this period. To avoid these concerns, in columns 3 and 4 we report the results in a shorter time window. We consider the 30 days before and the 30 days after the announcement. In column 3 we consider the broader control group and in column 4 we consider the tighter one.

We find that the magnitude of the effect is smaller, but it goes in the same direction. The larger decrease for non-eligible bonds occurs immediately after the announcement. The larger coefficient for the full sample implies that this immediate effect is magnified as time goes by.

As shown in Tables 1 and 2, there are bonds that do not have ratings. As these bonds may have very different levels of credit risk, they might somehow affect the results. To be sure that is not the case, in columns 5 and 6 we estimate the regressions for the shorter time window of 60 days, for the two control groups, using only rated bonds. The

10. There is another possible explanation for the differences found between the reaction to the announcement of the CSPP of eligible and non-eligible bonds. The latter are typically more volatile, so price reactions may be exacerbated. That said, the differential effect seems to be long-lived and not concentrated only around the announcement date.

differential effect between eligible and non-eligible bonds actually becomes larger in this more comparable sample.

Finally, we estimate equation 1 excluding the variables $Rating$ and $Tenor$ from the regressions. Both variables are part of the eligibility criteria, as only investment grade bonds with a residual maturity of at least 6 months can be part of the programme. To make sure there is no collinearity, in columns 7 and 8 we run the regressions without these controls. The results on the post-announcement effects are broadly unchanged.

Summing up, the results consistently point towards the prevalence of an indirect effect, which may be explained by portfolio rebalancing strategies in a search for yield environment. One important question that remains unanswered is if these effects were visible across the entire euro area or only in some countries.

In Table 4 we report the results for the shorter estimation window for the countries that were more affected by the euro area sovereign debt crisis (Greece, Ireland, Italy, Portugal, and Spain - GIIPS) and the other ones, as these two groups of countries might have been differentially affected by the CSPP (Adelino, Ferreira, Giannetti, and Pires, 2020). The first two columns show the results for the former and the last two for the latter. We report the results for the broader control group in columns 1 and 3, and for the tighter control group in columns 2 and 4.

The results show that portfolio rebalancing was not seen across the entire euro area. Indeed, the indirect effects of the CSPP were only observable in the non-GIIPS countries. In the GIIPS countries, the CSPP lead to a decrease in bonds yields, but eligible and non-eligible bonds were not differentially affected in these countries.

There might also have been heterogeneity within the euro area due to the size (and liquidity) of corporate bond markets in each country. In Table 4 we also report the results for countries with smaller and larger corporate securities markets. We divide euro area countries in these two groups depending on whether non-financial corporate debt securities outstanding as a percentage of GDP where below or above the median when the CSPP was announced.[11]

We find that portfolio rebalancing effects were present in both groups of countries. The larger decline in yields for non-eligible bonds was seen both in countries with smaller and larger corporate debt markets, though the effects were marginally larger for the latter.

11. Countries with smaller corporate securities markets are: Lithuania, Greece, Latvia, Slovenia, Malta Ireland, Germany, Estonia, Slovakia). Countries with larger corporate securities markets are: Cyprus, Italy, Spain, Austria, Netherlands, Belgium, Portugal, Finland, France, Luxembourg).

Dependent variable: yield

	GIIPS All bonds, [-30, 30]				Non-GIIPS All bonds, [-30, 30]				Countries with smaller corporate securities markets All bonds, [-30, 30]				Countries with larger corporate securities markets All bonds, [-30, 30]			
	Control group 1		Control group 2		Control group 1		Control group 2		Control group 1		Control group 2		Control group 1		Control group 2	
	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
Eligible*Post	0.02		0.08		0.25	***	0.29	***	0.29	***	0.33	***	0.32	***	0.36	***
	(.24)		*(.85)*		*(5.26)*		*(6.23)*		*(4.48)*		*(4.88)*		*(9.60)*		*(10.23)*	
Eligible	-3.02	***	-4.30	***	-2.41	***	-4.23	***	-0.14	***	-0.14	*	-0.18	***	-0.17	***
	-(6.16)		*-(7.57)*		*-(12.06)*		*-(18.29)*		*-(2.61)*		*-(1.95)*		*-(5.47)*		*-(3.87)*	
Post	-0.33	***	-0.38	***	-0.50	***	-0.55	***	-0.53	***	-0.57	***	-0.61	***	-0.66	***
	-(3.56)		*-(4.10)*		*-(11.40)*		*-(12.06)*		*-(8.72)*		*-(8.92)*		*-(19.72)*		*-(19.65)*	
Rating	0.00		0.09	**	-0.04	**	0.07	***	0.00		0.00		0.00		0.00	
	(.06)		*(2.12)*		*-(2.52)*		*(4.51)*		*(.79)*		*(.26)*		*(.86)*		*(.03)*	
Tenor	0.0001	***	0.0002	***	0.0001	***	0.0003	***	0.0000	**	0.0000	**	0.0000	***	0.0000	***
	(3.46)		*(2.67)*		*(5.31)*		*(9.72)*		*-(2.25)*		*-(2.34)*		*-(2.58)*		*-(8.86)*	
Constant	3.99	***	3.91	***	2.86	***	2.61	***	0.20	***	0.25	***	0.29	***	0.34	***
	(14.58)		*(13.39)*		*(13.20)*		*(11.40)*		*(3.63)*		*(4.82)*		*(7.88)*		*(8.93)*	
Country fixed effects	Y		Y		Y		Y		Y		Y		Y		Y	
Observations	28,655		27,344		127,076		119,451		27,481		25,139		125,215		119,213	

TABLE 4. Regression results by country groups

Note: The table reports the results of the estimation of equation 1 for different groups of countries within the euro area. GIIPS are Greece, Italy, Ireland, Portugal and Spain. Columns 1 and 2 report the results for GIIPS and columns 3 and 4 for the remaining euroa area countries. Countries with smaller corporate securities markets are those with corporate debt securities outstanding as a percentage of GDP below the euro area median (Lithuania, Greece, Latvia, Slovenia, Malta Ireland, Germany, Estonia, Slovakia). Countries with larger corporate securities markets are those above the median (Cyprus, Italy, Spain, Austria, Netherlands, Belgium, Portugal, Finland, France, Luxembourg). Control group 1 refers to all non-eligible bonds in the sample. Control group 2 includes bonds that meet all the criteria except for the rating. All regressions include country fixed effects. *** significant at 1%, ** significant at 5%, * significant at 10%

For robustness purposes, we run an additional exercise at the euro area level. Instead of considering the level of bond yields as the dependent variable, we consider the change in bond yields. This allows to consider the magnitude of the change and not only the direction of the change in yields. In Table 5 we report the same set of specifications reported in Tables 3 and 4, but now using the change in yields as the dependent variable. For brevity, we report only the results using the tighter control group.

In all the specifications we obtain a positive coefficient on the interaction effect, as in Table 3. This result confirms that the yields on non-eligible bonds decreased more and faster than those of eligible bonds.

These results are broadly in line with those obtained by Abidi and Miquel-Flores (2017), who find that the impact on yields of non-eligible bonds is also greater than eligible bonds, thus meaning that the indirect effect of the CSPP dominates the direct one. This is consistent with portfolio rebalancing strategies, as the purchases conducted by the Eurosystem create a shortage of supply of some securities, potentially leading to scarcity in the market. This encourages investors to increase the demand for other (non-eligible), increasing their price and compressing their yields. The presence of this rebalancing effect is one of the most important factors in the transmission of quantitative monetary policy (also shown by Altavilla et al., 2015, and Gambetti and Musso, 2017, for the euro area, Joyce et al., 2011, for the UK and D'Amico et al., 2012, for the US). If the corporate purchase programme activity was distorting market functioning, the treatment group should have had a greater impact than the control group. However, according to Boermans and Keshkov (2018), and in line with portfolio rebalancing models, a distortion occurs when there is an impact on the dispersion of bond ownership with groups of investors being displaced asymmetrically due to the activity carried out by the central regulator.

Dependent variable: change in yields

	All bonds, full period (1)		All bonds, [-30, 30] (2)		Exclude non-rated, [-30, 30] (3)		All bonds, without controls, [-30, 30] (4)		All bonds, [-30, 30], GIIPS (5)		All bonds, non-GIIPS (6)	
Eligible*Post	0.52	***	0.36	***	1.06	***	0.36	***	0.20	***	0.40	***
	(7.49)		*(11.29)*		*(18.37)*		*(11.28)*		*(2.80)*		*(11.16)*	
Eligible	0.70	***	-0.17	***	-0.58	***	-0.17	***	-0.08		-0.19	***
	(7.85)		*-(4.36)*		*-(13.33)*		*-(8.43)*		*-(.98)*		*-(4.33)*	
Post	-1.15	***	-0.64	***	-1.34	***	-0.64	***	-0.52	***	-0.67	***
	-(24.32)		*-(21.57)*		*-(23.71)*		*-(21.55)*		*-(8.19)*		*-(20.02)*	
Rating	-0.06	***	0.00		0.01	***	-		0.00		0.00	
	-(9.10)		*(.18)*		*(3.77)*		-		*-(.10)*		*(.23)*	
Tenor	0.0000	**	0.0000	***	0.0000	***	-		0.0000	***	0.0000	***
	(2.30)		*-(9.01)*		*-(8.11)*		-		*-(3.13)*		*-(8.49)*	
Constant	0.46	***	0.32	***	0.51	***	0.28	***	0.24	***	0.34	***
	(7.49)		*(8.92)*		*(9.09)*		*(8.04)*		*(4.45)*		*(8.96)*	
Country fixed effects	Y		Y		Y		Y		Y		Y	
Observations	923,570		144,352		97,458		144,352		26,964		117,388	

TABLE 5. Regression results - change in yields

Note: The table reports the results of the estimation of equation 1, but considering as dependent variable the change in yields. All regressions include country fixed effects. Column 1 reports the results for the entire sample period. Column 2 reports the results using the 30 days before and after the announcement of CSPP. Column 3 excludes non-rated bonds from the control group. Column 4 estimates the regression without controls. Column 5 reports the estimates for the GIIPS countries and column 6 for the remaining countries. All the results refer to the second control group, which includes bonds that meet all the criteria except for the rating. *** significant at 1%, ** significant at 5%, * significant at 10%

6. The effects of the announcement of the CSPP in Portugal

While other authors have looked into announcement effects at the euro area level, there is no specific analysis on the effects on the Portuguese corporate debt market. In this section we replicate the analysis implemented in the previous one, but comparing only eligible versus non-eligible Portuguese bonds.

For the period under analysis (January 2016 to September 2017), only three corporations have bonds that are CSPP-eligible: Brisa, Energias de Portugal (EDP) and Redes Energéticas Nacionais (REN). Figure 1 shows the net issuance of Portuguese bonds. There was a small increase in 2017, which might have reflected the incentives provided by the CSPP, but it was apparently short-lived. During the sample period there were no new Portuguese CSPP-eligible issuers.[12]

Figure 5 shows the change of bond yields in the Portuguese corporate debt market after the annoucement of the CSPP programme. In this case, the situation is very different from that seen in the euro area. There was a steep decrease in the yields of eligible bonds, while the yield on other bonds remained broadly unchanged in the months following the announcement of the program. Figure 5 reports the results for the tighter control group, but they look similar when all non-eligible bonds are considered.

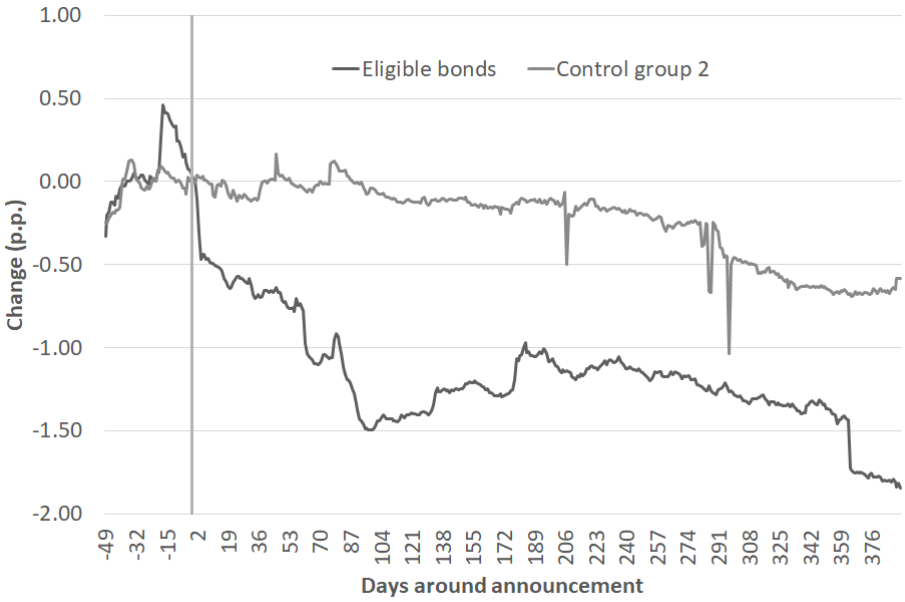

FIGURE 5: Change in bond yields in the Portuguese corporate debt market
Note: Control group 2 refers to bonds that meet all the eligibility criteria except for the rating.

In Table 6 we report summary statistics for Portuguese corporate bonds. Comparing the values for the entire sample of Portuguese bonds with those of the euro area, we find that Portuguese issues have, on average, higher yields, shorter maturities and lower

12. In 2018, Metropolitano de Lisboa and Nos SGPS also had eligible securities.

credit ratings. These differences also hold for the sub-sample of eligible bonds. However, when we compare the control groups, we find that the average bond yields of non-eligible bonds are smaller in Portugal than in the euro area. There is also less dispersion in Portuguese non-eligible bonds. This suggests that the non-eligible Portuguese bonds may be less risky than the euro area average, while the opposite holds for eligible firms. Another important difference, already illustrated in Figure 5, is that the drop in yields was larger for eligible than for non-eligible firms, unlike what was seen in the euro area.

All bonds						
Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	2.52	2.20	1.98	-0.83	16.50	27,590
Tenor	1,828	1,243	2,757	0	21,805	27,590
Credit rating	C/C	Not rated	CCC/Caa2	Not rated	BBB/Baa2	27,590

Eligible bonds						
Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	1.08	1.22	0.82	-0.23	3.90	3,134
Tenor	1,635	1,697	1,005	183	3,657	3,134
Credit rating	BBB/Baa2	BBB/Baa2	Not rated	BBB-/Baa3	BBB/Baa2	3,134
Cum. yield change	-1.07	-1.19	0.47	-1.84	0.46	3,134

Control group 1 (all non-eligible bonds)						
Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	2.70	2.42	2.01	-0.83	16.50	24,456
Tenor	1,853	1,204	2,906	0	21,805	24,456
Credit rating	D/C	Not rated	CC/Ca	Not rated	BBB/Baa2	24,456
Cum. yield change	-0.24	-0.20	0.20	-0.86	0.15	24,456

Control group 2 (bonds that meet all criteria except rating)						
Variable	Mean	Median	Std. Dev.	Min	Max	Observations
Yield	2.57	2.34	1.84	-0.40	16.50	22,269
Tenor	1,595	1,263	1,150	183	5,306	22,269
Credit rating	Not rated	Not rated	C/Ca	Not rated	BB+/Ba1	22,269
Cum. yield change	-0.26	-0.14	0.23	-1.03	0.17	22,269

TABLE 6. Descriptive statistics for the treatment and control bonds

Note: This table reports the descriptive statistics for the key variables of Portuguese corporate bonds for the period between January 2016 and September 2017. The first control group considers all non-eligible bonds. The second considers bonds that meet all eligibility criteria except for the credit rating.

We estimate the same regressions as in the previous section for the Portuguese corporate bond market. The results are reported in Table 7. In the first four columns we report the results using the bond yields as dependent variables (as in Table 3) and in the last four we use the cumulative change in bond yields (as in Table 5). For each dependent variable, we first consider the full period for the estimation (columns 1, 2, 5, and 6) and afterwards we focus on the shorter window around the announcement date (columns 3, 4, 7 and 8).

	Dependent variable: yield								Dependent variable: change in yields							
	All bonds, full period				All bonds, [-30, 30]				All bonds, full period				All bonds, [-30, 30]			
	Control group 1 (1)		Control group 2 (2)		Control group 1 (3)		Control group 2 (4)		Control group 1 (5)		Control group 2 (6)		Control group 1 (7)		Control group 2 (8)	
Eligible*Post	0.41		0.02		0.02		-0.14		-0.94	***	-1.02	***	-0.58	***	-0.60	***
	(.87)		*(.05)*		*(.06)*		*-(.48)*		*-(3.70)*		*-(4.10)*		*-(3.10)*		*-(3.17)*	
Eligible	-0.99		-2.06	***	-1.80	**	-2.02	***	0.02		-0.19		-0.01		-0.08	
	-(1.30)		*-(3.12)*		*-(2.28)*		*-(2.58)*		*(.08)*		*-(.81)*		*-(.08)*		*-(.41)*	
Post	-0.82	**	-0.56		-0.42	**	-0.29	*	-0.26		-0.19		-0.06		-0.04	
	-(2.54)		*-(1.58)*		*-(2.39)*		*-(1.67)*		*-(1.48)*		*-(1.17)*		*-(.59)*		*-(.37)*	
Rating	-0.07		0.04		0.00		0.03		0.00		0.02		0.01		0.02	
	-(1.34)		*(.90)*		*-(.07)*		*(.67)*		*-(.11)*		*(1.51)*		*(.96)*		*(1.49)*	
Tenor	0.0002	**	0.0004	**	0.0002	***	0.0003		-0.0001	***	0.0000		0.0000	***	0.0000	
	(2.54)		*(2.19)*		*(2.60)*		*(1.04)*		*-(4.71)*		*-(.15)*		*-(3.65)*		*-(.78)*	
Constant	3.21	***	2.35	***	3.14	***	2.68	***	0.19		-0.02		0.08		0.03	
	(8.00)		*(4.53)*		*(6.97)*		*(3.83)*		*(1.62)*		*-(.10)*		*(.86)*		*(.23)*	
Country fixed effects	N		N		N		N		N		N		N		N	
Observations	27,590		25,403		3,320		3,092		22,453		20,419		3,215		3,011	

TABLE 7. Regression results for Portugal

Note: The table reports the results of the estimation of equation 1 for Portuguese bonds. The regressions do not include country fixed effects. Columns 1 to 4 show the results when the dependent variable is the yield and columns 5 to 8 show the results for the cumulative change in yields. Columns 1-2 and 5-6 show the results for the full sample period and columns 3-4 and 7-8 show the results for a 60 days window centered on the announcement day. Columns 1, 3, 5, and 7 show the results for the broad control group and the remaining columns show the results for the tighter control group. *** significant at 1%, ** significant at 5%, * significant at 10%

The results are indeed very different from those observed for the entire euro area, in line with what was suggested by the descriptive analysis of the data. When we consider the effect on bond yields (columns 1 to 4), we find that even though there was a decline in bond yields, the eligible bonds were not differentially affected. In other words, the decrease in the yields of eligible bonds was not statistically different from that seen for the other Portuguese bonds.

When we consider the effect on the cumulative change in bond yields (columns 5 to 8), we find that the decrease in bond yields was actually larger for eligible than for non-eligible bonds after the announcement of the CSPP. The effect is stronger when we consider the tighter control group, which includes bonds that meet all the eligibility criteria except for the rating. This means that the direct effect is stronger than the indirect one. This goes in line with the finding that the results regarding the indirect effects are dominant only in the non-GIIPS countries (Table 4). In Portugal, a country that was in the eye of the storm during the euro area sovereign debt crisis, the indirect effects are not visible.

7. Conclusion

Through an extensive granular data collection, particularly at the credit rating level, our study provides new insights regarding the impact of the CSPP announcement. The analysis conducted confirms previous evidence of a general decrease in the cost of funding for non-financial corporations in the euro area. This decrease was more pronounced for non-eligible bonds, what is consistent with a portfolio rebalancing effect towards riskier securities. However, this rebalancing was visible only in the non-GIIPS countries of the euro area. Actually, in the Portuguese case we find that the decrease in bond yields was concentrated on the eligible bonds. The results also suggest that securities lending is crucial to avoid bond scarcity and to ensure that there is enough liquidity in the euro area corporate debt market.

Our analysis focuses only on the announcement effects of the CSPP on bond yields. However, the effects of the programme are certainly more general. The incentives for companies to issue more public debt in very advantageous market conditions significantly increased. This should have freed banks' resources, making them more willing to finance companies without access to bond markets (Arce, Gimeno and Mayordomo, 2017, Grosse-Rueschkamp, Steffen and Streitz, 2019). The generally lower funding costs and improved access to funding should also have contributed to positive real outcomes, for instance in terms of corporate investment and job creation.

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Non-technical summary

July 2020

The relation between PD and LGD: an application to a corporate loan portfolio

António R. dos Santos

Empirical evidence has shown a positive relation between default rates and loss given default rates. This article uses detail statistical information at the firm level to perform a conceptual exercise that, by integrating this positive relation relationship, provides reference values for the add-on to be applied to the long-run expected LGD. The exercise adopts the Frye-Jacobs LGD function within the Internal Ratings-Based (IRB) framework for the Portuguese banks' aggregate loan portfolio of non-financial corporations and estimates several one-period credit risk measures. These measures are then compared with the ones assuming a constant LGD, allowing to evaluate by how much credit risk can be underestimated when adopting the static assumption and the necessary add-on to the long-run expected LGD.

The results suggest that, except for very high LGD values, assuming a constant LGD leads to a significant underestimation of credit risk. This conclusion is in line with the Basel recommendation to use a downturn LGD instead of expected LGD to compensate for not explicitly modeling the PD/LGD relation. In the base case it is found that, in order to account for downturn conditions, expected LGD should have an add-on of approximately 15 percentage points - Figure 1. A sensitivity analysis for a wide range of expected LGD values shows that only for high values of expected LGD – values where there is not much more a lender could lose - the add-on should be below 10 pp. These results are in line with some of the applications found in the literature and survive a number of robustness tests.

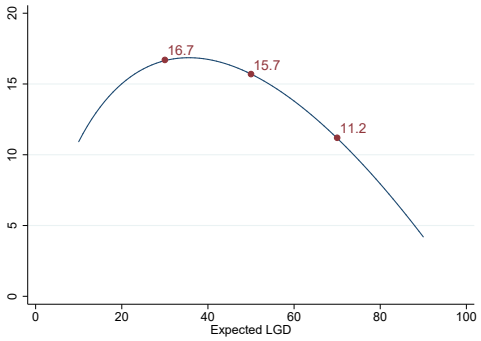

FIGURE 1: LGD add-on as a function of the expected LGD. Three expected LGD values are highlighted: 50% (base case), 30% and 70%.

The relation between PD and LGD: an application to a corporate loan portfolio

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Abstract
This article performs a conceptual credit risk exercise for the Portuguese banks' aggregate loan portfolio of non-financial corporations within the Basel IRB framework and that takes into account that default rates and loss given default rates vary together systematically. The article estimates the loss distribution and several credit risk metrics for each year between 2006 and 2019 using a one-year simulation-based single-factor model. The results suggest that, except for very high LGD values, assuming a constant LGD leads to a significant underestimation of credit risk. This conclusion is in line with the Basel recommendation to use a downturn LGD instead of expected LGD to compensate for not explicitly modeling the PD/LGD relation. In the base case it is found that, in order to account for downturn conditions, expected LGD should have an add-on of approximately 15 percentage points. A sensitivity analysis points to an add-on below 10 percentage points for only high levels of expected LGD. (JEL: G17, G21, G32)

1. Introduction

Credit risk is the risk of a loss that may occur from a borrower's failure to repay its debt. The likelihood of loss materialization is tied to the borrower's probability of default (PD) while the severity of loss in the event of default is accounted for the loss given default (LGD).

Empirical evidence has shown that default rates and loss given default rates vary together systematically (Frye 2000b; Düllmann and Trapp 2004; Altman *et al.* 2005). During economic downturns, defaults occur more frequently, assets decrease in value and recovery rates tend to be smaller. Failing to account for this relationship may lead to a significant underestimation of credit losses and necessary capital in adverse macro-economic conditions. Conventional portfolio credit risk models have focused on default risk, neglecting its relation with loss given default rates. These models treat LGD either as a constant parameter (Boston 1997: *Creditrisk+*) or as a stochastic variable independent of the probability of default (Wilson 1997: *CreditPortfolioView*; Gupton *et al.*

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1997: *CreditMetrics*; Crosbie and Bohn 2003: *PortfolioManager*). Assuming an infinitely granular portfolio, both assumptions lead to identical loss distributions regardless of the assumed distribution of individual LGD and are unable to integrate the relationship between PD and LGD.

Recent models try to address the PD/LGD relationship within the Merton (1974) structural model framework (see for example Frye 2000a; Pykhtin 2003; Tasche 2004; Giese 2005). These models provide distinct LGD specifications that arise from different premises on the functional form linking PD and LGD. However, due to rare default events, the calibration of these models is nontrivial. In addition, insufficient data undermine the ability of practitioners to distinguish between theories.

Frye and Jacobs Jr (2012) suggest an LGD function that expresses a moderate, positive relationship between default and loss given default rates using only parameters that are already part of regular credit loss models. Frye (2013) argues that risk managers can use this function to avoid introducing unnecessary parameters into their models and unneeded noise into their predictions. The author shows via simulation studies that this model works well under different scenarios and can be easily implemented for stress testing.

This article performs a conceptual exercise adopting the Frye-Jacobs LGD function within the Internal Ratings-Based (IRB) framework for the Portuguese banks' aggregate loan portfolio of non-financial corporations. The loss distribution and several one-period credit risk metrics are estimated for each year between 2006 and 2019 using a simulated-based single-factor model. These results are then compared with the ones assuming a constant LGD or a stochastic LGD independent from the PD and independent across borrowers. This exercise allows to evaluate by how much credit risk can be underestimated when adopting the static assumption and the necessary add-on to the expected LGD that reflects downturn conditions. The exercise benefits from a very rich dataset with information for PD and exposure at the firm level. The objective is to provide reference values for the add-on to be applied to the long-run expected LGD to obtain the downturn LGD and to help micro and macro-prudential authorities to have a complementary tool to assess credit risk for the banking system.

2. Methodology

This section is organized as follows. Section 2.1 presents the Asymptotic Single Risk Factor (ASRF) model, a methodologically framework that transforms unconditional PDs into conditional PDs which reflect adverse macroeconomic conditions. Section 2.2 describes the method and assumptions for the estimation of the Frye-Jacobs (FJ) LGD function. Finally, section 2.3 establishes how to generate the loss distribution trough Monte Carlo simulations using the ASRF model and the FJ LGD function. This section also shows how to compute different risk measures based on the loss distribution.

2.1. The Asymptotic Single Risk Factor (ASRF) model

The ASRF model (Vasicek 2002) assumes that the standardized asset return X of a firm i is a linear function of a single systematic risk factor, Y, and an idiosyncratic risk factor, ε_i:

$$X_i = \sqrt{r}Y + \sqrt{1-r}\varepsilon_i. \tag{1}$$

In the above equation Y and ε_i are assumed to be standard normally distributed random variables independent from each other. The systematic risk factor, Y, is unobservable and can be viewed as representing aggregate macroeconomic and financial conditions. The factor weight (or factor loading), $r \in [0,1]$, measures the sensitivity of asset returns to the risk factor. The higher the value of r, the more firms are exposed to the business cycle. This parameter introduces interdependency between defaults of any pair of firms by assuming correlation in asset returns. The correlation value equals the factor weight (r).

Based on the seminal work of Merton (1974) a default is triggered when a firm's assets value is less than debt value. That is, the default happens if the value of firm's standardized asset return, X, is below the threshold implied by the unconditional probability of default (PD) for that firm:

$$X_i \leq \Phi^{-1}(\mathrm{PD}_i), \tag{2}$$

where Φ denotes the cumulative distribution function for a standard normal random variable.[1] In this model framework the unconditional probability of default, PD, reflects expected default rates under normal business conditions. The conditional probability of default, cPD, is the probability that a firm defaults conditional on an aggregate macro-financial scenario, Y:

$$\mathrm{cPD}_i = P_r(X_i \leq \Phi^{-1}(\mathrm{PD}_i)|Y). \tag{3}$$

The intuition behind this specification is that the systematic risk factor serves to "scale up" or "scale down" the unconditional PD. Assuming an infinitely granular portfolio, i.e., the number of exposures tends to infinity and each exposure is of negligible size, and substituting equation (1) on equation (3) entails:

$$\begin{aligned} P_r(X_i \leq \Phi^{-1}(\mathrm{PD}_i)|Y) &= P_r(\sqrt{r}Y + \sqrt{1-r}\varepsilon_i \leq \Phi^{-1}(\mathrm{PD}_i)|Y) \\ &= P_r(\varepsilon_i \leq \frac{\Phi^{-1}(\mathrm{PD}_i) - \sqrt{r}Y}{\sqrt{1-r}}|Y) \\ &= \Phi(\frac{\Phi^{-1}(\mathrm{PD}_i) - \sqrt{r}Y}{\sqrt{1-r}}). \end{aligned} \tag{4}$$

1. Thus, Φ^{-1} denotes the inverse cumulative distribution function.

2.2. *The Frye-Jacobs LGD function*

The Frye-Jacobs LGD function connects the conditional LGD rate (cLGD) to the conditional default rate (cDR) under four assumptions.[2] The first assumption is that a greater rate of credit loss accompanies a greater rate of default. This assumption is much less restrictive than the common assumption that greater default rates and greater LGD rates go together. The technical assumption is that the asymptotic distributions of default and loss are comonotonic.[3] Loss and DR are comonotonic if and only if they are nondecreasing functions of the same random variable, Y. This implies that loss rate and default rate take the same quantile, q, within their respective distribution:

$$\mathrm{CDF}_{\mathrm{Loss}}[\mathrm{cLoss}] = \mathrm{CDF}_{\mathrm{DR}}[\mathrm{cDR}] = q, \tag{5}$$

where $\mathrm{CDF}_{\mathrm{Loss}}$ is the cumulative density function of the loss distribution and cLoss is a specific loss, conditional on an aggregate macro-financial scenario. Similarly, $\mathrm{CDF}_{\mathrm{DR}}$ is the cumulative density function of the default distribution and cDR is a specific default, conditional on the same aggregate macro-financial scenario. Since the loss rate is the product of default rate and loss given default rate, for any value of q, the cLGD rate equals the ratio of loss to default:

$$\mathrm{cLGD} = \frac{\mathrm{CDF}^{-1}_{\mathrm{Loss}}[q]}{\mathrm{CDF}^{-1}_{\mathrm{DR}}[q]} = \frac{\mathrm{CDF}^{-1}_{\mathrm{Loss}}[\mathrm{CDF}_{\mathrm{DR}}[\mathrm{cDR}]]}{\mathrm{cDR}}. \tag{6}$$

The model also assumes that both credit loss and default have two-parameter distributions. Within this type of distributions the model assumes the Vasicek distribution.[4] The final assumption is that the value of the factor loading, r, also applies to the loss distribution. Substituting the expressions for the Vasicek distribution into equation (6) produces the LGD function:

$$\mathrm{cLGD} = \frac{\Phi[\Phi^{-1}[\mathrm{cDR}] - \frac{\Phi^{-1}[\mathrm{PD}] - \Phi^{-1}[\mathrm{EL}]}{\sqrt{1-r}}]}{\mathrm{cDR}}, \tag{7}$$

which is fully determined by the unconditional probability of default, the factor loading and the expected loss. Thus, it only uses parameters that are already part of the standard model.

2. For a portfolio with homogeneous PDs and with equal size exposures, the cDR is equal to the cPD. For a portfolio with heterogeneous PDs and with different size exposures, the cDR is the weighted average of the cPD where the weight is the exposure of each firm in the portfolio.

3. The concept of comonotonicity has been showed to be a helpful tool for solving several research and practical problems in the domain of finance and insurance (see Deelstra *et al.* 2011).

4. Frye and Jacobs Jr (2012) recognize that this assumption is a matter of convenience since other distributions such as the Beta and the Lognormal distributions produce similar relationships but their implementation is not as practical.

2.3. *The loss distribution*

The loss distribution for a given portfolio can then be estimated through Monte Carlo simulations of the systematic factor. In each simulation/scenario, the loss, L, is the sum of the product of each firm i conditional probability of default, cPD_i, the exposure to firm i, EXP_i, and the conditional loss given default, cLGD:

$$L = \mathrm{cLGD} \cdot \sum_{i=1}^{N} \mathrm{cPD}_i \cdot \mathrm{EXP}_i \,. \tag{8}$$

Each Monte Carlo simulation can be seen as a scenario or state of the world. After simulating the common factor, the article calculates the conditional PD for each exposure and the average conditional PD of the portfolio. The latter is used to obtain the cLGD for the portfolio using equation 7.[5] Each scenario generates a particular loss for the portfolio. The frequency of various outcomes/losses after a large number of simulations generates the credit loss distribution. Figure 1 illustrates the process.

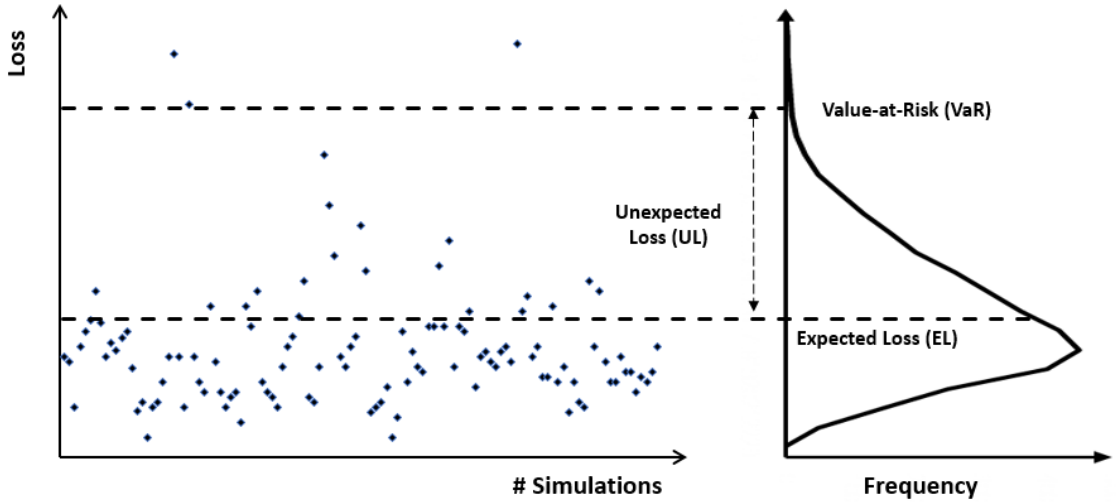


FIGURE 1: Credit Loss Distribution.

There are several risk measures that can be computed based on the portfolio loss distribution. The most commonly referred are the expected loss (EL), the value-at-risk (VaR), the unexpected loss (UL) and the expected shortfall (ES). The EL corresponds to the expected value of the portfolio loss L, which can be estimated as the mean of the simulated loss scenarios.[6] The VaR_p is the maximum possible loss if we exclude worse outcomes whose probability is less than $(1-p)\%$. The VaR is a quantile of the

5. The reasoning for this calculation relates with empirical evidence that there is a positive relation between default rates and loss given default rates at the aggregate level. Alternatively, one could use the conditional PD for each exposure to obtain the cLGD for each exposure. However, this approach would imply a positive relation between a firm's PD and LGD at the firm level.

6. The EL can also be estimated as PD $\times$ LGD $\times$ EXP. The EL estimation does not depend on the model used.

distribution. The UL_p is the difference between the VaR_p and the EL. We can interpret the unexpected loss as the capital required to sustain losses in $p\%$ of cases. In turn, the ES measures the average loss beyond a specified quantile, the expected loss on the portfolio in the worst $(1-p)\%$ of cases. Basel's internal ratings-based (IRB) approach is calibrated to a probability p of 99.9%, and this is the probability level used throughout the rest of this article.

3. Data and Calibration

This article uses a unique dataset with series for non-financial corporations (NFCs) operating in Portugal between 2006 and 2019. This dataset includes individual credit exposures from the central credit register (CRC) and one-year ahead probabilities of default available from Banco de Portugal in-house credit assessment – SIAC (*Sistema Interno de Avaliação de Crédito*).[7] The initial sample covers roughly the population of NFCs that have at least one loan granted by a resident financial institution. Nevertheless, only firms whose loans are considered to be performing are included in the analysis because only those are at risk of entering default in the next year. Thus, when a firm defaults at year t it is excluded from the analysis at $t+1$ and for as long as it is considered in default.[8]

The individual exposure observed in the last month of year $t-1$ is considered as the exposure of company i at year t. In this way, all credit risk measures for year t are estimated using only information available at year $t-1$ and, consequently, can be used as early warning indicators of credit risk. The factor weight, r, is calibrated for each firm through the function determined in the Basel Accord. r is a decreasing function of the PD bounded between 0.12 (highest possible PD) and 0.24 (lowest possible PD).[9]

The last parameter needed to estimate Frye-Jacobs function is the EL. Given that the probability of default is available in the dataset, this is equivalent to saying that the model calibration requires information about the expected LGD. However, due to scarcity of data and recovery timing discontinuity there is limited information about this number. As such, this article assumes the commonly used central value of 50% as a baseline scenario and performs a sensitivity analysis considering two alternative values: 30% and 70%. Finchetto *et al.* (2019) find an average loss given default rate close to 70% for Italian firms during the same period of this analysis, while the 30% is the symmetrical value w.r.t. to 50%. Moreover, the latter might be more in line with

7. See Antunes *et al.* (2016).

8. The default is at the level of the firm and not at the level of the loan. A firm is considered to be "in default" towards the financial system if it has 2.5 per cent or more of its total outstanding loans overdue. The "default event" occurs when the firm completes its third consecutive month in default.

9. All exposures are considered as exposures to corporate - Capital Requirements Regulation article 153. A sensitivity analysis was performed on this parameter and the results are quantitatively similar.

average rates for secured exposures in accordance with banks' own estimates within the regulatory framework.[10]

4. Results

For the purpose of this exercise, either a constant value or the one given by the Frye-Jacobs function is assumed for LGD. Both approaches use the ASRF model to incorporate default risk dependency between borrowers through a unique risk factor, but only the latter captures the link between loss given default and default rates. This section starts by analyzing the loss distribution for the Portuguese banks' aggregate loan portfolio of non-financial firms using the FJ function. The results are then compared with the ones assuming a constant LGD. Finally, a sensitivity analysis is performed on the baseline scenario for an expected loss given default of 50%.

Figure 2 shows the expected loss and the three tail credit risk measures – value-at-risk, unexpected loss and expected shortfall – at 99.9% between 2006 and 2019 using the FJ LGD function.[11] In order to allow for comparisons between different years, all credit risk measures are presented as a percentage of the total exposure. Santos and Silva (2019) perform a similar exercise and find that all measures display a common pattern: a continuous increase between 2006 and 2013, followed by a decline until 2017.[12] The results presented in Figure 2 corroborate their findings and reveal that the decline after 2013 continues until 2019, following the pattern of the business cycle. In 2019, the EL was approximately at the same level as in 2008, while the UL was close, but still higher, to the minimum value reported in 2006.

When assuming a constant LGD all three tail credit risk measures decrease. This result is implicit in the construction of FJ model and should be interpreted with caution. Still, there are two important metrics that emerge from this comparison: (i) the UL difference, which evaluates by how much credit risk can be underestimated when adopting the (constant) expected LGD; and (ii) the necessary add-on to expected LGD that would provide the same required capital under both assumptions. This second measure relates with the concept of downturn LGD discussed at the beginning of this article. Figure 3 (A) illustrates the two unexpected losses and Figure 3 (B)

10. Under the Foundation IRB Approach, institutions should use LGD with values of 45% for senior exposures without eligible collateral and 75% for subordinated exposures without eligible collateral. LGD for collateralized exposures depend on the type and level of collateralization, but are bound to the 'ceiling' value of 45%. Under the Advanced IRB Approach, LGD are provided by banks based on own estimates, with some flexibility in the choice of estimation methodology. Regardless of this choice, the estimates should be calibrated to the long-run average LGD and then have an add-on to reflect the impact of downturn conditions. In order to ensure a minimum level of conservatism and to address the problem of excessive variability in risk-weighted assets, BIS (2016) proposes applying floors on estimated LGDs: 25% for unsecured exposures and between 0% and 20% for secured exposures, depending on collateral type: 0% for financial collateral, 15% for receivables, 15% for commercial or residential real estate and 20% for other physical collateral.

11. Figure A.1 in Appendix A reports the loss distributions between 2006 and 2019.

12. The results for the tail credit risk measures are quantitatively different since the authors use a multi-factor model and calibrate the exercise using their own estimates for the factor loading.

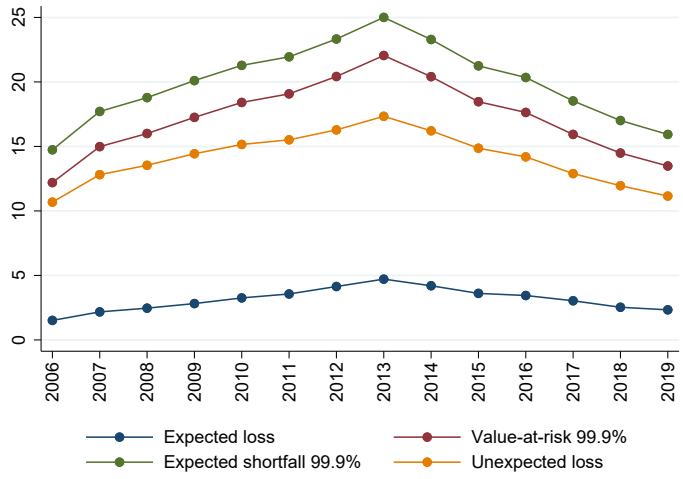


FIGURE 2: Credit risk measures as a percentage of the total exposure assuming the FJ LGD function.

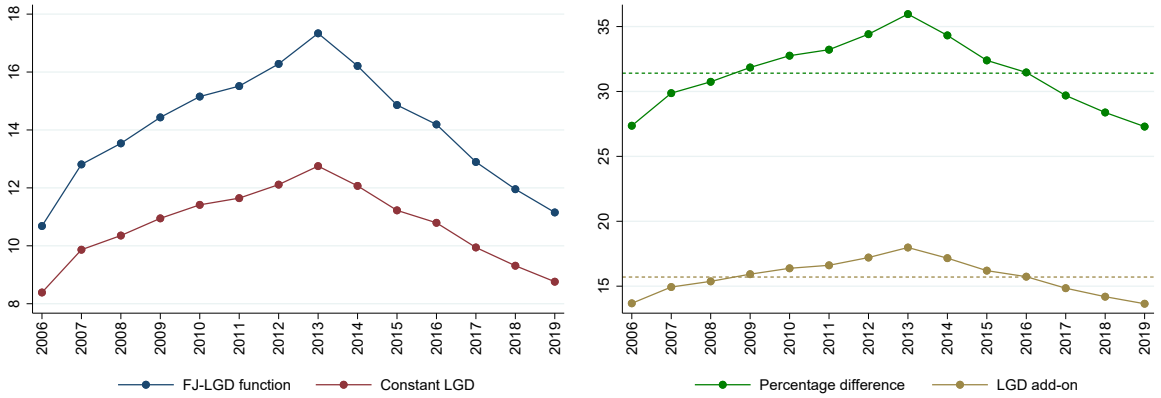
presents the percentage difference between the two measures, as well as the LGD add-on.[13] The results show that capital requirements would be underestimated by between approximately 27% to 36% under a constant LGD assumption. These numbers correspond to an add-on between 13.5 and 18 percentage points to the expected LGD. Both panels of Figure 3 also reveal a similar trend between the two metrics and the unexpected loss which indicate that the cyclicality of the tail credit risk measures is accentuated when accounting for the PD/LGD relation.

The period between 2006 and 2019 includes a full economic cycle with both an expansion and a recession. In this period the UL with the FJ LGD function is, on average, 31.4% higher than the UL under a constant LGD. This value corresponds to an average LGD add-on of 15.7 percentage points. The average value is chosen to produce a through-the-cycle measure in the spirit of the Basel framework. A through-the-cycle credit measure has a high degree of stability and smoothness which may potentially help stabilize the financial system since it creates capital during times of economic expansion that can then be utilized during economic downturns.[14]

The sensitivity analysis is performed using also the average value for each metric, as a trough-the-cycle measure. Figure 4 reports the sensitivity analysis for the base case of 50%, highlighting two alternative values for the expected LGD: 30% and 70%. Figure 4 (A) shows that the unexpected loss percentage difference is a decreasing and convex function of the average LGD. Intuitively, when the expected LGD is very high, there is not much more a lender could lose. The smaller the expected value, the greater the skew of the loss distribution. The corresponding necessary add-on to expected LGD is

13. The two metrics have a direct correspondence since the UL is proportional to the LGD values used in its calculation. This explains the identical behaviour of both series in Figure 3 (B).

14. A robustness check using through-the-cycle PDs produces the same average values for both metrics but shows less volatility throughout the years. These results corroborate the choice of averages as the benchmark values.

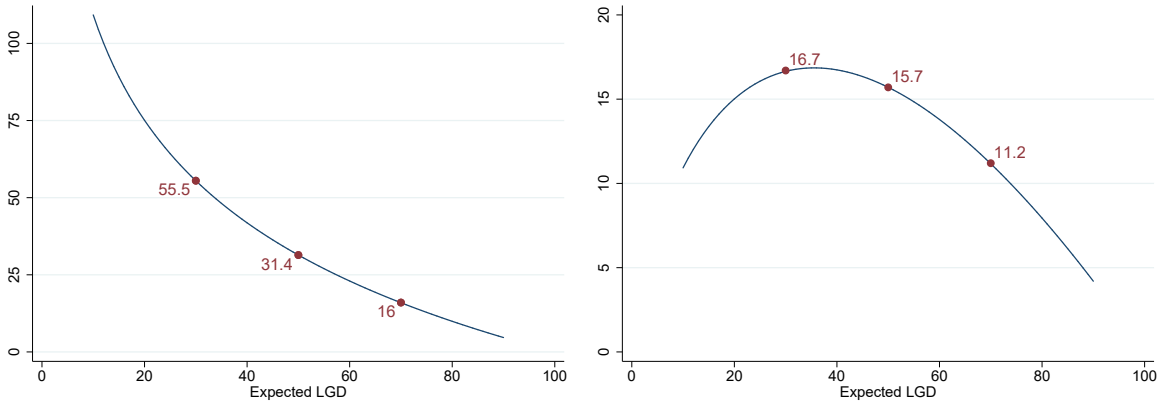


(A) UL as percentage of total exposure. (B) UL percentage difference and LGD add-on.

FIGURE 3: Unexpected Loss under FJ-LGD function *vis-à-vis* constant LGD.

reported in Figure 4 (B). Departing from 15.7 percentage points (pp) for the baseline scenario, the 30% expected LGD implies a slightly higher add-on of 16.7 pp while the 70% only translates into 11.2 pp. Even when expanding the sensitivity analysis to a wider range of values (10%–90%), one can observe that only a very high expected LGD would lead to an add-on below 10 pp. Thus, unless the average LGD computed by banks is very high, the downturn LGD used should be substantially above its expected value.

The results suggest that in order to account for downturn conditions the expected LGD should have an add-on of approximately 15 percentage points. This value is in line with some of the applications found in the literature. Frye (2000b) argues that LGDs might increase between 20 and 25 percentage points from their normal-year average. In addition, when integrating the PD/LGD relation, Miu and Ozdemir (2006) find that economic capital increases by 35%–45% in corporate loan portfolios and 16% for a middle-market portfolio, while Altman *et al.* (2001) claim that about 30% needs to be added.



(A) UL percentage difference. (B) LGD add-on in percentage points.

FIGURE 4: Sensitivity analysis for expected LGD. Both panels report average values for the period under analysis. Three expected LGD values are highlighted: 30%, 50% and 70%.

5. Downturn LGD in the IRB framework

The Asymptotic Single Risk Factor (ASRF) model used in the Advanced IRB-approach requires banks to estimate a loss given default. To compensate for not explicitly modeling the PD/LGD relation, Basel regulation requires the use of a downturn LGD.[15] But while banks estimate average PDs and use a supervisory mapping function to reflect economic-downturn conditions and transform them into conditional PDs, there is no explicit supervisory function to transform average LGDs into conditional/downturn LGDs. Recognizing "significant differences in practices" and "unwarranted variability in risk-weighted exposure amounts when own estimates of LGDs" are used, EBA (2019) published new technical standards that provide guidance on the types of approaches to be implemented, while still leaving flexibility with respect to the actual estimation methodology. Modeling downturn LGD is of utmost importance, as capital requirements are directly proportional to the LGD values used in the calculation.

This article obtains an estimate of 15 pp add-on to the expected LGD in order to reflect downturn conditions. This value could be used as a reference in the context of capital requirement regulation, regarding the Advanced IRB-approach. However, there are differences between some of the concepts used in this article and the ones defined by EBA: all exposures are considered as corporate[16]; the default is define at the level of the firm to the banking system and not at the level of the firm to the institution or, for firms classified as retail, at the level of the loan; probabilities of default are point-in-time and not though-the-cycle PDs; and the downturn LGD is computed using portfolio extreme losses while the regulatory downturn LGD should be computed using portfolio losses around significantly negative values for the systematic factor – possibly, not always, extreme. This conceptual exercise is applied to Portugal taking advantage of the extremely detailed statistical information covering roughly the population of NFCs. It is important to have in mind that the proportion of the loan portfolios using the Advanced IRB in Portugal is low, in European average terms, and was particularly low in the lowest phase of the economic cycle. But although the interpretation and applicability of this article's results should be interpreted with caution, they are in line with some of the applications found in the literature. Furthermore, according to EBA (2019) banks have to apply a minimum margin of conservatism (MoC) requirement of 15 percentage points on LGD estimates when using the type-3 approach, one of the three approaches proposed by EBA to estimate the downturn LGD.[17]

15. Since the implementation of Basel II, under Pillar 1 of bank capital regulation, banks can opt to either use a regulatory standardized approach to calculate credit risk capital requirements, or follow an Internal Ratings-Based (IRB) approach using their own estimated risk parameters. The IRB formula is based on the ASRF model. Portugal complies with the Credit Requirement Directive (CRD-V) and Capital Requirements Regulation (CRR II), a supervisory framework in the European Union that reflects the Basel rules.

16. It is not distinguished between SMEC, SMER, CORP e LCORP. Nevertheless, if considering all exposures as retail, the results would be similar, although slightly lower - on average, the results are approximately 2pp lower.

17. Type-1 approach calibrates downturn LGD based on the observed impact on losses of a particular downturn period; type-2 approach calibrates downturn LGD based on the estimated impact on losses

6. Conclusion

Empirical evidence has shown that default rates and loss given defaults rates are correlated. Therefore, the concept of downturn LGD in the Capital Requirements Regulation is of extreme importance to compensate for not explicitly modeling this relation. This is even more so given that capital requirements are proportional to the assumed value for LGD.

This article uses detail statistical information at the firm level to perform a conceptual exercise that, by integrating the PD/LGD relationship, provides reference values for the add-on to be applied to the long-run expected LGD. The exercise uses the Frye-Jacobs LGD function within the Basel IRB framework. This model may not be flexible enough to produce different shapes of PD/LGD correlation but, under certain assumptions, derives a relationship without any additional parameters. Due to scarcity of data, it is a parsimonious solution that attributes moderate LGD risk and works well under different scenarios. The results suggest that, except for very high figures, assuming a constant LGD leads to a significant underestimation of credit risk. In the base case it is concluded that in order to account for downturn conditions expected LGD should have an add-on of approximately 15 pp. A sensitivity analysis for a wide range of expected LGD values shows that only for high values of expected LGD – values where there is not much more a lender could lose - the add-on should be below 10 pp. These results are limited to the definition of some concepts and the parameters used but survive some robustness tests and are in line with some of the applications found in the literature.

using a limited set of methodologies; type-3 approach can be applied in rare cases, where neither type-1 nor type-2 approaches can be used. Only in exceptional cases can type-3 be approved by the Supervisory Authority since institutions should, under normal conditions, demonstrate the merits of approaches 1 and 2 when applying them.

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Appendix

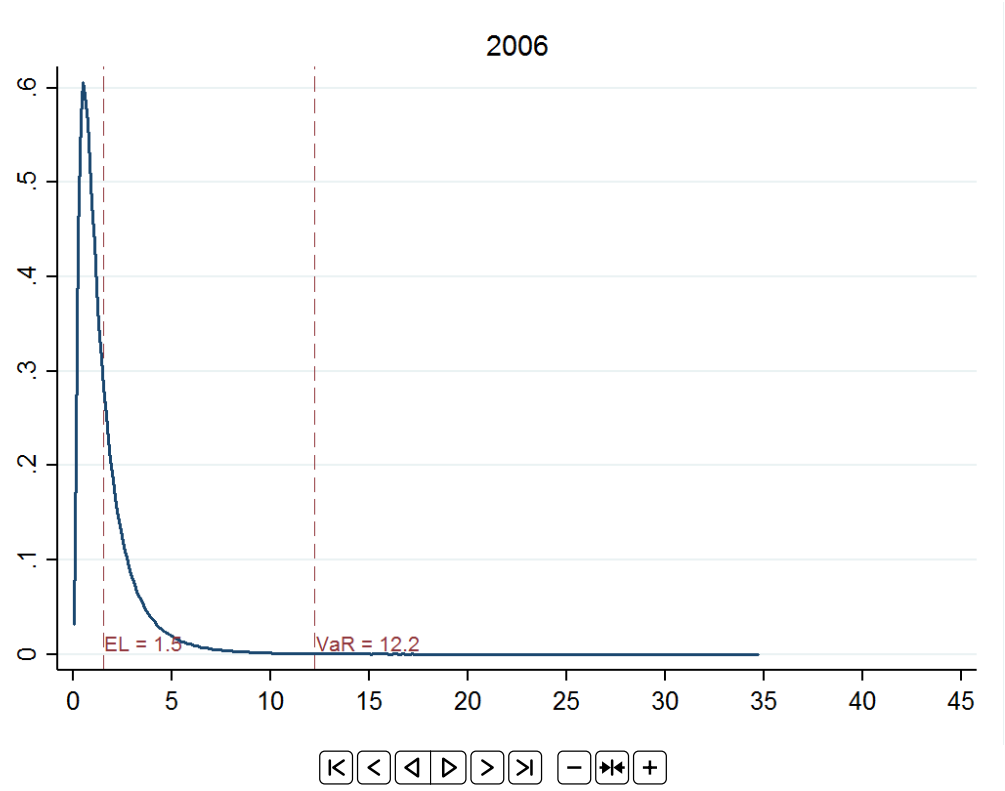

FIGURE A.1: Portfolio loss distribution as a percentage of the total exposure assuming the FJ LGD function for each year between 2006 and 2019. Results for 1,000,000 Monte Carlo simulations. **Dynamic Figure**: open the document as a PDF file.

Non-technical summary

July 2020

The capital surcharge on banks offering 'superdeposits': An early example of macroprudential policy measure in Portugal

Paulo Soares Esteves, Maximiano Pinheiro

This article describes and documents the context, the specification, and the effects of the capital surcharge imposed by Banco de Portugal in October 2011, and later adjusted and reinforced in April 2012, on banks offering superdeposits (i.e. deposits with a remuneration deemed excessive). The motivation for this measure was macroprudential, as it addressed a significant financial stability concern, although at the time the current institutional framework of macroprudential policy was not yet in place.

In 2011, Portuguese banks were aggressively trying to raise more funds through deposits, in a context of very unfavorable macroeconomic conditions. Excessive competition for deposits was amplifying bank losses by raising interest expenses. Furthermore, the higher deposit rates were passing-through to the loan rates, thus contributing to further deepen the recession and to increase the stress on the banking system. In the months following Banco de Portugal intervention, the amount of superdeposits started to decline (left side of the figure). For the Portuguese banking system as a whole, and taking into account that monthly contributions add to the deduction from own funds during a period of one year after the superdeposits were contracted by banks, the right side of figure provides our estimate of the amount of capital charge effectively imposed by Banco de Portugal. It peaked at €million 211 in September 2012. This is relevant for a banking sector that at the time was very pressed to substantially increase the capital ratios.

It is always hard to prove the existence of causality, and in the case under examination the Portuguese economy was experiencing changing conditions which may help in large part to explain the return of deposit rates to more normal levels. Indeed, at about the same time that Banco de Portugal decided to impose the capital surcharge, money market interest rates began to decline and the ECB considerably widened the eligibility of assets accepted as collateral for its refinancing operations. Moreover, by end-2011 there were negotiations between the troika, the Portuguese government and some of the largest banking groups for the public recapitalization of the latter, which eventually took place in June 2012 and January 2013 and undoubtedly also eased liquidity concerns of those banks. Nevertheless, the evidence discussed in the paper, based both on macroeconomic data and on microdata on individual deposits collected from banks for monitoring purposes, suggests that the imposition of the capital surcharge contributed to contain the war for deposits amongst Portuguese banks.

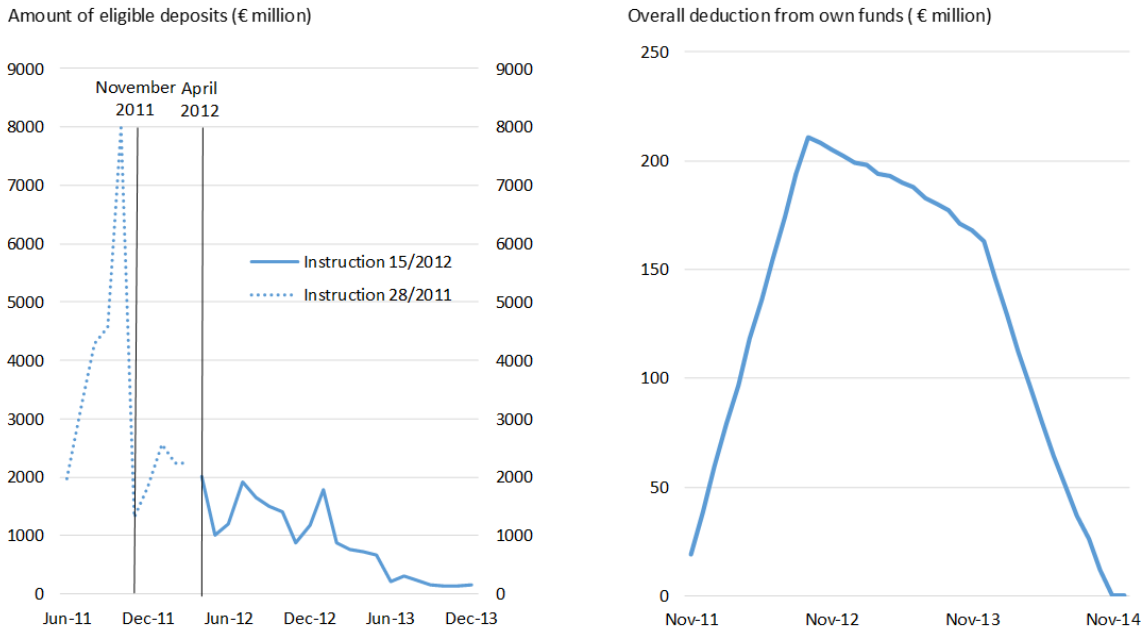

FIGURE 1: Eligible deposits and overall deductions from own funds

Note: Amounts weighted by maturities, excluding branches of banks incorporated in other EU member states.

As to the concrete specification of the policy measure, directly penalizing the own funds of banks offering superdeposits was considered preferable to raising the associated contributions to the deposit insurance fund, as in Spain, in particular because directly penalizing banks' own funds did not exempt deposits above €100,000 from the penalty.

It is worth emphasizing that the very particular and problematic circumstances under which the capital surcharge was applied impeded the materialization of the risks reported in the economic and financial literature as being potentially associated with policy measures controlling deposit rates.

It is often argued by critics of deposit rates ceilings that, while preventing destructive competition amongst banks for deposits, they facilitate cartel behavior and may result from the capture of the regulator by bankers who use the ban on competition to serve their private interest. In general terms, these critics may have a point but in Portugal in the years 2011-2012 banks were sorely pressed by the deep recession affecting the economy, the dire state of the public finances and the contraction in international capital inflows. This highly stressing situation was not the environment for a bank cartel to extract rents from a policy measure which restraints competition in the deposit market.

Another criticism of deposit rate controls is that they muddy the waters for monetary policy-making. There is merit in the argument for a country with its own currency. However, Portugal being a small economy participating in a vast area with common currency and monetary policy, the argument seems to be irrelevant.

More relevant are the warnings about the potential reduction of deposits in the presence of interest rates significantly constrained by ceilings when close substitutes

to deposits are available. This 'leakage' of deposits may be serious and put pressure on bank liquidity. Again, due to the specific economic conditions at the time and the consequential heightened risk perception and aversion by Portuguese households and companies, the imposition of the capital surcharge on banks offering superdeposits did not lead to an overall reduction of deposits, in spite of the occasional episodes of savings flowing out from deposits to securities of under-perceived riskiness (e.g. investments promoted by the banks on their own equity or debt, or on securities issues by related parties).

Finally, a criticism raised in the literature against deposit rate ceilings is that these controls may have undesirable allocative and distributive consequences. According to this criticism, deposit rate ceilings may discriminate against the small savers who cannot earn market interest rates from their savings, being impeded by the significant minimum denominations of market instruments and by their own unfamiliarity and ignorance on the functioning of capital markets. This is particularly true when the ceilings or the penalty only apply to deposits below a given amount, but as mentioned, in the period when the capital surcharge on banks was in force in Portugal, it was being applied both to small and large depositors, and there were no worthy investment alternatives to them. Therefore, the concern about its distributive consequences was rather muted.

The capital surcharge on banks offering 'superdeposits': An early example of macroprudential policy measure in Portugal

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Abstract
In October 2011, Banco de Portugal imposed a capital surcharge on banks offering 'superdeposits', i.e. deposits with a remuneration deemed excessive. This policy measure was later adjusted and reinforced in April 2012. Its motivation was macroprudential in nature, addressing a significant financial stability concern. It was an early example of such type of measures in Portugal, before the current institutional framework of macroprudential policy was in place. At the time, Portuguese banks were aggressively trying to increase their funding through deposits, in a context of very unfavorable macroeconomic conditions and the associated materialization of credit risk. Excessive competition for deposits was amplifying bank losses by raising interest expenses and thereby increasing the risks to the stability of the Portuguese banking system. Furthermore, the higher deposit rates were passing-through to the loan rates, thus contributing to further deepen the recession. The available evidence discussed in the paper, based both on macroeconomic data and on microdata on individual deposits collected from banks for monitoring purposes, suggests that the imposition of the capital surcharge contributed to contain the war for deposits amongst Portuguese banks. (JEL: G21, G28)

1. Introduction

Macroprudential policies address risks and vulnerabilities which relate to the whole or significant parts of the financial system rather than to individual financial institutions. According to Clement (2010), the term 'macroprudential' goes back to the late 1970s but became widely used only after the global financial crisis in 2007-8. The Basel III Accord, signed in November 2010 by bank regulatory agencies from major industrialized countries, acknowledged the need to mitigate systemic risk whose materialization so strongly impacted the financial system during the acute period of the crisis (and again during the subsequent sovereign debt

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crisis in several European Union – EU – member states). The terms of the Accord were transposed into EU law in 2013, by the Capital Requirements Directive (CRD IV)[1] and the Capital Requirements Regulation (CRR)[2] , and included some provisions which reflect a macroprudential approach to banking regulation, e.g. new liquidity requirements and counter-cyclical and other capital buffers.[3] The CRD IV also required member states to formally set up a 'designated authority' for macroprudential policy. The European System Risk Board (ESRB), with operations supported by the European Central Bank (ECB), was established in December 2010 and given a coordination role of macroprudential policies carried out by the national designated authorities and by the ECB, with little direct enforcement power.[4] Although the initiative to implement macroprudential measures remains primarily with national authorities, since 2014 the ECB also plays a role in macroprudential policy for the European Banking Union, according to the Single Supervisory Mechanism Regulation.[5]

In October 2011, before this transformation of the European banking regulatory framework took place, before Banco de Portugal was formally designated as the Portuguese macroprudential authority,[6] and a few months following the agreement on the Financial Assistance Programme requested by the Portuguese authorities to the EU and the International Monetary Fund (IMF), Banco de Portugal decided to impose a capital surcharge, in the form of a deduction from own funds, on banks raising deposits bearing interest deemed excessive. This measure had not been foreseen in the Programme and had a clear macroprudential motivation,[7] because it addressed a financial stability risk which was becoming very significant. In this paper, we discuss and assess this policy measure.

At the time, Portuguese banks were aggressively trying to increase their funding through deposits, in a context of very unfavorable macroeconomic conditions and the associated materialization of credit risk. Excessive competition for deposits was amplifying bank losses by raising interest expenses. Furthermore, the higher deposit rates were passing-through to the loan rates, thus contributing to further deepen the recession.

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1. Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013.

2. Regulation (EU) 575/2013 of the European Parliament and of the Council of 26 June 2013.

3. Some provisions are not yet in force due to transitional periods and the still ongoing process of preparation and approval of implementing legislation.

4. The ESRB was established by Regulation (EU) 1092/2010 of the European Parliament and of the Council of 24 November 2010, following a recommendation of the 'Larosière Report'. In response to the global financial crisis, this report was prepared by a High Level Group, chaired by Jacques de Larosière and tasked by the European Commission to consider how financial supervision could be strengthened.

5. Council Regulation (EU) 1024/2013 of 15 October 2013. This Regulation gives the ECB the power to tighten (but not to scale down) certain macroprudential measures implemented by the national authorities.

6. Banco de Portugal was designated the Portuguese macroprudential authority by Decree-Law 142/2013 of 18 October 2013, which amended the central bank statute for that purpose (Articles 12(c) and 16-A), following the ESRB Recommendation ESRB/2011/3 of 22 December 2011 (published in the Official Journal of the European Union on 14 February 2012).

7. Although at the time Banco de Portugal did not use the term 'macroprudential' when referring to it.

In the following sections of the paper, we will look into specific issues and details related to the enforcement and effectiveness of this macroprudential policy measure. We will start in section 2 by discussing the evolution of deposit interest rates in Portugal in 2011-12 as well as the relevant macroeconomic and financial context for that evolution. In section 3, we will provide some historical background on deposit rate controls in Portugal. In section 4, we will give a brief account of the measure taken by the Spanish authorities in June 2011, also to discourage high deposit rates, which preceded by some months the capital surcharge imposed by Banco de Portugal and undoubtedly served as an inspiration for it. Section 5 will present in more detail the measures taken by Banco de Portugal in 2011 and 2012. Section 6 is based on the microdata collected from banks for monitoring purposes on the individual deposits which were contributing to the deduction from banks' own funds (for the ease of exposition, hereafter we will refer to them as 'superdeposits'). We will make use of this data set to characterize the scope and evolution of superdeposits. Finally, in section 7 we will make some concluding remarks.

2. Deposit rates and macroeconomic and financial background in 2011-12

After a steady decline of deposit interest rates since the beginning of the financial crisis in 2008, most of the previous decrease was reverted during the second half of 2010 and in 2011. From values close to 1.4% in 2010Q2, interest rates of new deposit operations jumped to levels above 4% by 2011Q3 (Figure 1). In the same period, the spread vis-à-vis the 3-month Euribor rate increased almost 200 basis points (bp) to 2.6 percentage points (pp), an abnormally large value for this indicator and its maximum since the inception of the euro.[8]

The hike in the (average) deposit rates was accompanied by an increase in dispersion across banks. Being rather moderate before the crisis, dispersion started to increase thereafter, and became clearly apparent in 2010/2011. Considering the distribution of the deposit rates covering 40 banking groups, the distance between percentiles 20 and 80, which was very low until 2008 and around 150 bp in the beginning of 2010, had more than doubled by the end of 2011, reaching a maximum of 300 bp in the last quarter of 2011.

Since the second half of the 1990s, due to the lack of domestic savings, the Portuguese banking sector had been intermediating the required borrowing from abroad. By mid-2010, liabilities of Portuguese banks evidenced by debt placed on the wholesale funding markets amounted on average to more than 20% of their balance sheet and they had virtually lost access to these markets, while needing to redeem the maturing debt. At the time, banks were also financing heavily the Portuguese Treasury, which faced increasing difficulties in placing debt through the international government bond

8. From 1999 up to 2008, deposit rates on new operations were lower than the 3-month Euribor (with an average spread around -35 bp). From 2008 onwards, with the beginning of the global financial crisis, the spread became positive but below 1 pp until 2010.

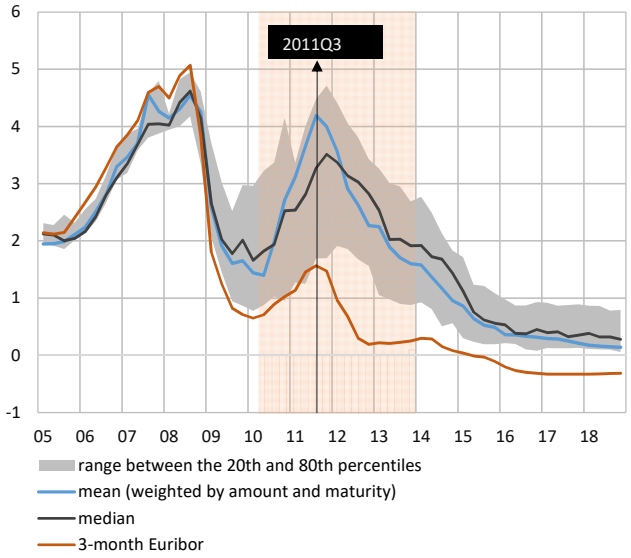

FIGURE 1: Deposits interest rates (new operations and renewals)
Source: Banco de Portugal and Esteves *et al.* (2019)

markets. Moreover, the Financial Assistance Programme negotiated and agreed in the spring of 2011 required a substantial deleveraging process of the Portuguese banking system, including a target for the loans-to-deposits ratio (also called 'transformation ratio') of 120% for end-2014, a value significantly lower than the average level of about 160% observed by end-2010, with some banks reaching much higher levels (Figure 2).[9]

Portuguese banks resorted to funds from the Eurosystem (Figure 3) but were confronted with very tight limits to collateral availability, against the background of rating downgrades of the Portuguese government debt. Therefore, turning to deposits was an obvious choice. By the summer of 2011, it was clear that a 'war for deposits' was raging amongst Portuguese banks. And it was also clear that the overall stock of deposits was expanding at significant rates (middle chart of Figure 2). The higher deposit remuneration offered by banks and the heightened risk perception and aversion were causing a recomposition of portfolios, especially but not only of households, in favor of deposits and in detriment of other assets. This process was much facilitated by the fact that management companies of investment funds were controlled by banks and the portfolios of the funds included a large proportion of securities issued abroad.

Increased costs with deposit interest were beginning to impact on the profit and loss accounts of Portuguese banks, already suffering from the effects of very unfavorable macroeconomic conditions, reflected in a rise in impairment costs due to loans that had recently become non-performing. Moreover, the pass-through from deposit rates to interest rates on new loans was taking place, contributing to depress even further

9. After the third programme review mission in February 2012, this objective became only an "indicative" target. For most banks the indicator converged rather quickly to the target and then overachieved it.

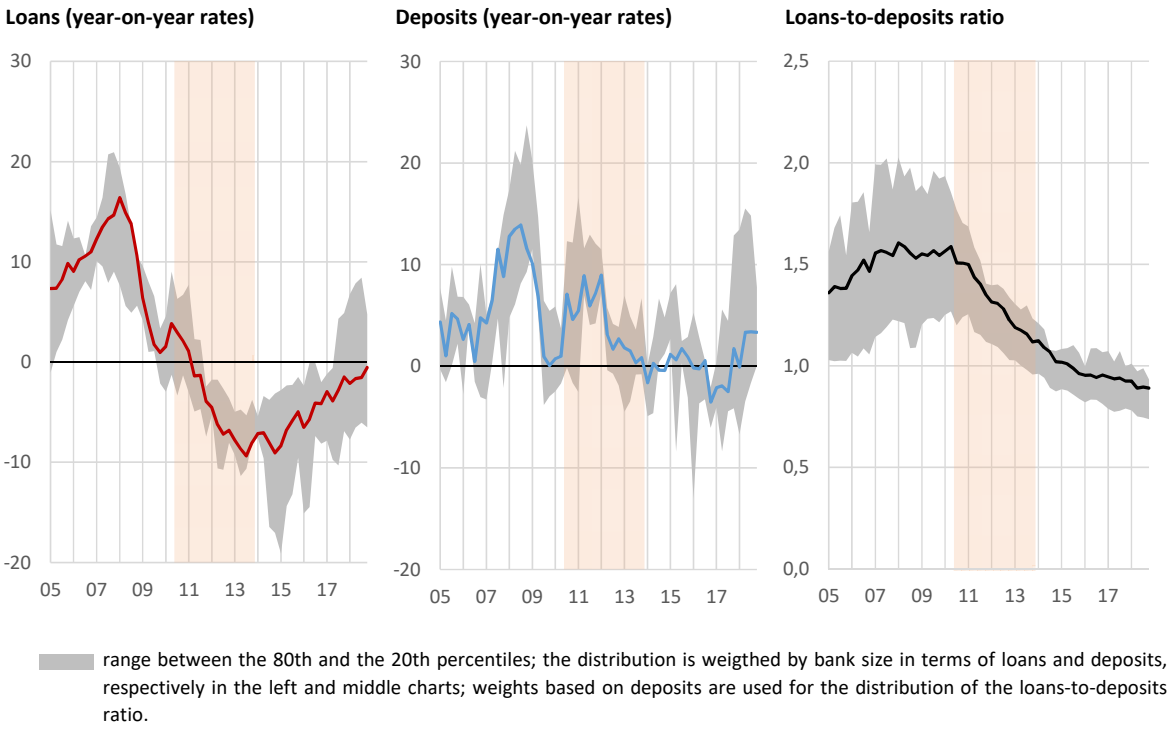

FIGURE 2: Loans-to-deposits ratio
Source: Esteves *et al.* (2019).

FIGURE 3: Eurosystem funding to Portuguese banks (€ million)
Source: Banco de Portugal

the amount of credit to the economy and to deepen the recession. Cross-correlations computed for the period 2010-2013 between the monthly changes of deposit rates and monthly changes of loan rates (in both cases new operations and renewals) (see Figure 4) suggest that the former were indeed anticipating the latter by a few months.

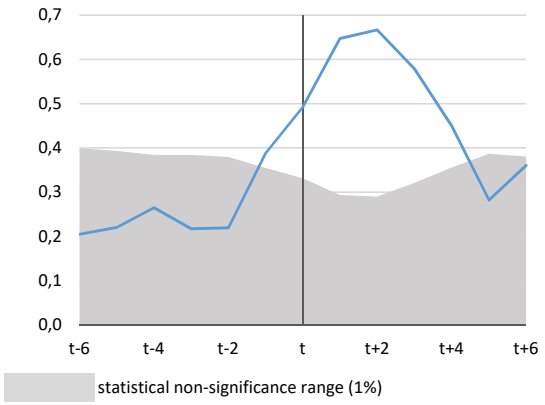

FIGURE 4: Cross-correlations between changes in deposit rates and in loan rates (2010-13, new operations and renewals, based on monthly data)

This is confirmed by a formal causality test controlling for the change in the market rates represented by the 3-month Euribor. We estimated the following dynamic linear regression by ordinary least squares and monthly data for the period 2010-13:[10]

$$\Delta il_t = c^{(l)} + \sum_{j=1}^{5} \alpha_j^{(l)} \Delta il_{t-j} + \sum_{j=1}^{5} \beta_j^{(l)} \Delta id_{t-j} + \sum_{j=1}^{5} \gamma_j^{(l)} \Delta ie_{t-j} + \varepsilon_t^{(l)}$$

where Δ il, id, ie and ε denote month-on-month change, the average loan rate on new operations, the average deposit rate on new operations, the 3-month Euribor rate, and a residual term, respectively. The joint hypothesis of non-significance of coefficients $\beta_j^{((l)}$ $(j = 1, \ldots, 5)$ was rejected with a P-value of 0.011. [11]

The left chart of Figure 5 confirms that the hike on deposit rates from mid-2010 was indeed passing through to the loan rates on new operations and renewals. In spite of the jump observed in deposit rates, the margin only slightly decreased from 2010Q2 to 2011Q3 and the right side chart of Figure 5 reveals that it happened because the three largest banking groups did not choose (or were not able) to increase it, unlike most smaller banks.[12]

10. The number of lags on the right-hand side was selected using the Akaike Information Criterion (AIC) which is known to perform better than alternative criteria in small samples.

11. The reverse Granger causality (i.e. from changes in loan rates to changes in deposit rates), also controlling for changes in the 3-month Euribor, provided evidence on the lack of causality (the test was associated with a P-value of 0.659. This test was based on the equation

$$\Delta id_t = c^{(d)} + \sum_{j=1}^{5} \alpha_j^{(d)} \Delta id_{t-j} + \sum_{j=1}^{5} \beta_j^{(d)} \Delta il_{t-j} + \sum_{j=1}^{5} \gamma_j^{(d)} \Delta ie_{t-j} + \varepsilon_t^{(d)}$$

and consisted of testing the joint nullity of $\beta_j^{(d)}$ $(j = 1, \ldots, 5)$.

12. Using microdata for January 1990 – December 2002, Antão (2009) concluded that the response of deposit rates to changes in market rates tended to be smaller than one, and around one for loan rates. Therefore, in the pre-crisis period, an increase in market rates like the one observed from mid-2010 up

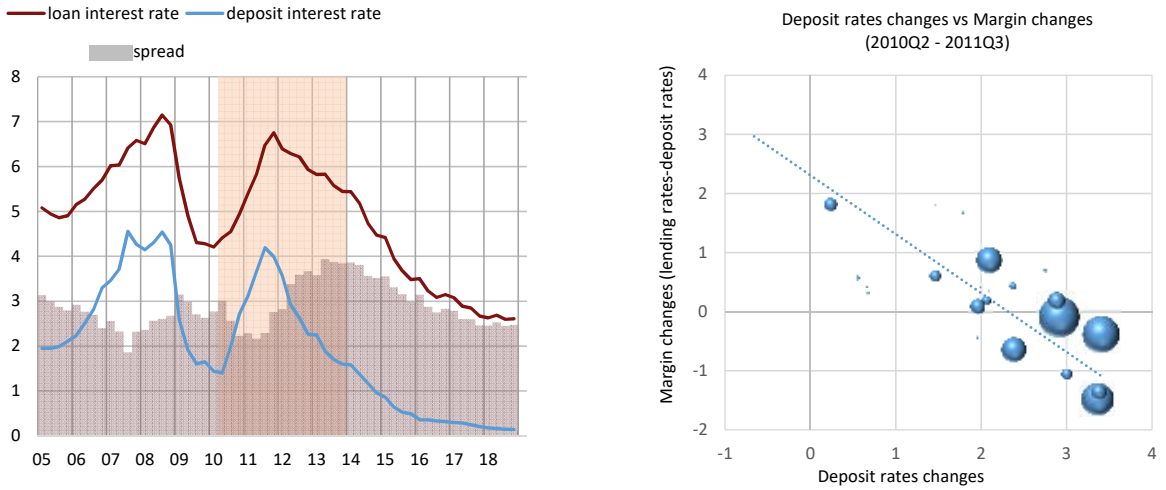

FIGURE 5: Loan rates vs deposit rates (new operations and renewals)

Source: Esteves *et al.* (2019).
Note: The size of the circles on the right side chart reflects the relative size of each banking group evaluated by the sum of the stocks of loans and deposits at end-2010.

All in all, in October 2011, the recession of the Portuguese economy was still worsening, deposit rates were increasing out of control, the pass-through to loan rates was taking place and contributing to deepen even further the recession, and the stock of bank deposits was expanding in response to the higher deposit rates and to a much heightened risk aversion of economic agents and to the response of management companies of investment funds.

In this context, getting inspiration from a measure taken by the Spanish authorities some months before, in June 2011, but adapting it to overcome some of its shortcomings, Banco de Portugal decided to impose a deduction from banks' Core Tier 1 own funds, effective as from 1 November 2011, based on the amount of deposits contracted with rates 300 bp or higher than the relevant Euribor rate.

Soon after the new measure was enforced, the average interest rates on new deposit operations (and renewals) began to decline. The evolution of deposit rates also greatly benefited both from a reversal in the upward movement of market interest rates and from the decision by the ECB, in December 2011, to widen the eligibility of assets accepted as collateral for its refinancing operations,[13] which eased the binding collateral constraints that Portuguese banks were facing.

In April 2012, the capital surcharge was adjusted and reinforced, by the clarification of its coverage regarding demand deposits, by the reduction of the spread over market

to 2011Q3 would probably be followed by a widening of the margin between loan and deposit rates. Nevertheless, given the macroeconomic background in 2010-11, and in particular the scarcity of bank funding, it is remarkable that the margin did not decrease more significantly.

13. ECB decision ECB/2011/25 of 14 December of 2011 on additional temporary measures relating to Eurosystem refinancing operations and eligibility of collateral. This decision was taken shortly after President Mario Draghi came into office.

rates for shorter term time deposits, and by the doubling of the former deduction to own funds. On 30 June 2012, three of the four largest banking groups were recapitalized by the Treasury,[14] and another smaller banking group was recapitalized in January 2013, which also contributed to ease the liquidity concerns of these banks.

Deposit rates continued to gradually decline throughout 2012 and the years thereafter. The differential to the 3-month Euribor narrowed significantly but only after early 2013. The stock of deposits levelled off in 2012 but did not decrease in the following years in spite of the new measure. Upon entry into force of the CRR in 2013, Banco de Portugal was no longer empowered to require from banks a capital surcharge as the one imposed in 2011-12, and thus it ceased to apply, but meanwhile the war for deposits had lost its relevance.

3. Deposit interest rate ceilings in Portugal

Portugal experienced a wide range process of liberalization in the financial sector in the second half of the 1980s and the early 1990s. Since the mid-1970s, the Portuguese economy was tightly controlled by the state. In particular, the banking sector was almost fully state-owned, with the exception of few mutual and foreign-owned banks, which represented a small market share. After an amendment of the Portuguese Constitution approved by Parliament in late 1982, bank ownership was opened to domestic and foreign entrants from August 1983. In the years following Portugal's accession to the European Community in 1986, capital movements were progressively liberalized in tandem with the modernization of the operational framework of monetary and exchange rate policies. Bank deposit and loan markets were also gradually liberalized during the period 1987–92.

The legal provisions which were enabling the control of interest rates by the Portuguese authorities in the late 1980s had been in place since 1965.[15] Under these provisions, throughout the 1970s and the 1980s several changes of deposit rate floors and ceilings had occurred in response to changes in inflation and other macroeconomic conditions. As for demand deposits, from 1974 onwards only households' demand deposits could bear interest and the corresponding maximum rate was set by Notice of Banco de Portugal.[16] In January 1987,[17] the ceiling on demand deposits by households was removed, but it was reinstated again on 18 March 1989, defined as one third of the

14. The largest banking groups, which were subjected to the European Banking Authority's stress test exercise, were required to strengthen their capital positions in order to reach a Core Tier 1 capital ratio of 9% by 30 June 2012 following an assessment of their sovereign debt exposures at market prices as at 30 September 2011. This decision led to the public recapitalization of CGD, BCP and BPI banking groups.

15. Articles 8 and 9, Decree-law 46492 of 18 August of 1965, with further details provided by Ministerial Order 21477 of the same date. For the Portuguese interest rate regulations before 1965, see for instance Pinheiro *et al.* (1997), p. 23-27 of Volume II and legal references included in Table "End of period banks' lending and deposit rates" of Volume I.

16. In the period 1978-84, besides deposits by households, deposits by local governments, cooperatives and charitable bodies could also earn interest.

17. Banco de Portugal Notice 1/1987 of 6 January 1987.

ceiling set for 6-month time deposits. In May 1992,[18] there was the full liberalization of demand, time and savings deposit rates, about six months before the adoption of a new legal framework for credit institutions and financial companies,[19] transposing into Portuguese law the Second Banking Directive, the Solvency Ratio Directive and the Own Funds Directive.[20]

Therefore, when the capital charge on superdeposits was decided by Banco de Portugal in October 2011, Portuguese banks had been operating in a fully liberalized deposit market for about twenty years. Ando to our knowledge, not many similar policy measures had been taken elsewhere. The one policy measure that comes closest was taken by the Spanish government in June 2011, just a few months before the Portuguese measure was adopted, and it also aimed at disincentivising deposit rates perceived as excessive without strictly banning them. But while in the Portuguese case deposits bearing interest above certain limits implied a deduction to the bank's own funds, the Spanish regulation instead increased the contribution to the deposit guarantee fund for such deposits.

4. The Spanish measure in June 2011

At the outset of the global financial crisis in 2007, Spain had a comparatively low sovereign debt level among euro area countries. However, it was experiencing a significant property bubble. Coinciding with the financial crisis of 2007–08, Spanish real estate prices began to fall. The burst of the bubble contributed to a severe economic downturn and created serious liquidity and solvency problems in many Spanish banks which were heavily exposed to the construction and real estate sectors. The problems of liquidity were exacerbated by the significant decline in the turnovers of the interbank market and the bank issued bond market.

The crisis expanded in the following years, and required the public bailouts of several banks. It happened in the context of an intensification of tensions in the sovereign debt markets of several euro area countries. Greece had to resort to a financial assistance programme from the EU and the IMF in May 2010, Ireland and Portugal followed soon in November 2010 and May 2011, respectively.

18. Banco de Portugal Notice 5/1992 of 20 May 1992.

19. Decree-law 298/92 of 31 December 1992.

20. Following the first Basel Accord (Basel I), signed in July 1988, minimum capital requirements for banks were gradual and formally adopted in most developed countries, whilst ceilings on (deposit and credit) interest rates, which were commonly used in banking regulation until then, were progressively eased or abandoned. In Europe, the Basel I Accord was laid down into Community law through the adoption in 1989 of the Solvency Ratio and Own Funds Directives. Together with the Second Banking Directive, they aimed at harmonizing prudential banking supervision regulation, and were transposed into national law by the member states by 31 December 1992. The Second Banking Directive dealt with authorization requirements for banks, as well as with the main rules to which banks were subject once licensed to operate. It was built upon the First Banking Directive of 1977, a rather modest initial step towards the harmonization of banking supervisory rules in the common market.

In spite of the favorable starting situation in terms of public accounts, the bank bailouts, the economic downturn, and the falling real estate tax revenue increased the Spanish public deficit and debt levels and led to a substantial downgrading of its credit rating. In June 2012, Spain's 10-year government bonds reached a 7% yield, culminating the increased difficulty in accessing bond markets. In July 2012, the Eurogroup decided to provide financial assistance to Spain, to be channeled to fund the restructuring and recapitalization of Spanish banks.[21]

One year before, on 3 June 2011, amidst the worsening of the banking crisis, which was turning systemic, the Spanish government passed a decree [22] stipulating, amongst other measures, additional contributions to the deposit guarantee fund for the deposits raised by banks bearing interest above certain limits. Specifically, those limits were set at: (i) 100 bp above the one-month Euribor rate for demand deposits; (ii) 150 bp above the 3-month Euribor rate for time deposits with agreed maturity of up to 3 months; (iii) 150 bp above the 6-month Euribor rate for time deposits with agreed maturity higher than 3 months and lower than one year; (iv) 100 bp above the 12-months Euribor rate for time deposits with agreed maturity higher than one year. For the purpose of determining the contribution to the deposit guarantee fund, deposits with excessive remuneration (if eligible for the guarantee) were to be weighted at 500%, i.e. they would require five times as much contributive effort as the remaining regular deposits (which was legally set since 2002 at 0.6‰ of the guaranteed deposit amount).

This legal provision, which became popularly referred to as "Ley Salgado" (after Elena Salgado, then Second Deputy Prime Minister and Minister of the Economy and the Treasury), was approved when banks were fiercely competing for funds in the deposit market and deposit rates were increasing, heightening financial stability concerns. The measure was reported by the media as attempting to halt the "war" between banks for raising deposits.[23]

The Spanish measure in 2011 appears as more flexible and market friendly than the legal imposition of rigid deposit rates ceilings. Nevertheless, it raised issues of coverage equal treatment, mainly because additional contributions to the deposit guarantee fund only applied to deposits below €100,000 and larger deposits were exempted.

In early August 2012, the Spanish news agency EFE reported that officials from Banco de España and from the Ministry of the Economy and Treasury were studying

21. The envelope of approved financial assistance amounted to € 100 billion. Upon request by the Spanish government, the European Stability Mechanism disbursed € 39.5 billion in December 2012 and further € 1.8 billion in February 2013.

22. Royal Decree 771/2011 of 3 June 2011. Banco de España Circular 3/2011, of 3 July 2011, provided the implementing rules for the enforcement of the contributions.

23. Most foreign banks operating in Spain were established as subsidiaries and therefore were contributors to the Spanish deposit guarantee fund and were affected by Salgado law. Two exceptions were the branches of Banco Espírito Santo and of ING, the former a Portuguese bank and the latter of Dutch origin, which continued to offer deposit rates quite above the soft legal limits set for banks incorporated in Spain.

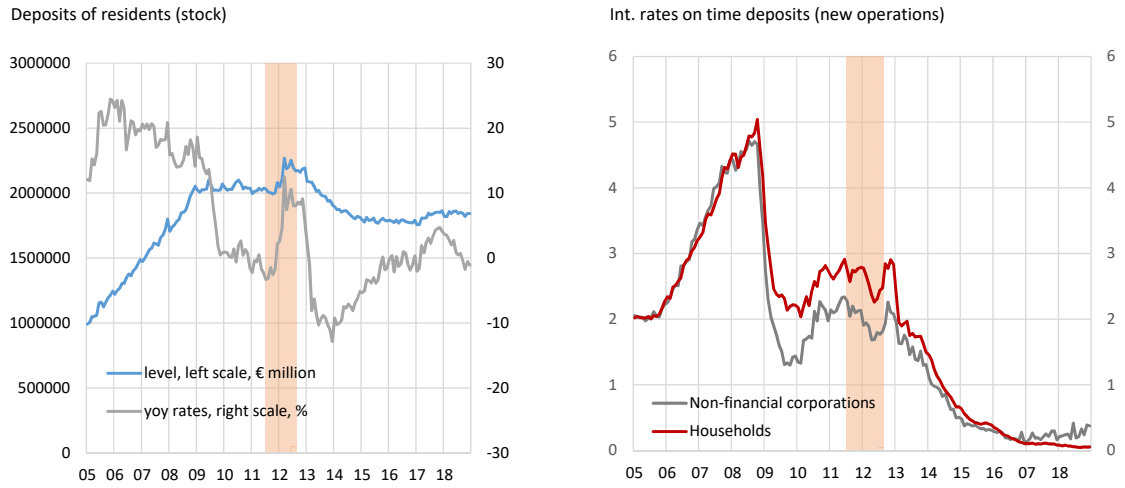

FIGURE 6: Spain: Deposits of residents
Source:Banco de España (Statistical Bulletin)

the possibility of terminating Salgado law, hinting at problems regarding its lack of effectiveness. Salgado law was actually repealed on 31 August 2012.[24]

The political context in Spain had changed significantly since the enforcement of Salgado law, specifically after the general election of November 2011.[25] Meanwhile, the regular contribution rate to the deposit guarantee fund had been raised to 2‰ and the management of the fund (chaired by a deputy Governor of Banco de España) was empowered to collect additional contributions from the banks if needed (the cap for the total contributions was set at 3‰ of eligible deposits).[26] Moreover, by the time Salgado law was repealed, the upward pressure on interest rates was weakening and deposits were beginning to decline (Figure 6).

5. The Portuguese measure

In the run-up to the participation in the euro, in the second half of the 1990s, Portugal enjoyed moderate to high real GDP growth, a very substantial decline in borrowing costs, and a significant increase in private sector debt, whilst its current account deficits were rapidly deteriorating. Due to the lack of domestic savings, the Portuguese banking sector intermediated the required borrowing from European banks. In the period

24. By Real Decreto-ley 24/2012 of 31 August 2012. The repeal was reiterated by Ley 9/2012 of 14 November 2012.

25. Socialist Prime-Minister José Luís Zapatero resigned in September 2011, and his government gave way in December 2011 to the first conservative government of Prime-Minister Mariano Rajoy. As of Banco de España, Governor Miguel Ordónez had reached the end of its term of office in June 2012, being replaced by Governor Luís Linde de Castro, at around the time of approval of the financial support package granted to Spain by the Eurogroup.

26. Real Decreto-ley 16/2011 of 14 October 2011 and Real Decreto-ley 19/2011 of 2 December 2011.

2000-07, Portugal's economic performance deteriorated with lower growth, ongoing large current account deficits, continued increase in private sector debt, and a rise in government deficit and debt. Interest rates remained relatively low and banks went on funding the gap in domestic savings through further funding from abroad.

The global financial crisis had an important impact on the Portuguese economy: real GDP stalled, before falling sharply in 2009; the current account deficit continued unabated in 2009 and 2010, leading to a substantial increase in net foreign liabilities; and the government deficit increased dramatically, rising to above 10% of GDP in 2010. The era of low interest rates on Portuguese debt ended during this period, along with the rising spreads on sovereign debt of other European periphery countries and emerging markets.

The Greek crisis began in October 2009, and spreads on Portuguese ten-year government bonds versus German bonds continued to widen, with some fluctuations. In March 2011, spreads reached almost 5 pp and the main credit rating agencies downgraded Portugal's sovereign rating. Portugal's Prime Minister José Socrates resigned after the opposition rejected the Stability and Growth Programme proposed by his minority government. The following month, the credit rating of Portuguese sovereign debt was downgraded once again. The sovereign spread versus German bonds widened even further and capital inflows fell sharply.

In response to the sudden stop in capital inflows and to the dire situation of Portuguese public finances, the government requested financial assistance, setting the stage for the Financial Assistance Programme agreed with the EU and the IMF in May 2011. The total amount of financing granted for the period 2011-14 was €78 billion, of which €52 billion and €26 billion corresponded to financing through the European mechanisms and to assistance from the IMF, respectively. The Programme contained measures to support the banking system in terms of solvency and liquidity,[27] including the strengthening of banks' collateral buffers and the issuance of government guaranteed bank bonds.

With virtually no access to the wholesale funding markets, and facing limits to Eurosystem financing due to collateral availability, Portuguese banks made aggressive efforts towards raising deposits. Their commercial strategy consisted of increasing deposit rates, waging a "deposits war" which shared some features with the one that was being observed in Spain. In a context of heightened risk aversion, there was a readjustment of households' portfolios in favor of deposits and to the detriment of other savings instruments perceived as more risky. By the end of September 2011, total deposits were growing 4.0% year-on-year, reflecting an increase in household deposits of 9.2% that was partial offset by a decline of 12.9% in non-financial corporation deposits.

However, the favorable behavior of deposits was being achieved at the expense of spiraling deposit rates. Interest rates of new deposits jumped from 1.4% in 2010Q2 to 4.2% by 2011Q3. Four months after the measure taken by the Spanish authorities,

27. Regarding the former, €12 billion (of the total amount of €78 billion) was allocated to the so called Bank Solvency Support Facility.

Banco de Portugal also decided to intervene and penalize banks offering very high deposit rates. Instead of raising the contribution for the deposit insurance fund for those superdeposits, Banco de Portugal opted to require additional capital to the bank whenever a new deposit was raised bearing interest above a certain level.

Even without this intervention related to the excessive remuneration of some deposits, Portuguese banks were already very pressed to raise their capital ratios, which were deemed low by the troika, and in addition were suffering the impact of substantial losses associated with the fall in economic activity.[28] Therefore, directly penalizing the own funds of banks offering superdeposits was considered potentially more effective than raising the associated contributions to the deposit insurance fund. Adopting the Spanish measure in Portugal would have required a change (by the government) of the legal framework regulating the contributions to the deposit insurance fund, in order to allow: (i) different contribution rates depending on the deposit remuneration; and (ii) infra-annual collection of contributions from the banks (which in Portugal are only collected once a year in April).[29] Moreover, directly penalizing banks' own funds did not exempt from the penality deposits above €100,000 and deposits from entities not covered by the deposit insurance (in particular public administrations and financial corporations) as it would have happened if the measure was defined as an increased contribution to the deposit insurance fund.

Banco de Portugal intervention to discourage superdeposits became effective as from 1 November 2011.[30] New (or renewed) deposits became eligible to contribute to the deduction from own funds whenever its deposit rate offered by the bank exceeded the reference rate, defined as the Euribor rate of the relevant maturity plus 300 basis points.[31] For a given superdeposit with amount d_n (in euros), maturity m_n (expressed in days), and rate i_n (scaled such that 1% = 0.01), the following formula was provided by Banco de Portugal for computing the contribution c_n (in euros) of that deposit to the deduction from own funds over the period of one year:[32]

$$c_n = d_n.m_n.(i_n - r_n).\rho$$

where r_n is the reference rate for deposit n (i.e. the Euribor rate of a similar maturity plus 0.03) and ρ is a scaling factor set at 0.005. For superdeposits in currencies other than the euro, the amount was to be defined as the euro equivalent using the exchange rate of the day and the reference rate was to be computed with the interbank market rate (with similar maturity) of the currency concerned substituting for the Euribor. Using

28. Banco de Portugal Notice 3/2011 of 17 May 2011 had been released just some months earlier requiring banks to strengthen their Core Tier 1 capital ratios from 8% of risk-weighted assets to 9% and 10%, respectively by 31 December 2011 and by 31 December 2012.

29. Otherwise, the first effect of the measure would only be felt by banks in April 2012.

30. The legislative basis were Banco de Portugal Notices 7/2011 and 8/2011, both published on 25 October 2011, and Instruction 28/2011, effective as from 1 November 2011.

31. Only deposits placed or renewed after 31 October 2011 were eligible.

32. That is, an eligible deposit placed with bank X on day t of a given year Y contributed to the deduction from own funds of bank X from day t of year Y up to day t-1 of year Y+1.

the formula above, and for example, a one-year deposit of €1,000 contracted on 15 November 2011 with an interest rate 4 pp above the one-year Euribor, resulted in a deduction from the bank's own funds of €18.25 during the period from 15 November 2011 to 14 November 2012.

The capital surcharge did not apply to European banks operating in Portugal through branches because they were not subject to Banco de Portugal's supervision on capital requirements.[33] These branches would also had been excluded from the coverage if the measure had been designed (like in Spain) to affect the contribution of superdeposits to the Portuguese deposit insurance fund, as the deposits placed with these branches contributed to the funds of their home countries and not to the Portuguese fund.

Effective as from 2 April 2012,[34] Banco de Portugal adjusted the new prudential regulation, on three counts. First, it clarified that the contribution of demand deposits, in terms of amount and maturity, should be computed only once a month using the monthly average of new eligible demand deposits during that month and considering a one-month maturity.[35] Second, the scaling factor ρ was doubled to 0.01. Third, it clarified in more precise terms which market rate should be picked and reduced most of the spreads which should be considered when computing the reference rate to be used in the formula above (Tables 1 and 2). Considering the example provided above, a similar one-year deposit of €1,000 contracted with an interest rate 4 pp above the one-year Euribor but on 10 May 2012 instead of 15 November 2011, would have required €36.50 of additional bank capital during the period from 10 May 2012 to 9 May 2013 due to the increased scaling factor.

Deposit maturity	Relevant market rate
Overnight	EONIA
Up to one year	Euribor for the maturity concerned
Longer than one year	max[Euribor(12 months); IRS for the relevant maturity]

TABLE 1. Market interest rate relevant for computing the reference rate

Notes: IRS defined as published by the International Swaps and Derivatives Association; For interim maturities, market rates were to be linearly interpolated based on the closer available maturities.

Deposit maturity	Spread (bp) before 2 April 2012	Spread (bp) after 2 April 2012
Up to 91 days	300	225
From 92 to 182 days	300	250
From 183 to 273 days	300	275
Longer than 274 days	300	300

TABLE 2. Spreads when computing the reference rate

33. It was the case of *Barclays Bank*, *Deutsch Bank* and *Privatbank*.

34. Banco de Portugal Instructions 15/2012 and 16/2012 of 16 April 2012. The latter Instruction stipulated the data reporting obligations by banks (and was later amended by Instruction 30/2013 of 16 December 2013). For demand superdeposits initiated before 2 April 2012, Banco de Portugal Notice 15/2012 established that they had to contribute to the deduction to own funds but only as from 1 June 2012.

35. Which is roughly equivalent to abstain from any type of averaging and treat demand deposits as time deposits with one-day maturity.

This regime of contributions to the deduction from banks' own funds lasted until 31 December 2013, and ceased to be applicable upon entry into force of the CRR. Taking into account that contributions of superdeposits to the deduction from own funds were kept for a period of one year from their origination (or renewal), the deductions extinguished themselves on 31 December 2014, at the latest.[36]

6. A characterization of superdeposits based on microdata

6.1. Data processing

For the purpose of monitoring the compliance with the capital surcharge, banks were asked by Banco de Portugal to report on a weekly basis all the deposits newly contracted or renewed with interest rate above the reference rate. Although banks incorporated in other EU member states doing business in Portugal through branches were not affected, as above mentioned, by the capital surcharge imposed by Banco de Portugal, they were asked to report to Banco de Portugal using the same reporting templates.

For each individual superdeposit, information was reported *inter alia* on the date of contract, the maturity, the contracted deposit rate, the currency in which the deposit was denominated, the amount of the deposit, and the institutional sector of the depositor.[37] We were given access to these data for the period June 2011 – December 2013 covering about 1.3 million individual deposits. Although the capital surcharge was not yet in force before November 2011, the data reported by banks for the period June 2011 – October 2011 emulates the eligibility criterion which became effective on 1 November 2011.

Banks reported deposits denominated in 16 different currencies. However, deposits denominated in euro and in USD represented 96% and 3.5%, respectively, of reported deposits weighted by amount and maturity. In order to simplify the computations (in particular in what regards the interbank market rates in all different currencies) we removed from the data set all deposits but those denominated in euro and USD.[38]

The format of bank reports changed slightly during the period, most significantly for deposits contracted before and after 2 April 2012. In addition, as described in the previous section, on the same date more deposits became eligible for reporting due to the reduction of the spread used to compute the reference rate for each deposit (Table 2). We performed an exercise to check if the reported deposits were eligible, i.e. if the contracted deposit rate was higher than the relevant reference rate. For deposits contracted before 2 April 2012, 11% of their number and 7% of their overall amount (8% if the amounts are weighted by maturity) apparently did not comply with the eligibility condition (in the sense that their deposit rate was not higher than the reference rate as computed by

36. The prudential reporting of individual superdeposits initiated with Banco de Portugal Instruction 16/2012 was only formally terminated later on with Instruction 6/2017 of 3 April 2017.

37. It should be mentioned that there is no identification of the depositors other than their institutional sectors.

38. We also removed from the data set 1,070 observations either with negative maturity, or negative amount, or no currency identification, or with an invalid date of contract.

us). However, it is worth mentioning that the maturity for deposits contracted before 2 April 2012 is not exactly known because we only had available the maturity range they belonged to. We converted these non-overlapping ranges into specific maturities expressed in number of days by assigning to each deposit a maturity equal to the upper limit of the range (which tended to be the mode of the distribution observed in the sub-period after 2 April 2012). Hence, the maturity assigned was 7 days for deposits pointing to the range 'up to 1 week', 31 days for 'more than 1 week up to 1 month', 92 days for 'more than 1 month up to 3 months', 183 days for 'more the 3 months up to 6 months', 365 days for 'more than 6 months up to 1 year'. When the deposit maturity was indicated to be 'more than 1 year', it was assumed a maturity of 913 days, reflecting the average of 730 and 1095 days (respectively 2 and 3 years), which were the two maturities of more than 1 year around which we observed the higher relative frequency in the information available from 2 April 2012 onwards.

Regarding deposits reported by banks which were contracted after 2 April 2012, only 2% of their number and 5% and 3% of their amount (non-weighted and weighted by maturity, respectively) did not comply with the eligibility condition as emulated by us. Demand deposits reported in this second sub-period indicate either zero or 1 day maturities, and we opted to harmonize the maturity of demand deposits to 1 day.[39]

6.2. Superdeposits in the period 2011-2013

On the right side of Figure 7 we present the proxy (based on the filtered data just described and excluding branches of banks incorporated in other EU member states) for the overall amount of the monthly contributions to the deductions from own funds which resulted from contracting superdeposits. As mentioned in the previous section, Banco de Portugal established that these contributions once generated had to be deducted from the Core Tier 1 capital over a period of 12 months.[40]

The left side of Figure 7 shows the overall monthly amount of superdeposits when weighting the individual operation amounts by maturity (expressed in days) and dividing by 365. By simply summing the contracted amounts of the superdeposits would be meaningless given that we would be adding amounts of deposits with very short maturities (and likely high turnover) to amounts of deposits with long maturities (and less frequent turnover). The result would grossly over represent deposits with small maturities in detriment of deposits with larger maturities. By performing the described type of weighting, we are adjusting deposit amounts so that we can treat them as if they were all contracted with a 1-year maturity.

When analyzing both charts, we should remind that the values for months prior to November 2011 (including those for October 2011) are only emulations of what those variables would be if the regulation had already been in place, which it was not, for the deposits contracted during that period.

39. This assumption is consistent with the remark made in footnote 35.

40. For instance, the contribution resulting from the superdeposits contracted on June 2012 affected the banks' capital from June 2012 to May 2013.

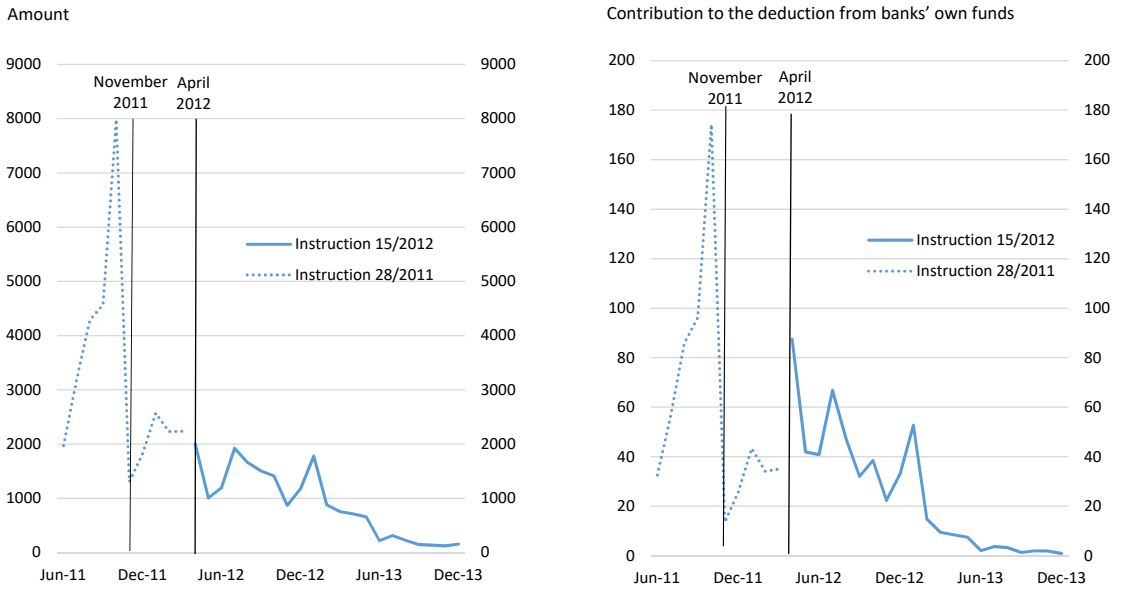

FIGURE 7: Superdeposits: Weighted amount and contribution to the deduction from capital (€ million, monthly data, excluding branches of banks incorporated in other EU member states)
Note: Amounts weighted by maturities expressed as no. days / 365

From Figure 7 we take that the capital surcharge seems to have discouraged superdeposits upon its entry into force. There was a remarkable increase in the amount of superdeposits contracted from June 2011 to October 2011.[41] The exceptional high values obtained in October were influenced by some few very large deposits with long maturities.[42]

Another point to be taken from Figure 7 is the increase in the monthly contribution to the deduction from banks' own funds which occurred in April 2012, on the occasion of the capital surcharge reinforcement, in spite of no jump being visible in the weighted amount of superdeposits. This means that the larger contribution to the capital charge was mainly associated with the doubling of the scaling factor ρ (from 0.005 to 0.01). It is also worth highlighting that the contribution to the capital surcharge in the beginning of 2013 was already quite small, and it became virtual nil from mid-2013 onwards.

In the left side of Figure 8 we have the distribution across banking groups on a consolidated basis of the ratio computed as the amount of superdeposits (again weighted by maturities divided by 365 and excluding branches of banks incorporated in other EU member states) over the corresponding bank's stock of deposits, whilst the right side of Figure 8 is the chart of the distribution, also across banking groups on a consolidated basis, of the contribution to the capital surcharge as percentage of

41. The number of superdeposits reported by the banks (not shown in Figure 7) increased from 9,200 in June 2011 to 67,000 in October, afterwards declining sharply to 12,100 in November.

42. The five largest deposits, when weighted by maturity and divided by 365, account for almost €1.1 billion (14% of the monthly total for October).

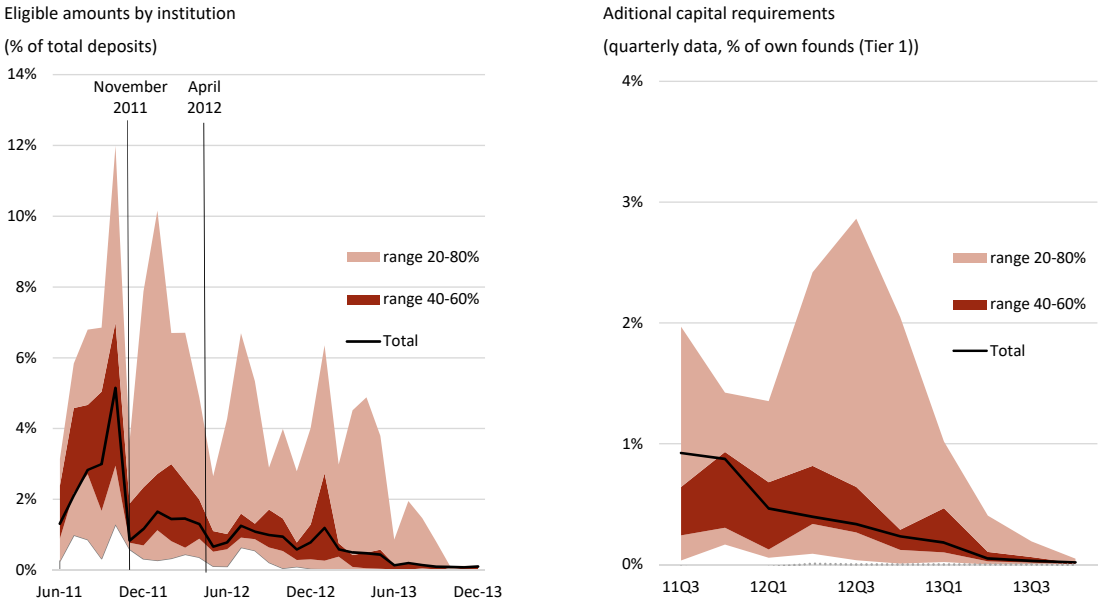

FIGURE 8: Institutions reporting superdeposits: Distributions across banks by weighted amount and by contribution to deduction from capital (on a consolidated basis)

Notes: Branches of banks incorporated in other EU member states are not considered; Banking groups are not weighted according to their size; "Total" corresponds to the ratio for the banking system excluding branches of banks incorporated in other EU member states.

banks' Tier 1 capital.[43] We should notice that the former indicator does not represent the distribution of the share of superdeposits in total deposits across Portuguese banking groups because the scaling of numerator does not provide a proxy for the stock of superdeposits. There was no way of computing a reasonable approximation of that share with the available information so our only goal in producing the ratios underlying the chart on the left side of Figure 8 was to display some relative indicator more comparable across banks.

Both distributions presented in Figure 8 confirm that the capital surcharge did not affect banking groups in a similar way. Some banks were considerably more exposed to the penalty imposed by Banco de Portugal than others. When considering the 1-year long moving sum of contributions[44] as stipulated by Banco de Portugal's regulation, we may infer that for some banks the deduction from own funds exceeded 10% of their Tier 1 capital. For the Portuguese banking system as a whole, and taking into account that monthly contributions add to the deduction from own funds during a period of one year after the superdeposits were contracted by banks, Figure 9 provides our estimate of the amount of capital charge effectively imposed by Banco de Portugal. It peaked at €211

43. For both distributions, the mass of probability attached to each bank is given by its share in the stock of deposits.

44. Note that the right side of Figure 8 does not show the capital penalty (i.e. the moving sum) but only the quarterly contributions to it.

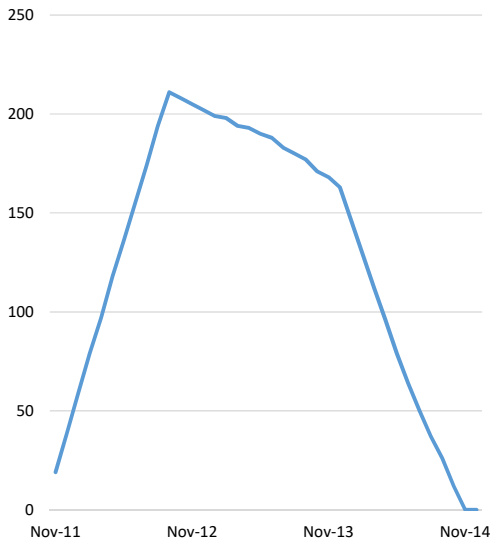

FIGURE 9: Overall deduction from own funds (€ million)
Note: Branches of banks incorporated in other EU member states are not considered.

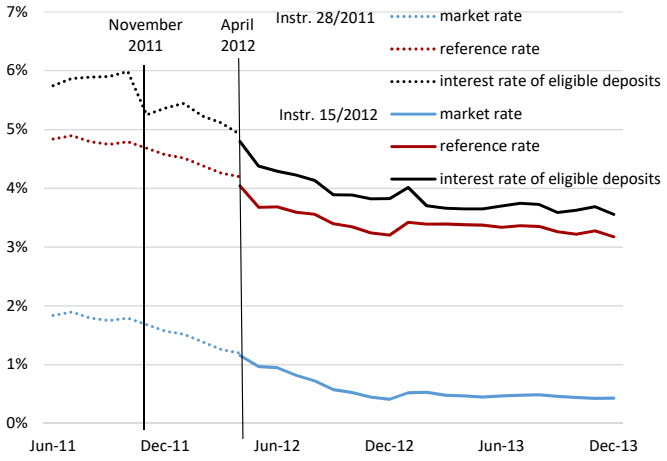

FIGURE 10: Superdeposits: Interest rates
Note: Interest rates were weighted by deposit amounts and maturities.

million in September 2012. This is relevant for a banking sector that at the time was very pressed to substantially increase the capital ratios.

Figure 10 and Figure 11 complement the information provided so far by presenting the evolution of interest rates associated with superdeposits placed with banks subjected to Banco de Portugal's supervision on capital requirements. All lines in Figure 10 were obtained by doubly weighting interest rates by amount and by maturity of each individual superdeposit. The slight downward discontinuities observed from March to April 2012 (in transition from the dotted to the continuous lines) reflect the change in spreads relative to market rates as indicated in Table 2.

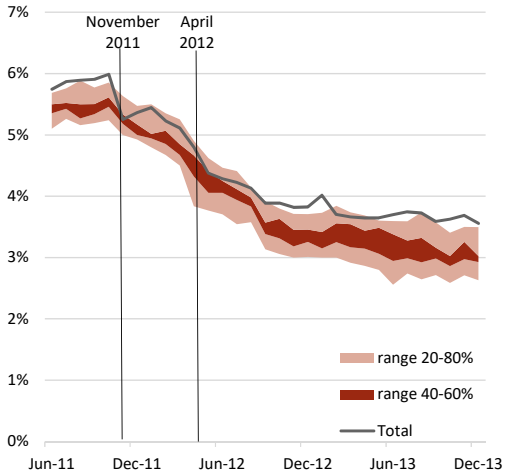

FIGURE 11: Superdeposits: Distribution of interest rates across banks

Notes: Banks are not weighted according to their size. "Total" corresponds to the the banking system excluding branches of banks incorporated in other member states.

Interestingly, we see in Figure 10 that interest rates of superdeposits kept a relatively constant spread over the market relevant rates during the period 2011-13, implying that the phasing out process of superdeposits did not take place through a gradual downward adjustment of spreads relative to market rates, but mostly through their declining amounts. In turn, Figure 11 presents the distribution by bank (non-weighted by bank size) of average interest rates of superdeposits, confirming the conclusion from Figure 8 that over the period 2011-13 there was significant heterogeneity across banks.[45]

Figure 12 allows comparing the amount[46] and interest rates[47] of superdeposits contracted by banks subjected to Banco de Portugal's supervision on capital requirements with those declared for monitoring purposes by branches of banks incorporated in other EU member states.[48] With the exception of two months (May and June 2012), the amounts of highly remunerated deposits placed with branches of European banks were not significant, thus implying that the leakage of deposits from banks subjected to Banco de Portugal' capital surcharge was rather limited (in amount and in time). It is worth noting the lack of leakage of deposits to banks incorporated in other EU countries even during 2013, when they were offering higher interest rates. Probably, more significant were investments promoted by banks away from deposits on banks' equity or debt, or on securities issues by related parties. Nevertheless, given the depositors' heightened aversion to risk at the time, the magnitude of these outflows to

45. The heterogeneity across banks explains why the (weighted) average interest rate of superdeposits is above the percentile 80 of the (non-weighted) distribution for some of the months.

46. Weighted by no. days / 365 days

47. Weighted both by amount and by maturity.

48. Notice that for the former banks, the values underlying Figure 11 are the same as presented in the left chart of Figure 7 and in Figure 10.

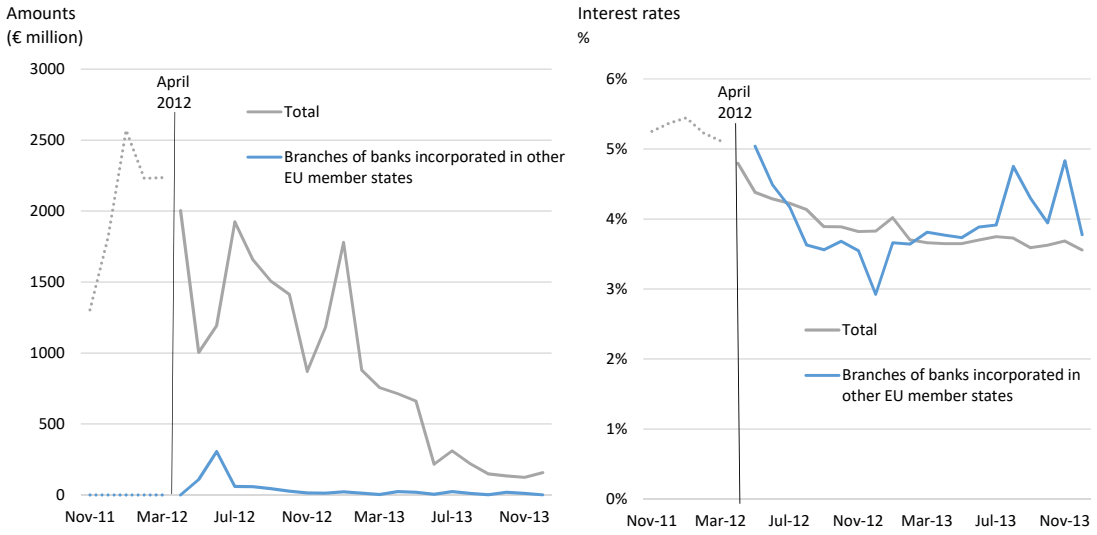

FIGURE 12: Superdeposits: Distribution of Interest rates across banks

Notes: Banks are not weighted according to their size. Total" corresponds to the the banking system excluding branches of banks incorporated in other member states.

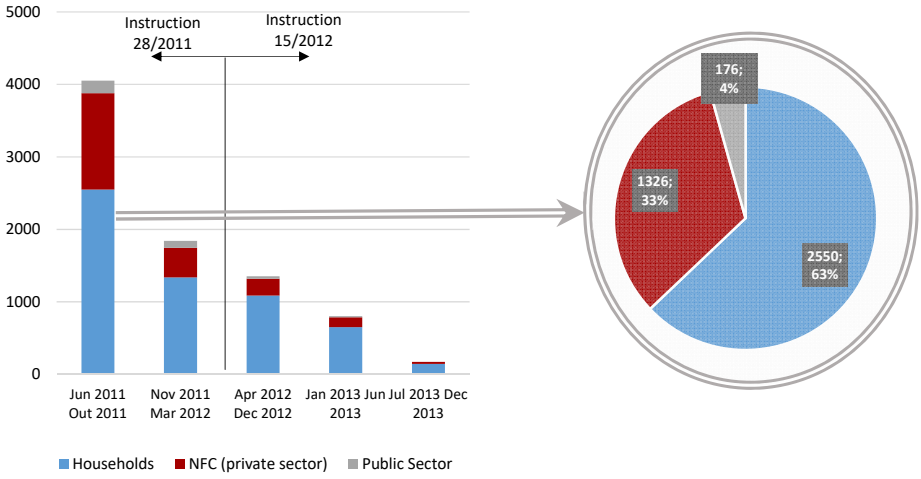

FIGURE 13: Superdeposits by institutional sector of the depositor (€ million, based on monthly data, excl. branches of banks incorporated in other EU member states)

Notes: Public sector is defined as general government entities and state-owned companies. Amounts are weighted by maturity (no. days / 365). The value for a period is the non-weighted monthly average in that period.

securities other than deposits never led the overall stock of deposits to decline during the relevant period.

Before concluding, we look at the breakdown of superdeposits by institutional sector of the depositor (Figure 13 and Figure 14). In the months leading to Banco de Portugal's decision, more specifically in the period June-October 2011, when weighting by maturity, household deposits represented 63% of the deposits with

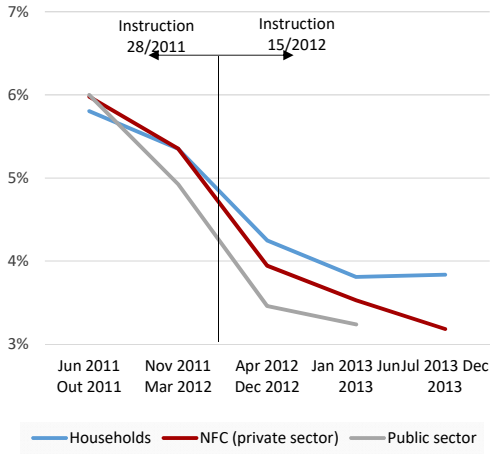

FIGURE 14: Interest rates of superdeposits by institutional sector of the depositor (excludes branches of banks incorporated in other EU member states)

Notes: Public sector is defined as general government entities and state-owned companies. Interest rates are doubly weighted by amount and maturity.

remuneration deemed excessive (i.e. bearing interest at a rate over 300 bp higher than the relevant Euribor rate), while deposits of non-financial corporations represented 33%, the remaining 4% being deposits by public sector entities.[49] It is also worth noting that, in the phasing-out process of superdeposits, household deposits proved to be more resilient, fading more gradually than the deposits of the other two institutional sectors. Deposit rates contracted with households also declined more slowly.

7. Concluding remarks

The paper described the motivation and documented the effects of the capital surcharge imposed by Banco de Portugal in October 2011, and later adjusted and reinforced in April 2012, on banks offering superdeposits (i.e. deposits with a remuneration deemed excessive). The motivation for this measure was macroprudential, as it addressed a significant financial stability concern, although at the time the current institutional framework of macroprudential policy was not yet in place.

In 2011, Portuguese banks were aggressively trying to raise more funds through deposits, in a context of very unfavorable macroeconomic conditions. Excessive competition for deposits was amplifying bank losses by raising interest expenses. Furthermore, the higher deposit rates were passing-through to the loan rates, thus contributing to further deepen the recession and deteriorate the loans portfolios of

49. Although not directly comparable, at end-October 2011, the share of household deposits and of non-financial corporations deposits in the overall stock of deposits of residents excluding financial institutions was 73.1% and 18.6%, respectively (source: Portuguese monetary and financial statistics published by Banco de Portugal).Public sector is here defined as general government entities and state-owned companies.

banks. In the months following Banco de Portugal intervention, deposit rates started to decline and so did the amount of superdeposits.

It is always hard to prove the existence of causality, and in the case under examination the Portuguese economy was experiencing changing conditions which may help in large part to explain the return of deposit rates to more normal levels. Indeed, at about the same time that Banco de Portugal decided to impose the capital surcharge, money market interest rates began to decline and the ECB considerably widened the eligibility of assets accepted as collateral for its refinancing operations. Moreover, by end-2011 there were negotiations between the troika, the Portuguese government and some of the largest banking groups for the public recapitalization of the latter, which eventually took place in June 2012 and January 2013 and undoubtedly also eased liquidity concerns of those banks. Nevertheless, the evidence discussed in the paper suggests that the imposition of the capital surcharge contributed to contain the war for deposits amongst Portuguese banks.

As to the concrete specification of the policy measure, directly penalizing the own funds of banks offering superdeposits was considered preferable to raising the associated contributions to the deposit insurance fund, as in Spain, in particular because directly penalizing banks' own funds did not exempt deposits above €100,000 from the penalty.

It is worth emphasizing that the very particular and problematic circumstances under which the capital surcharge was applied impeded the materialization of the risks reported in the economic and financial literature as being potentially associated with policy measures controlling deposit rates.[50] It is often argued by critics of deposit rates ceilings that, while preventing destructive competition amongst banks for deposits, they facilitate cartel behavior and may result from the capture of the regulator by bankers who use the ban on competition to serve their private interest. In general terms, these critics may have a point but in Portugal in the years 2011-2012 banks were sorely pressed by the deep recession affecting the economy, the dire state of the public finances and the contraction in international capital inflows. This was not the environment for a bank cartel to extract rents from a policy measure which restraints competition in the deposit market.

Another criticism of deposit rate controls is that they muddy the waters for monetary policy-making. There is merit in the argument for a country with its own currency. However, Portugal being a small economy participating in a vast area with common currency and monetary policy, the argument seems to be irrelevant.

More relevant are the warnings about the potential reduction of deposits in the presence of interest rates significantly constrained by ceilings when close substitutes to deposits are available. This 'leakage' of deposits may be serious and put pressure on bank liquidity. Again, due to the specific economic conditions at the time and the consequential heightened risk perception and aversion by Portuguese households and companies, the imposition of the capital surcharge on banks offering superdeposits did

50. This issue of Banco de Portugal's *Economic Studies* includes a synopsis on deposit interest rate ceilings.

not lead to an overall reduction of deposits, in spite of the occasional episodes of savings flowing out from deposits to securities of under-perceived riskiness (e.g. investments promoted by the banks on their own equity or debt, or on securities issues by related parties).

Finally, a criticism raised in the literature against deposit rate ceilings is that these controls may have undesirable allocative and distributive consequences. According to this criticism, deposit rate ceilings may discriminate against the small savers who cannot earn market interest rates from their savings, being impeded by the significant minimum denominations of market instruments and by their own unfamiliarity and ignorance on the functioning of capital markets. This is particularly true when the ceilings or the penalty only apply to deposits below a given amount, but as mentioned, in the period when the capital surcharge on banks was in force in Portugal, it was being applied both to small and large depositors, and there were no worthy investment alternatives for them. Therefore, the concern about its distributive consequences was rather muted.

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Non-technical summary

July 2020

Economic Synopsis
Deposit interest rate ceilings

Maximiano Pinheiro, Paulo Soares Esteves

Interest rate ceilings were commonly used in banking regulation until the 1980s. Following the first Basel Accord, signed in July 1988, minimum capital requirements were gradual and formally adopted in most developed countries, whilst controls on (deposit and loan) interest rate were progressively eased or abandoned.

This article surveys two strands of literature on deposit interest rate ceilings. First, we provide an overview of articles on the so called 'Regulation Q', which was promulgated in the United States in 1933 in the wake of the 1929 stock market crash and amidst the greatest spate of bank failures in the US history. Regulation Q lasted for more than 50 years and since the mid-1960s the deposit rate ceilings became permanently binding. It is a very rich experience with deposit rate controls and their subsequent liberalization, and it generated large controversy amongst US economists. We also review a second and mostly unrelated strand of literature consisting of articles, some of them rather recent, which discuss and assess deposit rate ceilings as a prudential tool, alone or in conjunction with some form of minimum capital requirements, based on banking models developed for the purpose.

Deposit rate ceilings may be envisaged as a possible alternative or, more likely, as a complementary prudential banking regulatory tool to minimum capital requirements, either on a permanent or on a temporary basis. However, they are also subject to several important shortcomings.

Higher capital requirements reduce the return on equity and hence banks' franchise value. They also imply larger losses for the banks' shareholders in case of default. With sufficient competition, banks will find desirable to gamble and prudential regulation making use of minimum capital requirements may become a Pareto-inferior policy choice due to the large social loss generated when banks default. The problem is mitigated if capital requirements efficiently discriminate in favor of investment in prudent assets by attaching a larger risk weight to riskier assets when computing the denominator of the capital ratio.

If banks are forced to pay more for deposits then they are tempted to invest in riskier assets to help defray their larger financing costs, implying an increase of the chance of a bank crisis. Unlike capital requirements, which work mainly through the increase of capital at risk for banks' shareholders, the relevant channel for deposit rate ceilings is the franchise value effect. By enlarging the interest margin of banks, deposit rate ceilings

increase the present value of the banks' future profits and so stakeholders have more to lose when the bank gambles.

Furthermore, in the absence of deposit rate ceilings, a bank in distress has the incentive to take advantage of the public deposit insurance by raising interest rates. But doing so it will lead other banks to also raise interest rates in order to minimize the outflow of insured deposits, decreasing their profitability and therefore increasing their instability. In case of default, the distressed bank's higher market share of insured deposits will increase the cost faced by the deposit insurance scheme (ultimately by the taxpayer).

Significant regulation-induced disintermediation may occur if legal ceilings prevent banks from the payment of higher interest rates on deposits as offered on market instruments. Deposit rate ceilings are only effective if bank deposits and other liquid investments with non-banks are not close substitutes. In advanced economies these processes of substitution would tend to scatter a significant part of deposits out of banks, largely compromising the effectiveness of the legal ceilings and at the same time pushing household savings to securities often of under-perceived riskiness. This movement out of deposits will be more pronounced for large uninsured deposits, although it may be non-negligible even for relatively small time and savings insured deposits.

Disintermediation has real effects if shortage of deposit funds arises and forces banks to cut back on lending to borrowers that rely on intermediated finance. This response by banks may be mitigated by the central bank through appropriate financing which becomes crucial in the presence of binding deposit rate ceilings. Indeed, the latter have the potential to affect monetary policy transmission mechanism and thus provide monetary policy with a greater role due to the increased leverage over real activity.

The imposition of deposit rate ceilings might encourage banks to strongly raise the level of customer convenience services by offering depositors a variety of services free-of-charge, and to excessively expand their office network in order to become more conveniently located. This non-rate competition of banks for deposits may imply a substantial increase in costs incurred by banks besides those associated with the payment of interest on deposits. The corresponding fall in their franchise value will counteract the main channel through which deposit rate ceilings exert their prudential effect.

Finally, a relevant effect of a policy of deliberately keeping low deposit rate ceilings relative to market interest rates is that it may have strong allocative and distributive consequences, discriminating against individuals with small incomes and wealth. Wealthy savers can always shift their deposits to liquid market securities and escape the financial penalty induced by the ceilings, whereas small savers have the fewest alternative ways to invest their limited assets and are least sophisticated about using those alternatives.

Economic Synopsis
Deposit interest rate ceilings

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Abstract
This article surveys two strands of literature on deposit interest rate ceilings. First, we provide an overview of articles on the so called 'Regulation Q', which was promulgated in the United States in 1933 and lasted for more than 50 years. It is a very rich experience with deposit rate controls and their subsequent liberalization, and it generated large controversy amongst American economists, in particular since the mid-1960s when the deposit rate ceilings became permanently binding. We also review a second and mostly unrelated strand of literature consisting of articles, some of them rather recent, which discuss and assess deposit rate ceilings as a prudential tool, alone or in conjunction with some form of minimum capital requirements, based on banking models developed for the purpose.

1. Introduction

Interest rate ceilings were commonly used in banking regulation until the 1980s. Before the implementation of the first Basel Accord (Basel I), signed in July 1988, there were already in place minimum capital ratios for banks in some advanced economies but with limited scope and low harmonization. Following Basel I, minimum capital requirements were gradual and formally adopted in most developed countries, whilst controls on (deposit and loan) interest rate were progressively eased or abandoned.[1]

There is a strand of economic and financial literature which assesses the experience with deposit rate controls and their subsequent liberalization in specific countries. A large part of this literature, and in our view the most interesting for its lessons, focus on the particular case of the regulation on deposit interest rates in the United States (US), generally known as 'Regulation Q', which was promulgated in 1933 and lasted for more than 50 years. It generated great controversy amongst the US economists, in particular since the mid-1960s when the deposit rate ceilings became permanently binding. In section 2, we will provide an overview of articles devoted to Regulation Q and its effects.

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1. In Europe, the Basel I Accord was laid down into Community law through the adoption in 1989 of the Solvency Ratio and Own Funds Directives. Together with the Second Banking Directive, they aimed at harmonizing prudential banking supervision regulation, and were transposed into national law by the member states by 31 December 1992.

In section 3, we will review an unrelated strand of literature, some of it rather recent, which discusses and assesses deposit rate ceilings as a prudential tool, alone or in conjunction with some form of minimum capital requirements, based on banking models developed for the purpose.

In section 4, we will conclude by summing up the main take-aways from our overview of the literature in terms of prudential banking supervision, monetary policy and also distributive consequences of imposing deposit rate ceilings.

2. Regulation Q in the United States

In March 1933, in the wake of the 1929 stock market crash and amidst the greatest spate of bank failures in the US history, a bank holiday was declared and the Congress reconvened in a special session to pass emergency legislation, including the Banking Act of 1933 (also called Glass-Steagle Act), which was adopted by Congress in May and signed by President Roosevelt on 16 June 1933. Interest rate controls were included at a final stage during the discussion of the Banking Act at the Congress. Its Section 11 amended the Federal Reserve Act and forbade interest on demand deposits, as well as empowered the Federal Reserve Board to limit by regulation the rate of interest to be paid by member banks on time and savings deposits. As a result, the so-called Regulation Q was subsequently promulgated by the Federal Reserve on 29 August 1933.

The Banking Act of 1935 extended deposit rate ceilings to non-members banks of the Federal Reserve. More than 30 years after, the Interest Rate Act of 1966 empowered the Federal Home Loan Bank Board, the thrift institutions regulatory authority, to set interest rate ceilings to deposits placed with savings and loan associations and other thrift institutions. The ceilings for time and savings deposit rates were phased out during 1981–1986 after the Depository Institutions Deregulation and Monetary Control Act of 1980. It established the Depository Institutions Deregulation Committee[2] whose main duty was to phase out Regulation Q. As of 31 March 1986, all interest rate ceilings had been eliminated except for the ban on demand deposit interest. The prohibition of interest-bearing demand deposit accounts was effectively repealed by the (Dodd–Frank) Wall Street Reform and Consumer Protection Act of 2010. Beginning 21 July 2011, financial institutions in the US have been allowed to offer interest-bearing demand deposits.

Cox (1967) and Gilbert (1986) are two references, *inter alia*, for the historical background of Regulation Q in the US. According to the latter author, that were four main congressional objectives which led to the introduction of deposit rates ceilings in the US in 1933:

(1) To incentivize small country banks to lend more in their regional communities rather than hold balances with larger banks in financial centers, as there was the perception

2. Voting members of the DIDC included the Secretary of the Treasury and the chairpersons of the reserve Federal Board, Federal Deposit Insurance Corporation, Federal Home Loan Bank Board, and National Credit Union Administration. The Comptroller of the Currency was a non-voting member.

that the latter used the funds for speculative purposes, thus depriving local business and individuals of credit that could have been used productively;

(2) To reduce liquidity problems of the large banks because there was the belief that deposit withdrawals of small local banks from their accounts with the large national banks were contributing to pronounced seasonal patterns in liquidity and the occasional financial panic;

(3) To curb excessive competition for deposits which not only reduced bank profits by raising interest expenses, but also might have caused banks to acquire riskier assets with higher expected returns in attempts to limit the erosion of their profits;[3]

(4) Finally, to moderate protests of bankers about the high cost of the federal deposit insurance premiums because there was the belief by some members of Congress that the savings in interest expense resulting from deposit rate ceilings would exceed those premiums.

Objectives (2) and (3) have a clear macroprudential flavor (the term did not exist at the time the legislation was passed).

From 1933 through 1965, Regulation Q ceilings constrained deposit rates paid by most banks for only short intervals. However, after 1966 the ceilings effectively constrained the rates paid by commercial banks and thrift institutions on at least some categories of deposits. The second half of the 1960s were characterized in the US by rising inflation and market interest rates.

In the fall of 1966, interest rate ceilings on deposits were set slightly higher at thrifts than at commercial banks. Higher interest rates at thrifts were intended to induce depositors at commercial banks to shift their deposit accounts to thrift institutions. However, this policy did not yield the anticipated results. Keeping deposit rate ceilings (including those at thrift institutions) clearly below market interest rates (as they were for most of the period from 1966 to 1986), contributed to slow down the growth rate of deposits at banks and thrifts.

Since deposit rate ceilings became binding since mid-1960s, banks and thrifts competed for deposits by offering depositors a variety of gifts, 'free' services, and an expanded office network more conveniently located. Spellman (1980) discusses this non-rate competition of banks for deposits, which is the financial analogue to non-price competition in the goods and services markets. He remarked that besides the explicit and observed deposit rate, one may define and estimate an implicit deposit rate in the form of financial services and goods, determined by costs incurred by banks and thrifts besides those associated with the payment of interest on deposits.

Barro and Santomero (1972), when estimating the demand for money in the US, had provided a series of estimates of the implicit interest rate paid on demand deposits (which by law had a zero explicit interest rate). Startz (1983) followed on this issue using

3. Two studies carried out in the 1960s, Benston (1964) and Cox (1966), claimed that in the 1920s, before US bank deposit rates were regulated, there was little relationship between deposit rates and bank risk-taking, contrary to had been thought in the 1930s. Using more sophisticated statistical techniques and better data, Rolnick (1987) reassessed this conclusion and showed a strong multivariate correlation between the passbook deposit rate and risk variables like the leverage ratio.

a theoretical monopolistic competition model adapted from Chamberlain (1962) and concluded that a legal restriction on the demand deposit rate results in only a partially effective economic restriction. When a binding ceiling on the explicit deposit rate exists, the implicit rate will be positive but below the shadow rate. Also according to Startz (1983)'s model, given a binding ceiling on the explicit deposit rate, an increase in the number of banks competing in the deposit market will increase the implicit rate.

A relevant effect of Regulation Q was that it altered the distribution of wealth in the economy, discriminating against the relatively less wealthy savers. The wealthier savers could always shift their deposits to liquid market securities and escape the financial penalty induced by the deposit rate ceilings. This distributional effect was aggravated by the Federal Reserve decision in June 1970 to exempt from Regulation Q deposits of USD 100,000 or more.

Several prominent US economists reacted strongly against the Federal Reserve management of interest rate ceilings from the mid-1960s under Regulation Q and one of their main points was the allocative and distributive consequences of a policy of deliberately keeping low ceilings relative to market interest rates. Tobin (1970) claimed that it discriminated against the small saver who could not earn market interest rate (although the small borrower paid it). He wrote that small savers cannot easily go into the open market in search of higher yields because they are impeded by the significant minimum denominations and lot sizes of market instruments, by brokerage fees, and by their own unfamiliarity and ignorance. According toTobin (1970), by conducting the low deposit rate ceilings policy, the Federal Reserve was denying the small saver the compensation for the high inflation,[4] anticipating that such discriminatory policy could not last long and would gradually be eroded by some form of market arbitrage.

Tobin (1970) also dismissed the Federal Reserve arguments that increasing the deposit rate ceilings would be expansionary and thus would further contribute to increase inflation. He stated that, in principle, the same degree of effective monetary restraint can be easily achieved with low ceilings, high ceilings or with no ceilings, because the overall monetary effects of ceiling regulations tend to be small and easy to neutralize by traditional market-oriented monetary controls.

Friedman (1970) categorized the consequences of deposit rate ceilings into four classes: Equity, efficiency of capital markets, effect on monetary aggregates, and effects on inflation. As for equity, the arguments are very similar to the ones put forward by Tobin (1970): depositors who receive less interest on their deposits are mostly holders of relatively small deposits, generally individuals with small incomes and wealth, and these people have the fewest alternative ways to invest their limited assets and are least sophisticated about the alternatives. One populist justification was that the "poor" are

4. Tobin (1970) also argued that the low deposit rate ceilings policy had been advocated and supported by the Federal Home Loan Bank Board, the regulatory authority of savings and loans associations, on cosmetic grounds, such that losses would not show up either in the balance sheets or in the income statements of the thrift associations. Borrowing short (deposits) and lending long (home mortgage loans), the thrifts institutions had suffered significant capital losses when there was the general rise in interest rates (their portfolios were full of mortgages made at the low interest rates of the past).

borrowers, not lenders, and deposit rate ceilings keep down the interest rate charged to borrowers. In any event, this argument would call for limiting interest rates on loans, not rates paid to depositors. Friedman (1970) considered that borrowers who were able to acquire funds at a lower interest rate were not those who borrowed from institutions affected by the controls but those who borrowed from other lenders. The deposit rate ceilings reduced the real volume of funds available to the institutions affected because it rendered less attractive to place funds with those institutions. Given the smaller volume of funds to lend, in some situations the interest rate charged for loans may even had been higher not lower than in the absence of controls.

Regarding the effect of deposit rate ceilings on the efficiency of capital markets, Friedman (1970) remarked that controls, if effective, distort the capital markets. Defenders of deposit rate ceilings in their argumentation had claimed they wanted to distort the market to favor housing, in order to divert funds from commercial banks (specialized in lending to businesses) to saving and loan associations (specialized in financing housing and construction). However, the deposit rate ceilings clearly had reduced the total real volume of funds going to banks and thrifts combined, resulting in both having less funds available, and meaning that credit to housing and construction had been hurt, not helped.

Concerning monetary aggregates, Friedman (1970) highlighted that one side effect of deposit rate ceilings is that they rendered the usual monetary aggregates difficult to interpret and they promoted instability of the relationship between monetary aggregates and income and other macroeconomic indicators. This is explained by the fact that, insofar as the controls are effective, they lead to changes in the ratio of demand to time and savings deposits as the spreads between ceilings and market rates change, thus affecting the relative rates of growth of monetary aggregates M1 and M2. If ceilings on time and savings deposits are clearly below market rates, M1 tends to be higher due a larger volume of demand deposits, and M2 becomes smaller with deposit rate ceilings than without controls due to disintermediation, i.e. leakage of deposits to close substitutes.

Therefore, if one sees in M2 more merit in terms of stability of the relationship with income, Regulation Q appeared as having anti-inflationary effects. However, the relationships of M1 and M2 with income are less stable than without controls and the effects on the velocity of money may be substantial, making it quite hard to establish a presumption whether the net result of regulation Q is anti- or pro-inflationary. According to Friedman (1970), in terms of monetary policy, the only possible advantage in using Regulation Q was political. The existence of ceilings on rates paid by banks was reducing the pressure for an expansive monetary policy from the housing industry, savings and loan associations.

As mentioned, these papers by Tobin (1970) and Friedman (1970) were published as a reaction to the management of deposit rate ceilings by the Federal Reserve (and the Federal Home Loan Bank Board) in the late 1960s. During the 1970s, interest rates were kept below market rates for time and savings deposits under USD 100,000. In June 1978, when market rates were rising sharply, the Federal Reserve authorized banks and thrifts to issue Money Market Certificates, with a minimum denomination of USD

10,000 and an interest rate ceiling that fluctuated with the yield on 6-month Treasury bills (the ceiling for thrifts was set each week 25 basis point higher than for commercial banks). Sharp increases in market interest rates in late 1979 and early 1980, combined with Regulation Q ceilings, induced large outflows of small denomination deposits from banks and thrifts. The situation triggered the above mentioned decision to gradually phase out Regulation Q. The Monetary Control Act of March 1980 increased federal deposit insurance from USD 40,000 to USD 100,000 and gave the Depository Institutions Deregulation Committee broad discretion in choosing the method for phasing out the ceilings, but the committee was not allowed to raise the ceilings above market rates before 1986.

Berger *et al.* (1995) reviews the changes undergone by the US banking industry over the period 1979-1994. Amongst the topics covered by this rather extensive paper, there is a discussion of deposit accounts deregulation following the establishment in 1980 of the Depository Institutions Deregulation Committee. The authors claim that market innovations played a fundamental role in the dismantling of regulatory restrictions on deposit interest rates in the US. As a consequence of the creation of rather safe deposit-like instruments that were not subject to Regulation Q and paid market interest rates, the banking industry lost much of its monopsony power over depositors in the early 1980s.

As of 1979, the ratio of banks' interest expenses over total assets was more than 5 percentage points below the one-year Treasury yield. By 1986, when deposit rates were already totally deregulated, the spread had decreased by more than 4 percentage points. These extra interest costs were not offset by a reduction in non-interest expenses, which could have been achieved by pruning extra branches and other services previously created in the spirit of increased non-interest competition amongst banks. On the contrary, between 1979 and 1986 the non-interest expenses rose somewhat, the number of banking offices increased by almost 16 percent and the number of ATMs more than quadrupled. These data suggest that external competition to the banking industry on the liability side, as well as competition amongst banks for deposits, encouraged banks to provide not only additional interest payments to depositors, but also raised the level of customer convenience services during the first half of the 1980s. In turn, this implied a substantial rise in costs of US banks and a corresponding fall in their franchise value.

The decline in the banking industry's profitability, along with severe problems of loan performance experienced by many banks, contributed to a dramatic increase in the number of bank failures, up to 1988 mostly of very small banks. By the end of the 1980s, about 200 banks were failing each year in the US. Before 1988, only five banks with assets over USD 1 billion had been closed, but in the next five years twenty seven banks of at least that size failed. From 1981 through 1994 a total of 1,455 banks failed in the US, with an estimated cost of around USD 50 billion.

Berger *et al.* (1995), the exact relationship between the deregulation of deposit rates and the high incidence and great public cost of bank failures is unknown, but a possible theory is that the reduction of profitability incentivized troubled banks to gamble by increasing their portfolio risk. Most banks that failed in the late 1980s and early 1990s

had both high costs and large quantities of non-performing loans, indicating that moral hazard played an important role in the process.

Berger *et al.* (1995) also document that the failures occurred in spite of deposit rate ceilings being progressively replaced by capital requirements. Up to 1981, there were no formal minimum capital ratios in the US, and supervisory oversight generally required less capital for large banks because of their presumed better diversification of risks.[5] From December 1981, when deposit rate ceilings were being phased out, flat (i.e. non risk-weighted) capital requirements were introduced for regional and community banks, and only in June 1983 were the standards extended to cover banks with business in multiple states and/or different countries. These flat-rate capital standards did not require any capital against off-balance sheet activities, and therefore encouraged the substitution of off-balance sheet counterparty guarantees (such as standby letters of credit and loan commitments backing up commercial paper) for on-balance sheet loans.

It appears that in 1980s the largest banks significantly increased their credit risk exposure by substituting from cash and securities holdings into loans.[6] About half the growth in loans was associated with commercial real estate lending, one of the riskiest investments that banks can make.[7]

Sherman (2009) summarizes and assesses the main regulatory changes that took place in the US banking system during the three decades previous to the Global Financial Crisis of 2008, thus also covering the phasing out period of Regulation Q. He reports that, from the late 1970s, investors could lend directly to borrowers in the commercial paper market, bypassing banks as intermediaries. Brokers and other financial institutions began to create money market mutual funds, which pooled investors' funds to purchase commercial paper. These money market funds operated without reserve requirements or restrictions on rates of return, and quickly became popular, even amongst small investors who shifted their money out of deposits.

In 1982, the US Congress passed the Depository Institutions Act (also known as the Garn-St. Germain Act) which authorized thrifts to engage in commercial loans up to 10 percent of their assets and offer a new type of deposit account to compete directly with money market funds. It also provided direct capital assistance to distressed institutions and expanded federal regulators' ability to deal with them. While intending to benefit thrift institutions, the Garn-St. Germain Act allowed them to behave more like banks and take new types of risks which proved some years later to be a problem.

Moreover, the thrift industry was already in distress since the end of the 1970s, and in the early 1980s was facing the disappearance of the advantage that it held over banks due to higher specific deposit rate ceilings. In their traditional business, in a period

5. In 1979, the leverage ratio (i.e. equity to total non-risk-weighted gross assets) for megabanks in the US was 3.9%, while it was 8.5% for small banks.

6. Between 1979 and 1989, banking groups with more than USD 100 billion in total assets increased the fraction of assets invested in loans and leases from 57.7% to 69.8% (and correspondingly decreased their cash and securities holdings from 32.2% to 19.4%).

7. Between 1979 and 1989, the share of assets going into commercial real estate nearly doubled from 6.3% to 11.6%.

of high inflation and strong competitive pressures for deposits, thrifts were especially vulnerable to the typical asset-liability mismatch (short-term deposits and very long term loans). Most thrifts reported large losses in the early 1980s, and institutions failed at a regular pace. However, no large-scale action was taken by the authorities for a variety of reasons. For one, the industry's deposit insurance fund was ill equipped to deal with the prospect of widespread insolvency. According to estimates at the time, it needed around USD 25 billion to bail out the industry in 1983 and had reserves of only around USD 6 billion.

In addition, between the years of 1982 and 1985, thrifts invested in condominiums and other commercial real estate, shifting the investment portfolios away from the traditional home mortgages into higher-risk loans. After the passage of the Tax Reform Act of 1986, which eliminated many of the tax shelters that had made real estate such an attractive investment, the boom in real estate went burst and deposits fled from thrifts. The thrift industry declined from 3,234 to 1,645 institutions and the failures cost to the tax payers around USD 210 billion (with the industry itself providing another USD 50 billion).

There are three other papers worth mentioning as regards the effects and consequences of Regulation Q in the US. The first of them is Mertens (2008), which claimed that the regulatory deposit rate ceilings and their removal was an important cause behind the change in output and price volatilities in the US. Output and inflation volatility had dropped considerably since the early 1980s, the so-called Great Moderation. Clarida *et al.* (2000) and Cogley and Sargent (2005), *inter alia*, focused on shifts in monetary policymaking, arguing that the Federal Reserve had become more successful in fighting inflation and stabilizing economic activity. Others, such as Bernanke and Mihov (1998) and Sims and Zha (2006), found little evidence for a break in the conduct of monetary policy in the US. Against this background in the literature, Mertens (2008) argued that a large part of the reduction in volatility was likely explained by the removal of the deposit rate ceilings. He based his conclusion on the results of two models, one theoretical (a dynamic stochastic general equilibrium model, based on a money-in-utility framework) and the other model empirical (a two-regime structural autoregressive model, one with and the other without binding deposit rate ceilings).

Regulation-induced disintermediation occurs when depository institutions experience drops in deposit inflows because legal ceilings prevent the payment of higher interest rates offered on market instruments. Whenever banks were unable to raise deposit rates above the legal ceilings, banks could not compete effectively with market instruments and failed to manage their liabilities in the same way as without binding regulations. Disintermediation potentially has real effects if the resulting shortage of loanable funds forces banks to cut back on lending to borrowers that rely on intermediated finance. In that case, deposit rate ceilings affects monetary policy transmission mechanism and provides monetary policy with a greater leverage over real activity. Thus binding deposit rate ceilings from mid-1960s up to the early 1980s may have contributed to business cycle volatility since, in contrast to the post 1980s years, every recession during that period was associated with outflows in all deposit categories.

In turn, Koch (2015) addressed empirically the related question of how deposit rate ceilings embodied in Regulation Q affected individual banks' lending and the transmission of monetary policy to credit in the US until de mid-1980s. For that purpose, Koch (2015) considered a panel of quarterly bank balance sheet data from 1959Q4 to2014Q4 containing about one million bank-quarter observations.

According to Koch (2015)'s results, during the Regulation Q era, large part of credit growth responses of banks can be explained by the interaction between rate ceilings and monetary policy (i.e. changes in the federal funds rate), whilst afterwards during the Great Moderation monetary policy seems to have had only very minor effects on bank level credit growth. All else being equal, the propagation of monetary policy through bank loan supply shifts seems to have diminished substantially, pointing to an attenuation of shock propagation driven by regulation. Hence, the result of deposit rate ceiling deregulation was primarily the diminished ability of the Federal Reserve to directly shift loan supply schedules of individual banks, implying that the traditional bank lending channel at the business cycle frequency is orders of magnitude weaker than in Regulation Q era, if not completely defunct.

Lucas (2013) concurs that the interaction of Regulation Q and the US inflation in the 1970s drove business deposits out of the regulated commercial banks and into substitute forms of liquidity, possibly setting the stage for the crisis of 2008. By 1980, the spread between the market rates and deposit rates were on the order of 8 percentage points. Such returns attracted competitors that offered substitute forms of liquidity paying depositors something closer to market interest rates. These processes of substitution scattered deposits out into the world of 'shadow banking' and largely ended the constraints imposed by Regulation Q, making the Glass-Steagall Act repeal just a formality. According to Lucas (2013), none of the substitutes of deposits (Eurodollars, money market funds, etc.) involved technical or conceptual advances in banking practice. They were simply workarounds designed to evade the restriction imposed by Regulation Q, contrary to other genuine financial innovations like the repo market and the derivative assets.

3. Deposit rate ceilings as a prudential tool

Financial liberalization tends to increase the intensity of competition between banks at the same time that banks are given greater freedom to allocate assets and to determine interest rates. As a consequence, the potential scope for gambling by banks also increases, thus raising the need for effective prudential regulation.

Besides papers on specific country experiences, especially those on the US Regulation Q summarized in the previous section, there is an another strand of literature developing (mostly theoretical) models of banking where deposit rate ceilings are discussed and assessed as a prudential tool, alone or in conjunction with some form of minimum capital requirements.

An earlier paper in this literature is Eichberger and Harper (1989). They present a very simple theoretical model, loosely motivated by the experience of financial

deregulation in Australia, with one single bank and one single non-bank financial institution which compete in duopsony for deposit balances. Deposits offered by the two institutions are imperfect substitutes, and they both have the objective of profit maximization. It is shown that the imposition of a deposit interest rate ceiling on the bank can increase its profit in the detriment of the non-bank. However, an increase in the degree of substitutability between the two types of deposits can reverse this conclusion.

Therefore, according to Eichberger and Harper (1989), if bank deposits and investments with non-banks are not close substitutes, deposit-rate ceilings prevent destructive competition amongst banks. If banks are forced to pay more for deposits then they are tempted to invest in riskier assets to help defray their larger financing costs, implying an increase of the chance of a bank crisis. In other words, there is a public interest in imposing a deposit-rate ceiling.

Nielsen and Weinrich (2019), using a relatively simple theoretical model of perfect competition in the banking sector, deal with a similar issue, and reiterate Eichberger and Harper (1989)'s conclusion. In their model, depositors maximize utility and live for only one period in non-overlapping generations. Each has an initial wealth at the beginning of the period, a portion of which can be transferred to the end of the period by depositing with a bank or investing in an outside asset. The bankers invest the funds raised as deposits either in a risk-free asset or in a risky asset. Depositors fund the deposit insurance through taxes and receive any bank profit at the end of the period. Depositor's utility depends both on consumption during the period and the final amount of his wealth.

If the return of the risky asset is close to the risk-free rate of return, i.e. if the risky asset is not too risky, deposit-rate regulation dominates no regulation in terms of welfare. As the return of the risky asset increases, there is market leakage out of deposits and deposit rate ceilings become ineffective. According to Nielsen and Weinrich (2019)'s model, there are two opposing forces at play when riskiness increases. On the one hand, the risky asset becomes more distortive making the absence of regulation less efficient. On the other hand, deposit rate regulation will suppress savings further.

To our knowledge, Hellman *et al.* (2000) was the first paper to confront the pros and cons of interest rate ceilings and minimum capital requirements as prudential tools. They considered a reduced form model of the deposit market. Deposits are fully insured by a government agency. A bank offers an interest rate on deposits in competition with other banks. The total volume of deposits mobilized by the bank depends positively on its own rate and negatively on the competitors' rates. The degree of competition in the deposit market is indirectly introduced through the elasticity of bank's deposits relative to its own rate (the larger the elasticity, the higher the competition). The bank allocates its resources (deposits and equity, the latter set as a proportion of the former) to an asset portfolio, and may choose between two assets: a prudent asset and a gambling asset. Competition erodes bank profits implying lower franchise values (i.e. the capitalized value of expected future profits) and thus lower incentives for granting prudent loans, increasing moral-hazard issues (because bank's owners have less at stake).

Some form of prudential regulation is needed so that banks bear some of the downside risk from investing in risky assets. The standard regulatory response has

been to tighten capital requirements, so that higher capital implies higher losses for the banks' shareholders in case of default. However, in addition to this "capital at risk effect", there is a "franchise value effect" that goes in the opposite direction. Higher capital requirements reduce the return on equity, and hence the banks' franchise values, so the combined effect of capital at risk and franchise value is ambiguous. Thus, with sufficient competition banks will find desirable to gamble and prudential regulation just making use of a capital requirement is a Pareto-inferior policy choice (because besides the private loss of bank shareholders there is the large social loss generated when banks become bankrupt).

Bank deposits are government insured and so banks are essentially borrowing using the government´s credit rating. When insured financial institutions deviate to gambling, they can use the government´s own credit rating to offer high deposit rates in (socially inefficient) competition with the government. That is the reason why deposit-rate ceilings should be set, preferably in relative terms and not in absolute terms. If the deposit-rate ceiling were set at some fixed maximum spread above the equivalent-duration government bond yield, then the ceiling would adjust in a timely way to changes in market conditions.

The equilibrium analysis in Hellman *et al.* (2000) relied on first order conditions that cannot be solved explicitly, implying that the effects of capital requirements cannot be precisely ascertained. Building on Hellman *et al.* (2000), Repullo (2004) developed a dynamic model of imperfect competition in the deposit market (with fully insured deposits) that overcomes the limitation. Imperfect competition was introduced as in Salop (1979) using a circular road model with uniformly distributed customers (depositors). Depositors incur in a searching cost for the best investment conditions, which is the source of banks' market power.

In the absence of capital requirements, there are two possible equilibria, one in which banks invest in the prudent asset, and other in which banks invest in the gambling asset. In that situation, if the intermediation margins are low (i.e. very competitive markets) only the gambling equilibrium exists, while for high margins (i.e. very monopolistic markets) only the prudent equilibrium exists. For intermediate margins, both equilibria coexist.

Under rather general conditions, capital requirements are always effective in ensuring the existence of a prudent equilibrium through the workings of the capital at risk effect (but the required level of capital requirements may need to be quite high if the margin is low). Indeed, the probability of losing the equity reduces the incentives to invest in the gambling asset. Importantly, the efficiency of capital requirements as a regulatory tool increases when they discriminate in favor of investment in the prudent asset (i.e. when a larger risk weight is attached to the gambling asset when computing the denominator of the capital ratio).

Like capital requirements, deposit rate ceilings are also effective in ensuring the existence of a prudent equilibrium. But unlike capital requirements which work mainly through the capital at risk effect, the relevant channel for deposit rate ceilings is the franchise value effect. By enlarging the interest margin of banks, deposit rate ceilings increase the present value of the banks' future profits and so stakeholders have more

to lose when the bank gambles. However, in order to be effective, deposit rate ceilings may require very low (even negative) interest rates so as to generate a sufficiently large margin. This is a similar limitation as obtained for flat (i.e. non-risk-weighted) capital requirements, which may require a large capital ratio in order to ensure the existence of a prudent equilibrium. The issue is solved when one resorts to a regulatory policy based on risk-weighted capital requirements, which does not need very high minimum capital ratios if the risk weights sufficiently discriminate against the gambling assets.

Egan *et al.* (2017) proposed a structural empirical model of the US banking sector inspired on the theoretical models put forward by Diamond and Dybvig (1983), Goldstein and Pauzner (2005), and related literature. It makes the important distinction between insured and uninsured deposits, and pays particular attention to the presence of multiple equilibria and the possibility of bank runs.

Deposits represent over three-quarters of the funding of US commercial banks and approximately half of the deposits are uninsured. Uninsured deposits become frequently impaired in cases of bank default, and therefore are potentially prone to runs. The strength of the feedback between deposits and financial distress depends on how costly deposits withdrawals are for banks, and how they respond to a raised probability of withdrawals (for example, by raising interest rates). Egan *et al.* (2017)'s model aims at quantifying these forces and at assessing the effects of different alternative regulatory policies (in particular, capital requirements and deposit-rate ceilings) with respect to bank stability and overall welfare. It was estimated and calibrated on a dataset covering the largest US banks over the period 2002-2013.

In the model, depositors are fully rational, anticipate the probability of default, and incorporate these beliefs when choosing a bank to place their deposits. Every period, depositors choose among banks to place insured and uninsured deposits, taking interest rates offered by banks as given. Besides interest rates, deposit demand responds to changes on the financial health of the bank in the case of uninsured deposits (but not in the case of insured deposits). The probability and magnitude of a bank run are influenced by the elasticity of uninsured deposit demand with respect to financial distress (the banks' probabilities of default are taken as given by depositors). The demand for deposits also depends on the differentiation of services associated with deposits from which depositors derive utility.

As regards banks, they compete for insured and uninsured deposits by setting interest rates in a standard Bertrand-Nash differentiated products setting (following Matutes and Vives (1996)). Banks earn stochastic returns from the investments made with the funds collected from deposits, long term debt and equity issuance, and choose optimal deposit rates given the demand for deposits which they face. Each period, banks decide (endogenously) whether to continue operations by repaying deposits and the long-term debt coupon. Alternatively, banks can declare bankruptcy if returns are low and fall short of required payments. A bank in financial distress has to offer higher interest rates on deposits, which decreases its profitability. Equity holders are allowed to recapitalize the bank in distress at the end of each period. Regulators then inspect whether the bank can repay all deposits and other debt that has come due. If not, the bank is taken into receivership.

Hence, in the model uninsured depositor utility depends on bank survival, and bank survival depends on demand for deposits. This interaction leads to potential multiple equilibria, in which different levels of default are possible for the same fundamentals of banks. If some depositors choose to not deposit with a bank, its value decreases, making it more likely that equity holders will allow the bank to slide into bankruptcy and that other depositors will not place funds with the bank. The bank will fail if it does not have enough funds to repay deposits and debt come due, and if equity holders decide not to recapitalize the bank.

The instability of one bank can propagate to other banks through competition, in particular through interest rates. The unstable bank mobilizes funds (both insured and uninsured deposits) by raising interest rates. Insured depositors will be less sensitive to the bank's probability of default and that may imply a rise in the bank's market share of insured deposits. In other words, the bank in distress has incentive to take advantage of the deposit guarantee with two consequences: 1) by raising interest rates it will lead other banks to also raise interest rates in order to minimize the outflow of insured deposits, decreasing their profitability and therefore increasing their instability; 2) in case of default, the distressed bank's higher market share of insured deposits will increase the cost faced by the deposit insurance scheme (ultimately by the tax payer).

In the baseline model, without capital requirements and deposit rate ceilings, limited liability protects equity holders and in case of default they only lose their investment. When a minimum capital ratio is considered, the return on equity decreases and banking sector stability in the model's best equilibrium declines (due to the reduced profitability). In this good equilibria, depositors believe banks are quite stable and demand for deposits is high, and so the consequences of imposing capital requirements are not very significant. However, while slightly deteriorating the good equilibria, capital requirements have the advantage of removing some of the worst equilibria faced by the banking sector when no capital requirements are considered. It is worth mentioning that, with the data for the US, the model indicates that overall welfare losses in bad equilibria are substantial for capital requirements below 18 percent (and that in the worst equilibrium welfare starts to decrease after capital requirements exceed 39 percent, but the latter value is not robust to model perturbations).

The imposition of a deposit rate ceiling might prevent banks from taking advantage of the deposit insurance scheme and will limit the effect of spillovers on the other banks. However, while a deposit rate ceiling makes the banking system more stable from the perspective of default rates and less costly to the deposit insurance scheme, it can have an adverse effect on the level of uninsured services provided by the banking system. Indeed, when including in the model limits on deposit rates, the model leads to several possible equilibria in which uninsured deposits leave the banking system even if banks are more stable.

4. Main take-aways from the literature

We conclude this article by summing up which are, in our opinion, the main take-aways from the economic and financial literature on the advantages and drawbacks of imposing deposit rate ceilings.

Higher capital requirements reduce the return on equity and hence banks' franchise value. They also imply larger losses for the banks' shareholders in case of default. With sufficient competition, banks will find desirable to gamble and prudential regulation making use of minimum capital requirements may become a Pareto-inferior policy choice due to the large social loss generated when banks default. The problem is mitigated if capital requirements efficiently discriminate in favor of investment in prudent assets by attaching a larger risk weight to riskier assets when computing the denominator of the capital ratio.

Deposit rate ceilings may be envisaged as a possible alternative or, more likely, as a complementary prudential banking regulatory tool, either on a permanent or on a temporary basis. If banks are forced to pay more for deposits then they are tempted to invest in riskier assets to help defray their larger financing costs, implying an increase of the chance of a bank crisis. Unlike capital requirements, which work mainly through the increase of capital at risk for banks' shareholders, the relevant channel for deposit rate ceilings is the franchise value effect. By enlarging the interest margin of banks, deposit rate ceilings increase the present value of the banks' future profits and so stakeholders have more to lose when the bank gambles.

Furthermore, in the absence of deposit rate ceilings, a bank in distress has the incentive to take advantage of the public deposit insurance by raising interest rates. But doing so it will lead other banks to also raise interest rates in order to minimize the outflow of deposits, decreasing their profitability and therefore increasing their instability. In case of default, the distressed bank's higher market share of insured deposits will increase the cost faced by the deposit insurance scheme (ultimately by the taxpayer).

However, deposit rate ceilings are subject to several important shortcomings.

Significant regulation-induced disintermediation may occur if legal ceilings prevent banks from the payment of higher interest rates on deposits as offered on market instruments. Deposit rate ceilings are only effective if bank deposits and other liquid investments with non-banks are not close substitutes. In advanced economies these processes of substitution would tend to scatter a significant part of deposits out of banks, largely compromising the effectiveness of the legal ceilings and at the same time pushing household savings to securities often of under-perceived riskiness. This movement out of deposits will be more pronounced for large uninsured deposits, although it may be non-negligible even for relatively small time and savings insured deposits.

The imposition of deposit rate ceilings might encourage banks to strongly raise the level of customer convenience services by offering depositors a variety of services free-of-charge, and to excessively expand their office network in order to become more conveniently located. This non-rate competition of banks for deposits may imply a substantial increase in costs incurred by banks besides those associated with the

payment of interest on deposits. The corresponding fall in their franchise value will counteract the main channel through which deposit rate ceilings exert their prudential effect.

Disintermediation has real effects if shortage of deposit funds arises and forces banks to cut back on lending to borrowers that rely on intermediated finance. This response by banks may be mitigated by the central bank through appropriate financing which becomes crucial in the presence of binding deposit rate ceilings. Indeed, the latter have the potential to affect monetary policy transmission mechanism and thus provide monetary policy with a greater role due to the increased leverage over real activity.

Last but not least, a relevant effect of a policy of deliberately keeping low deposit rate ceilings relative to market interest rates is that it may have strong allocative and distributive consequences, discriminating against individuals with small incomes and wealth. Wealthy savers can always shift their deposits to liquid market securities and escape the financial penalty induced by the ceilings, whereas small savers have the fewest alternative ways to invest their limited assets and are least sophisticated about using those alternatives.

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