Wholesale Funding Runs*

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Abstract

Banks heavily rely on wholesale funding markets. Theories based on adverse selection predict that if lenders cannot discriminate between high- and low-quality banks, funding markets can freeze. To shed light on this view, we use transaction-level data on a large, yet so far neglected, segment of the European wholesale funding market between 2008 and 2014. This segment is a priori fragile: It concerns short-term, unsecured debt. Yet, we do not observe any freeze during a period that includes both the subprime crisis and the European sovereign crisis. Many banks do, however, suddenly lose all of their funding and experience "wholesale funding runs". Banks with low future quality are more likely to face runs. Higher future quality banks tend to increase their reliance on the market in periods of stress. We conclude that, during the period we study, the wholesale market is not primarily affected by adverse selection, but seems to have been able to successfully reallocate funds from low- to high-quality banks.

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1 Introduction

To finance themselves, banks rely both on retail deposits and on wholesale funding. The latter includes repurchase agreements, interbank loans, and debt securities sold on financial markets. A prevailing view among economists and regulators is that wholesale funding is vulnerable to market freezes. If wholesale lenders cannot observe bank quality, due to asymmetric information, both high- and low-quality banks can lose access to borrowing – this effect being stronger in times of stress (Goldstein and Razin, 2015). Such market breakdowns have major macroeconomic consequences as they force banks to cut lending to the real economy (Iyer, Lopes, Peydro, and Schoar, 2014). To mitigate this concern, new regulatory liquidity ratios penalize the use of wholesale funding (Tarullo, 2014).

In this paper, we investigate the behavior of wholesale markets in times of stress. We use novel data on a large, yet so far neglected, segment of the European wholesale market. Our first null hypothesis is that high and low-quality banks are equally likely to lose access to wholesale funding (i.e., to experience a *wholesale funding run*) in times of stress. This hypothesis is consistent with extreme adverse selection where investors cannot accurately assess bank quality. We reject this hypothesis and find that runs predict further deterioration of banks' financial conditions, even after controlling for observable characteristics at the time of the run. Our second null hypothesis states that, in times of stress, high quality banks reduce their borrowing more than low quality banks. This hypothesis would be consistent with standard theories of market freezes based on adverse selection, whereby stress coincides with a deterioration of the pool of borrowers and may potentially lead to market failure. We also reject this second hypothesis and show that banks that increase funding during periods of market stress are of higher future quality, controlling for current performance.

Two facts motivate our analysis. First, several large segments of the wholesale funding market did not freeze during the financial crisis. The repo market did not collapse, neither in the U.S. (Krishnamurthy, Nagel, and Orlov, 2014; Copeland, Martin, and Walker, 2014), nor in Europe (Boissel, Derrien, Ors, and Thesmar, 2015; Mancini, Ranaldo, and Wrampelmeyer, 2015). Perhaps more surprisingly, some unsecured debt markets, such as

the U.S. Fed funds market, continued to operate even in the days following the collapse of Lehman Brothers (Afonso, Kovner, and Schoar, 2011). The second basic fact is that some banks did lose access to wholesale funding markets (see Shin, 2009, for a case study on Northern Rock). Together, the facts that (i) markets did not freeze in aggregate and that (ii) some individual institutions faced runs suggest that funds were reallocated across institutions. We study whether the basic patterns of reallocation are consistent with significant adverse selection in the market.

Our sample consists of more than 80% of the market for euro-denominated Certificates of Deposits (CDs), which is itself a sizable component of the European wholesale market. CDs are unsecured short-term debt securities issued by banks.[1] Our data include characteristics of all issues in this market segment at the ISIN level, as well as the identity of issuers, from January 2008 to December 2014. We analyse more than 1.3 million ISIN-level observations for 276 banks originating from 22 countries. Issuance data are matched with issuer characteristics from Bankscope and with market data from Bloomberg. We first document that this market is large. The amount of debt outstanding in our sample is around EUR 400 Bn. It is comparable to the European repo market, and about ten times as large as the unsecured interbank market. Second, we observe that the CD market did not experience any freeze during our sample period.

This resilience, however, masks considerable heterogeneity. We identify a number of banks that experienced wholesale funding runs, i.e., banks whose amount of CDs outstanding dropped to zero (full run), or dropped by more than 50% in the course of 50 days (partial run), in an otherwise stable market. We isolate 75 runs over the 2008-2014 period, of which 29 are full runs. We are careful in making sure that these runs are not demand-driven and do not come from banks' decisions to switch funding sources. For instance, we document that runs are preceded by a significant shortening of debt maturity.

We start by comparing ex ante characteristics of banks that experience runs to those of other banks. The former have on average lower profitability, more impaired loans, higher book leverage, and higher credit risk. We then test whether wholesale funding runs *predict*

[1]Bank CDs are the counterpart to commercial paper issued by non-financial corporations (Kahl, Shivdasani, and Wang, 2015).

future bank performance, which we use as a proxy for bank quality. We find that banks experiencing runs are those whose performance is set to decrease in the future, controlling for current characteristics. The occurrence of runs also predicts a subsequent increase in CDS spreads – and to a lesser extent negative excess stock returns. We address reverse causality (i.e., that runs could *cause* lower future performance) by providing additional evidence. First, runs also predict an increase in impaired loans, a measure admittedly less obviously prone to reverse causality. Indeed, these loans were extended prior to the runs. Second, the predictive power of runs on performance is not driven by banks that heavily rely on CD funding (for which a sudden dry-up would be more hurtful). Third, the lower future ROA of banks facing runs does not seem to be due to fire sales as their total assets remain stable.

Finally, we turn to issuers that did not experience any run. Banks that increase funding in the CD market are shown to perform better in the future, again, conditional on current information. Importantly, this effect increases with market stress – as measured by the number and the size of runs. Overall, these findings strongly support the idea that periods of stress are characterized by a cross-sectional reallocation through which better-performing banks receive *more* funds, not less. We therefore conclude that the allocation of funds in this market is not primarily affected by adverse selection.

This paper primarily contributes to the literature on the workings of wholesale funding markets in times of stress. To the best of our knowledge, this is the first empirical analysis of the CD market. Most papers so far study repo markets (Gorton and Metrick, 2012; Krishnamurthy, Nagel, and Orlov, 2014; Copeland, Martin, and Walker, 2014; Boissel, Derrien, Ors, and Thesmar, 2015; Mancini, Ranaldo, and Wrampelmeyer, 2015), and often find that they did not freeze during the recent financial crisis. In contrast, we focus on unsecured borrowing, which is arguably more likely to be subject to runs. Chernenko and Sunderam (2014) study the dollar funding run on European banks from the perspective of money market mutual funds, and find evidence of contagion to non-European borrowers. Few papers investigate the effect of bank characteristics on wholesale funding. Fecht, Nyborg, and Rocholl (2011) and Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2015)

study how the cross-section of liquidity needs and balance sheet characteristics affect banks' borrowing from the central bank. Closer to our paper, Afonso et al. (2011) analyse the unsecured U.S. Fed Funds market during the Lehman crisis. In contrast, we study a cross-section of runs, in which banks suddenly lose access to a large wholesale funding market over an extended period of time. In Europe, the CD market is about ten times as large as the interbank market, and has never been studied earlier.

Another contribution is to test whether asymmetric information plays a significant role in the allocation of wholesale funding (Bolton et al., 2011; Malherbe, 2014; Heider et al., 2015). We show that adverse selection models have a hard time rationalising actual patterns in wholesale markets: high-quality banks are both less likely to face runs, and more likely to attract additional funding in times of stress. Our finding helps to understand why wholesale funding markets have proved more resilient than expected. It also challenges the premise for introducing liquidity ratios. However, a full-fledged policy assessment of these regulatory tools would require negative externalities induced by runs to be taken into account.

The CD market is a unique laboratory to study the effects of asymmetric information on funding markets. First, as CDs are unsecured, the only source of asymmetric information is the creditworthiness of the borrower. In secured markets, such as the repo market, the quality of the collateral can also be uncertain. Second, since most lenders in this market are money market funds, funding dry-ups are unlikely to be driven by liquidity hoarding, as they could in the interbank market.

Our finding that lenders can distinguish between high- and low-quality banks is a prediction of theories of runs as disciplining devices (Calomiris and Kahn, 1991; Flannery, 1994; Diamond and Rajan, 2001). By threatening to run, lenders optimally induce high effort ex ante by the bank. The fact that the maturity of new issues shortens several months before a run suggests that investors actively monitor issuers. Finally, we acknowledge that we cannot formally test whether some runs are caused by coordination failures, as in Diamond and Dybvig (1983). Doing so would require disaggregated data on the

portfolios of lenders.[2]

We proceed as follows. Section 2 derives our two main hypotheses. Section 3 describes our data and the CD market. Section 4 documents the bank-specific nature of the runs we observe. Section 5 shows that runs predict future bank performance and offers evidence against explanations based on reverse causality. Section 6 shows that periods of stress are characterized by a reallocation of funds towards better-performing banks. Section 7 concludes.

2 Hypothesis development

The analysis of market breakdowns due to adverse selection goes back to Akerlof (1970), and to Stiglitz and Weiss (1981) in the context of credit markets. The main intuition is well-known: In times of stress, asymmetric information worsens, as the dispersion of the quality of borrowers (unobservable by lenders) increases. Faced with more asymmetric information about the quality of their counterparties, lenders increase interest rates for all counterparties. This induces high-quality borrowers to exit the market and further reduces the average quality of the remaining pool of borrowers. Heider et al. (2015) model adverse selection in the context of wholesale markets and derive two equilibria. When adverse selection is moderate, the market reaches an equilibrium with a high interest rate and low-quality borrowers only. When adverse selection further worsens, the market breaks down. Both high- and low-quality banks are left out of the market, since the interest rate is not high enough for lenders.

Alternatively, under full information about counterparty quality, the interest rate charged to any bank is commensurate to its quality. Therefore, high-quality banks are charged low interest rates, and do not exit the market, even in periods of stress. In contrast, low-quality banks face a high interest rate. In the presence of an outside funding source, such as central bank refinancing operations, low-quality banks can be excluded

[2] Iyer and Puri (2012) and Iyer, Puri, and Ryan (2015) empirically study bank runs by retail depositors. One key difference between retail depositors and wholesale lenders is that the former benefit from deposit insurance. Iyer and Peydro (2011) show that wholesale funding shocks can trigger retail deposit outflows.

from the market when their quality falls below a threshold. The new interest rate that they are charged is higher than their next best outside option. Under full information, an alternative prediction is thus obtained: The average quality of the pool of borrowers should increase in times of stress, since low-quality banks exit the market. We formulate our first null hypothesis to discriminate between these competing theories.

H1: Banks that experience wholesale funding runs have the same future quality as bank that do not.

A rejection of H1 with a negative relation between runs and bank quality would mean that investors running from banks are informed. In contrast, a rejection with a positive relation between runs and bank quality would provide evidence of adverse selection. It would also cast doubts on the idea that banks losing large amounts of funding are indeed experiencing runs, but instead self-select out of the market. Finally, the absence of significant relation between runs and future quality would indicate that runs occur as sunspots, as in Diamond and Dybvig (1983).

We further investigate the reallocation of funds among banks that do not experience a run. When markets are stressed and runs occur, all models based on adverse selection predict a reduction in the average quality of the pool of borrowers. Indeed, high-quality banks refuse to pay a higher interest rate and decide to withdraw from the pool. Theory therefore predicts that reallocation benefits low-quality banks more than high-quality banks. This lead us to our second null hypothesis.

H2: When runs occur, low-quality banks increase borrowing more relative to high-quality banks.

A rejection of H2 would indicate that adverse selection is not a key determinant of the allocation of funds in wholesale markets.

3 Data description

Our dataset covers a large part of the euro-denominated CD market. Before we describe the data, we briefly provide institutional details about this market.

3.1 Certificates of deposit

CDs are short-term papers issued by credit institutions, with an initial maturity ranging between one day and one year. Unlike central bank or repo funding, these securities are unsecured. Issuance in the primary market is over-the-counter and there is typically no post-issuance transactions. CDs are mainly placed to institutional investors, such as money market funds, pension funds or insurance companies.[3] The minimum principal amount is set to EUR 150,000. Furthermore, CDs can be zero-coupon or bear a fixed or variable interest rate.

Certificates of deposits are issued as part of programs. The documentation of a program specifies a number of legal characteristics that all issuances attached to it must satisfy. The advantage of issuing CDs within a program is that no new legal documentation has to be provided to investors each time a new CD is issued, as would be the case for traditional longer-term bond issues. In a given jurisdiction, an issuer typically operates one program only; an issuer may nonetheless run CD programs in multiple jurisdictions, either to overcome some form of market segmentation or to borrow in different currencies.

3.2 Data coverage

From the Banque de France, we obtained daily issuance data on the euro-denominated CD market, from January 1, 2008 to December 31, 2014. All currencies combined, the French market is the largest market for CDs in Europe and the second largest worldwide (behind the U.S. market but before the London market, see Banque de France (2013)).

[3] According to the Banque de France, more than 90% of euro-denominated CDs are purchased by money market funds.

It is the largest market for euro-denominated CDs.[4]

The aggregate size of the euro-denominated CD market is depicted in Figure 1. Over this period, the average market size, measured daily by taking the sum of all outstanding CDs, is EUR 372 Bn and the average daily amount of new issues is EUR 21.1 Bn. Even if CDs are unsecured, this market remained remarkably resilient during episodes of market stress, as shown in Figure 1. There was no significant drop in the size of the CD market until mid 2012. The subsequent decline in CD volume is not due to market stress but to the low interest rate environment. Indeed, in July 2012, the European Central Bank (ECB) lowered its deposit facility rate to 0%. The yields on euro-denominated CDs responded immediately and also decreased to close to 0% (Figure 2, Panel A). After that, the CD market became less attractive to investors.[5]

Our data represent a large share of the euro-denominated CD market. To show this, we rely on detailed data on the largest and most liquid subsegment of the European CD market, namely the Short-Term European Paper (STEP) market.[6] From the ECB, we obtained non-public daily data on the volume outstanding of each CD program benefiting from the STEP label. Figure 3 plots the breakdown of the aggregate volume of euro-denominated CDs. The French CD market is by far the largest, before the U.K. market and other markets (Belgian, Luxembourgian, etc.). On average over the sample period, it represents 81.5% of the aggregate euro-denominated CD volume.

3.3 Securities and issuer characteristics

Our data consist of the universe of CDs issued in the French market. There are 276 individual issuers, which are described in Panel A in Table 1. Among them, 196 are

[4]CDs in a number of other currencies (e.g. USD, JPY, GBP, CHF, CAD, SGD, etc.) are also issued in the French CD market. The issuance activity in currencies other than the euro, however, is much more limited and is not included in our analysis.

[5]Relatedly, Di Maggio and Kacperczyk (Di Maggio and Kacperczyk) find that money market funds were more likely to exit the U.S. market after the introduction of the zero interest rate policy by the Fed.

[6]Introduced in 2006, the STEP label results from an initiative of market participants aimed at increasing the Europe-wide integration and the liquidity of the market for short-term debt securities. Financial and non-financial firms benefiting from the STEP label can more easily issue CDs (or commercial paper) throughout Europe. See Banque de France (2013) for additional information on the STEP label.

French and 80 are not, but they almost exclusively come from European countries (Italy, Germany, U.K., Netherlands, and Ireland). Most of the largest European commercial banks are in our dataset. Our panel is unbalanced, as some issuers enter or exit the market during the sample period, due to failures or mergers and acquisitions.

The dataset contains 1,360,272 observations, corresponding to 819,318 individual securities (ISINs). After initial issuance, additional events correspond to events occurring during the lifetime of a security, including buybacks or re-issuances on the same ISIN, which are all observed. Our data include a number of security characteristics at the ISIN level, including the issuance and maturity dates, the issuer's name, and the debt amount.[7] Furthermore, we observe The breakdown of ISIN-level events is detailed in Panel B in Table 1.

As seen in Panel C of Table 1, the distribution of issued amounts is highly skewed, with a median of EUR 900,000 and a mean of EUR 51 Mn. CDs are mostly short-term as reflected by the 33-day median maturity. The issuance frequency per bank is high: its median is 2.1/week and its mean 8.4/week.

We further match issuers with balance sheet and market characteristics, including credit ratings. We obtain balance sheet data for 263 issuers from Bankscope. We retrieve variables pertaining to banks' activity, asset quality, profitability, and capital structure. Descriptive statistics for these variables are given in Panel A of Table 2. We obtain stock price and CDS spread data at a daily frequency from Bloomberg for 43 and 64 issuers, respectively. All variables are defined in the Appendix Table A1.

3.4 CDs versus other wholesale funding instruments

European banks are the most reliant on wholesale funding worldwide, far more than U.S. institutions (see International Monetary Fund, 2013, for international comparison). To get a sense of the relative size of the euro-denominated CD market, we compare in Figure 4 its outstanding amount to three close substitutes: the repo market, the ECB's Main

[7]For confidentiality reasons, we do not have access to ISIN-level CD yields. We only access CD yields by rating-maturity buckets.

Refinancing Operations (MRO), and the unsecured interbank debt market, all measured at the Eurozone level.[8]

From this benchmarking analysis, it clearly appears that the CD market accounts for a large fraction of the Eurozone wholesale funding market. Its size is almost as large as the estimated size of the repo market (Panel A). As seen in Panel B, the aggregate volume of CDs outstanding is roughly twice as large as all funding provided by the ECB to European banks through its MROs. Finally, as observed in Panel C, the CD market is also much larger than the unsecured interbank market, which has nonetheless received much more attention (de Andoain, Heider, Hoerova, and Manganelli, 2015; Gabrieli and Georg, 2015; Abbassi, Brauning, Fecht, and Peydro, 2015).

Panel B of Table 2 provides descriptive statistics on the importance of CD funding in banks' balance sheets. For the median bank, CD funding represents 21.5% of bank equity and 3.5% of total liabilities. Reliance on CD funding can be much larger, and represents 69% of equity and 9% of total liabilities at the 75th percentile.

4 Market freezes versus bank-specific runs

In this section, we show that there was no market freeze in the European CD market over the 2008-2014 period. We then turn to defining and describing the events which we treat as bank-specific wholesale funding runs.

4.1 The absence of market freeze

A market freeze on wholesale funding would translate into a large and sudden drop in issuances in the CD market. We see in Figure 1 that such a drop did not happen over our sample period. The CD market turned out to be resilient during recent episodes of market stress. The aggregate volume of CDs outstanding remained around EUR 400 Bn

[8]MROs are one-week liquidity-providing operations, denominated in euros. They take the form of repurchase agreements against eligible assets. Due to their short maturity, they are a closer potential substitute to CD funding than other non-standard operations, such as the Long-Term Refinancing Operations (LTROs), which have much longer maturities.

until mid 2012. After that, investors slowly left the market in an environment of near zero interest rates. Furthermore, the implementation of the Liquidity Coverage Ratio (LCR) penalized short-term debt issuances.

The fact that there was no market freeze is remarkable in two respects. First, CDs are unsecured, and could in theory be more subject to runs than collateralized wholesale funding instruments such as repurchase agreements. Second, our sample period spans both the 2008 financial crisis following the default of Lehman Brothers and the European sovereign debt crisis. Both of these periods were characterized by high levels of stress in the financial sector. Major events that could have led to a freeze in wholesale funding markets, such as the nationalization of Northern Rock, the failure of Lehman Brothers or the near-failure of Royal Bank of Scotland did not lead to system-wide drops in CD volume (see Figure 1). Similarly, the volume did not drop during the European sovereign debt crisis, following the bailouts of Greece and Ireland or other major events.

To establish the result that there was no market freeze, we address two potential concerns. First, there was a EUR 100 Bn contraction of outstanding volume in 2009. One may wonder whether this is symptomatic of a run on the CD market. To show that this is unlikely, we superimpose in Figure 1 the 5-year EU Banks Credit Default Swap Index. When market stress increased following the default of Lehman Brothers, the volume in the CD market remained stable and, if anything, slightly increased. The drop in volume in 2009 corresponds to a period in which spreads on European banks were falling. It also coincides with the first long-term liquidity program (LTRO) conducted by the ECB, which provided abundant liquidity to European banks. In the subsequent period, during the European debt crisis, the large increase in spreads for European banks took place while the CD market was stable or increasing, not decreasing. Overall, the positive comovement between credit default swap spreads and the issuance volume in the CD market casts serious doubt on the idea that a market freeze was taking place.

A second concern is that, even though there is no drop in volume, there may be an increased fragility of the CD market through maturity shortening for all issuers. In Figure 5, we plot the volume-weighted average maturity of new issues at a weekly frequency,

together with the 5-year credit default swap spread on EU banks. There is no system-wide reduction in the average maturity of new CD issues when spreads increase, either during the global financial crisis or during the European sovereign debt crisis. Similarly, there was no large increase in CD yields. Over the period, average yields always remained below the ECB refinancing rate (see Figure 2, Panel A).

Taken together, all results in this section strongly suggest that there was no market freeze on CDs over the sample period.

4.2 The identification of bank-specific runs

While we do not observe any freeze in the CD market, we do observe a number of runs on individual banks, which we term *bank-specific wholesale funding runs*. A *full run* is said to occur when an issuer loses all of its CD funding, i.e., its amount of CDs outstanding falls to zero. Similarly, a *partial run* occurs when an issuer loses 50% or more of its CD funding over a 50-day period. This 50% threshold is higher than what is typically considered in the literature; for instance Covitz, Liang, and Suarez (2013), Oliveira, Schiozer, and Barros (2014), and Ippolito, Peydro, Polo, and Sette (2015) use thresholds between 10 and 20%. We take this conservative approach to minimize run misclassification. We also stress that our main results are robust to more restrictive definitions of runs, either with a higher threshold (80%) or with a shorter time window (30 days).

We are particularly careful when identifying runs. First, we exclude infrequent borrowers in order not to wrongly classify the termination of their CDs as runs. We only include issuers with an outstanding amount greater than EUR 100 million before the run starts. We also ensure that all banks included in our sample issue CDs at least once a week over the six months period preceding the run. Second, we check for each detected run whether the absence of new issues is not caused by mergers or acquisitions, which would force issuers to become inactive.

We provide summary statistics on partial and full runs in Table 3. Panel A displays the number of runs, broken down by year and by country. We identify 75 runs, 29 of which are full runs. The year with the largest number of partial and full runs is 2011.

It marks the height of the European sovereign debt crisis and it is also the year when U.S. money market funds cut dollar funding to European banks (Ivashina, Scharfstein, and Stein, 2015). Yet, we do not see any system-wide dry-up, but a larger number of bank-specific runs. Over the sample period, countries facing the highest number of full runs are Ireland, Italy, and the United Kingdom.

Figure 6 provides illustration of our events of interest by focusing on two full and on two partial runs. Full runs are those on Banca Monte dei Paschi (BMPS) and on Allied Irish Banks (AIB). BMPS (run in November 2012) had been facing large acquisition-related write-downs and had large exposure to the Italian government debt. Hidden derivative contracts were made public by the end of November 2012, causing a large loss. AIB (run in June 2010) was severely affected by the global financial crisis and the collapse of the Irish property market. In 2010Q4, the Irish government injected capital and became majority shareholder. Partial runs on Unicredit and Dexia also occurred when these institutions publicly revealed major losses. Unicredit had to make writedowns on acquisitions and had a large exposure to Greek sovereign debt. Dexia was greatly exposed to the U.S. subprime market through its U.S. monoline subsidiary. In Appendix Table A2, we provide for all sample runs excerpts from press articles suggesting that banks were financially stressed around the time of the run.

To analyze the magnitude of runs and their dynamics, we define run size as the difference in CD amount outstanding before the run starts until it ends.[9] Panel B of Table 3 shows that there is large heterogeneity in run size. On average, the magnitude of a run is close to EUR 1 Bn and represents more than 23% of bank equity. For a subset of institutions heavily reliant on CD funding, the amount of funding lost during the run is larger than their equity.

To get an aggregate view on runs, we compute a *Run Index* at a monthly frequency as

$$RunIndex_t = \frac{\sum_i R_{it}}{CD_{mt}}, \tag{1}$$

[9]For full runs, the magnitude is equal to the outstanding amount 50 days before it falls to zero. For partial runs, the magnitude is equal to the difference between the outstanding amount 50 days before the run and the post-run amount.

where R_{it} is the euro amount of the run faced by any issuer i in month t (conditional on i facing a run; $R_{it} = 0$ otherwise) and CD_{mt} the aggregate size of the CD market at the beginning of that month. Both partial and full runs are included in the computation of the index. A high value of the index signals that a subset of issuers lose large amounts of funds in a given month. Figure 7 plots the Run Index over the sample period. It was high in 2008 and also spiked a number of times during the European sovereign debt crisis of 2011-2012. In our regressions, we use this index as a measure of stress in the CD market.

4.3 Identified runs are not demand-driven

Classifying drops in CD funding as runs relies on the implicit assumption that these events are supply-driven. To check whether the identified runs really reflect a shortage of funds, and not changes in demand, we investigate the dynamics of the maturity of new issues in the six months leading to these events. If the reduction in CD funding reflects rollover risk rather than demand factors, we should observe a shortening of the maturity of new issuances prior to the run. We estimate

$$Maturity_{it} = \sum_{j=1}^{6} \beta_j Run_{i,\tau-j} + FE_i + FE_t + \varepsilon_{it}, \tag{2}$$

where $Maturity_{it}$ is the volume-weighted average maturity of all new issues by bank i in month t. τ is the month in which institution i faces a run and $Run_{i,\tau-j}$ a dummy variable that equals 1 for i if it faces a run at date $t = \tau - j$. We estimate six of these dummy variables, for $j \in \{1, ..., 6\}$. The specification also includes bank fixed effects (FE_i), as we focus on within-issuer variations, and month fixed effects (FE_t), to difference out any time trend in maturity common to all issuers. Estimates are compiled in Table 4, for all types of runs (Panel A) and for full runs only (Panel B).

The average maturity of new issues starts to shorten about five months before the run takes place, and the shortening becomes statistically significant at the 1% level three months before the run. This is true for both full and partial runs. The effect is economically large, as the within-bank average maturity of new issues (after accounting for time

trends) drops by about 30 days before full runs and by 25 days before partial runs. The monotonic drop in average maturity suggests that creditors strengthen their discipline several months prior to the run. As a general feature of events which we treat as runs, such maturity shortening is hard to reconcile with a demand-driven explanation, but is consistent with a supply-driven explanation.

A second concern is that, even if demand for short-term funding is unchanged, banks may obtain funds by turning to close substitutes, such as interbank loans, repo transactions or central bank funding. If this is true, the fact that they no longer issue CDs would not be reflective of a genuine run. There are several reasons, however, why we think this is unlikely. Most importantly, CDs are cheaper than other short-term sources of funding. As seen in Panel A of Figure 2, the interest rate on CDs is lower than the ECB Main Refinancing Operations rate. Furthermore, Panel B indicates that the spread between CD rates and the Euribor with similar maturity is negative. On average, the CD rate is 15 basis points lower than the equivalent interbank rate. Finally, if an alternative source of funding was becoming more attractive than CDs, it would arguably be so for all issuers in the market, or at least for all those with a high rating. This is inconsistent with the fact that we do not see any large drop in market size. It is also at odds with the fact that the occurrence of runs is spread over all our sample period (see Table 3). To conclude, if there is substitution, it has to be towards more expensive sources of funds, and is therefore not inconsistent with the occurrence of runs in the CD market.

5 Informational content of runs

In this section, we test our first hypothesis H1, i.e. whether runs affect high- and low-quality banks equally.

5.1 Observable bank characteristics before runs

We begin by documenting which ex ante observable characteristics are associated with the occurrence of runs. We compare the mean and median values of balance sheet char-

acteristics for banks that face a full run and for banks that do not, and we do so one year and two years before each run. Specifically, we compute statistics in the pooled sample, after differencing out a year fixed effect for each bank characteristic to control for time trends. The equality of means is tested using a two-sample t-test and that of medians using the Wilcoxon-Mann-Whitney test. Results are displayed in Table 5.

Banks facing a full run and those not facing a full run do not differ from each other significantly in terms of their sources (deposits / assets) and uses (loans / assets) of funds. However, they differ along several other important dimensions, including profitability, asset quality, capitalization, and credit risk. Banks that are about to experience a run have a lower ROA at the end of the previous year, indicating that they use their funds less efficiently. The same lower profitability is reflected in the lower ROE, lower net income, and lower net interest margins before the run. One year before the run, these differences are statistically significant at the 1% level in all but one case. In some cases, they are also significant two years before. The fact that the profitability of banks that will face a run is lower arises in part from their asset quality being lower, as measured by their ratio of impaired loans to equity. These institutions have higher credit risk, as evidenced by a higher credit default swap spread the year before the run, and by a significantly lower credit rating up to two years before the run.

Institutions that will experience a run also have a significantly lower ratio of equity to total assets, up to two years before a run. The fact that they are significantly less capitalized, with an average equity ratio lower by 3.6 percentage points, is not reflected, however, by differences in regulatory capital, measured either by Tier 1 or total regulatory capital, normalized by risk-weighted assets. Measures of regulatory capital poorly predict the occurrence of runs. This is consistent with Acharya, Engle, and Pierret (2014), who find no correlation between regulatory capital and market perception of bank risk.

Overall, these results suggest that runs do not occur as sunspots, but correlate with publicly observable fundamentals. This is consistent with historical evidence on depositor runs by Gorton (1988) and with the theoretical model of Goldstein and Pauzner (2005).

5.2 Runs predict future bank quality

In this section, we provide evidence that runs are informative about future bank quality, unobservable at the time of the run. For each run occurring during year t, only the balance sheet characteristics at the end of year $t-1$ are observable. We test whether the occurrence of runs predicts the change in relevant balance sheet characteristics between dates $t-1$ and t, after including as controls standard predictors of such bank outcomes. We focus on year-to-year changes in balance sheet characteristics, because variables in levels are likely to be autocorrelated.[10] We estimate

$$\begin{aligned} \Delta Y_{it} &= \beta_0 Run_{it} + \beta_1 \text{Size}_{i,t-1} + \beta_2 \text{Controls}_{i,t-1} \\ &\quad + \beta_3 \text{Controls}_{c,t-1} + FE_c + FE_t + \varepsilon_{i,t}, \end{aligned} \tag{3}$$

where $Run_{it} = \mathbb{1}\{t-1 \leq \tau_{Run_i} < t\}$ and τ_{Run_i} is the time of the run. $\mathbb{1}$ denotes the indicator function and takes a value of one when a run occurs on issuer i between the end of year $t-1$ and the end of year t. $\Delta Y_{it} = Y_{it} - Y_{it-1}$ is the change in a given balance sheet characteristic between the end of year $t-1$ (observable) and the end of year t (unobservable at the time of the run). FE_c and FE_t are country and year fixed effects. We estimate regression coefficients separately for full and partial runs. Our coefficient of interest, β_0, is equal to zero under the null hypothesis H1.

Consistent with our focus on the efficiency of the allocation of funds in the CD market, our dependent variable is the change in ROA. Regression coefficients are in Table 6. Panel A is for all runs and Panel B for full runs only. As seen in our main specifications (Columns 1 and 2), the occurrence of a run during year t is associated with a decrease in ROA between the end of year $t-1$ and the end of year t. This is true for all types of runs, at statistically significant levels. It is also robust to the inclusion of several bank-level controls (size, ROA, and impaired loans over total loans at $t-1$) and country-level controls (GDP growth between $t-1$ and t). Our empirical evidence allows us to reject hypothesis H1 and suggests that runs contain information about future bank quality. We

[10] This regression specification is in the spirit of Bertrand, Schoar, and Thesmar (2007). In their paper, future changes in ROA of bank-dependent firms is regressed on the lending policy of banks.

conclude that adverse selection is not a primary force driving access to wholesale funding.

A potential interpretation concern when estimating Equation (3) is reverse causality. Indeed, drops in ROA could be caused by a reduction in funding (for instance because it forces fire sales). We address this concern in three ways. First, we replace changes in ROA by changes in the ratio of impaired loans over total loans as the dependent variable when estimating Equation (3). Changes in impaired loans arguably cannot be caused by the occurrence of a run, because they primarily relate to a stock of pre-existing loans, which have already been made at times the run occurs. It is thus exogenous with respect to the occurrence of a run. Estimation results in Table 7 are consistent with those obtained for changes in ROA. The occurrence of runs predicts an increase in the ratio of impaired loans, at statistically significant levels, even after including bank-level and country-level controls associated with loan performance.

Second, if changes in bank characteristics ΔY_{it} are endogenous to the occurrence of runs, this should be more true for banks that rely on CD funding to a larger extent. Thus, we interact the *Run* dummy variable with another dummy variable equal to one if the share of a bank's CD financing over total liabilities is in the third or fourth quartiles of the distribution. If endogeneity concerns are important, these interaction terms are expected to be statistically significant, with the same sign as that of the β_0 coefficient on the *Run* dummy variable, and increasing in magnitude. Estimation results are in Column 3 of Tables 6 (for ROA) and 7 (for impaired loans). In all cases, the estimated interaction coefficients are not statistically significant, indicating that the estimate for our main coefficient is not driven by a subset of banks with a large exposure to the CD market. Runs are also predictive of future profitability and asset quality even for banks with little CD funding. This result casts serious doubt on the idea that endogeneity concerns are severe in our context. In contrast, it is consistent with investors running on information about future fundamentals, as the share of CD funding over total liabilities should not matter in this case.

As additional evidence against reverse causality, we show that runs do not seem to force banks to downsize significantly. In the Appendix Table A3, we re-estimate Equation (3)

with changes in size (Panel A) and changes in loans to total assets (Panel B) as dependent variables. Coefficients on the dummy variable capturing the occurrence of runs are never statistically significant. As seen in Column 3, they are also not significant even for banks that rely heavily on CD funding. A potential explanation is that these banks manage to substitute CD funding with alternative sources of funds, such as ECB funding.[11] The fact that runs do not force banks to downsize significantly suggests that the reduction in ROA is not due to fire sales.

5.3 Consistency checks

In this section, we extend our baseline results along three dimensions. First, we provide evidence of the informational content of runs at longer-term horizons. We re-estimate Equation (3) with $Y_{it+1} - Y_{it-1}$ as the dependent variable, i.e., we consider whether runs predict future changes in ROA or impaired loans over a two-year period starting at the end of December of the year preceding a run. Estimates are in the Appendix Table A4. In Panel A, runs predict a longer-term decrease in ROA, even though not significant. In Panel B, they predict a longer-term increase in the ratio of impaired loans, which is significant at the 1% level. These results are again true regardless of whether banks rely on CD funding to a large extent or not, as seen in Column 3, and thus unlikely to be driven by reverse causality.

Second, we show that the informational content of runs does not disappear in times of high market stress. Indeed, with asymmetric information, the ability of lenders to distinguish between high- and low-quality borrowers should be lower in turbulent times (Heider, Hoerova, and Holthausen, 2015). If this is the case, runs may not be informative any longer during crises. In Column 4 of Tables 6 and 7, we re-estimate Equation (3) after including an interaction term between the *Run* dummy and a *Crisis* dummy that equals one in 2011 and 2012. These years correspond to the height of the European debt crisis. As seen in Figure 1, they are also the years in which the credit default swap spread

[11] Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2015) provide evidence that European banks borrowing from the ECB between 2007 and 2011 are significantly weaker than average.

of European banks reached its highest level. If the predictive power of runs diminishes or disappears in times of crisis, the estimated coefficient on this interaction term should have opposite sign as that on the *Run* dummy and be significant. We do not find this in any of the specifications, highlighting the fact that runs contain information even when market stress is high.

Finally, another potential concern with our approach is that it relies on accounting data only available at a yearly frequency. Thus, new information may be revealed between the end of the preceding year (when balance sheet information is released) and the time of the run. If this is the case, runs may not be informative about future characteristics but simply correlate with observable characteristics not yet reflected in balance sheet data. We address this concern by estimating Equation (3), using both excess stock returns and changes in credit default swap spreads as dependent variables.[12] Switching to market data brings the benefit of a higher (daily) frequency but also comes at the cost of having data for fewer banks, mainly publicly-traded ones. In Table 8, results are provided for the 6-month and one-year periods that follow the occurrence of a run. As seen in Panel A, the occurrence of a run is associated with a negative excess return at both horizons, which is significant in one case. In Panel B, the occurrence of a run successfully predicts a subsequent increase in credit default swap spread, at both horizons, and at significant levels. This is true even after including bank-level and country-level controls. The latter result suggests that the informational content of runs does not only arise from observable characteristics not yet incorporated in balance sheet data. Runs do predict future bank-specific outcomes, even after controlling for observable characteristics.

6 Reallocation of funds during

The absence of market freeze and the occurrence of bank-specific runs suggest that funds get reallocated in the cross-section when runs occur. We test out second null hypothesis, that low-quality banks increase borrowing more relative to high-quality banks when runs

[12] To compute excess stock returns, we use the return on an equally-weighted portfolio of all sample stocks as the market return.

occur.

6.1 Bank borrowing as a function of quality

We shift our attention from banks that face runs to banks that increase their CD funding. We study whether banks whose CD funding grows faster than the aggregate market are those that will make a more profitable use of these funds, as measured by an increase in ROA in the future. We find strong evidence that this is indeed the case.

We start by comparing the growth of CD issuance by each bank to the growth of the aggregate CD market. At a monthly frequency, we compute E_{it}, the growth rate in issuance by bank i in excess of the growth rate in issuance at the market level

$$E_{it} = \Big[\log\left(CD_{it}\right) - \log\left(CD_{i,t-1}\right)\Big] - \Big[\log\left(CD_{mt}\right) - \log\left(CD_{m,t-1}\right)\Big], \tag{4}$$

where CD_{it} is the amount of CD outstanding by issuer i at the end of month t and CD_{mt} the aggregate size of the CD market in that month. We drop observations for which $CD_{i,t-1}$ is below a threshold of EUR 10 Mn, to avoid including observations of issuers with low and volatile CD activity, or issuers that enter the CD market.

We test our second null hypothesis in two steps. First, we check whether high and positive values of E_{it} forecast future increases in ROA. If true, this means that banks whose CD funding grows more are able to make a productive use of these funds, and funds flow to such banks regardless of whether there are runs or not in the market. Second, we test whether the reallocation of funds towards better-performing banks is stronger at times runs occur in the market.

We construct a dummy variable I_{it} that equals one for any issuer i in month t if E_{it} is above some percentile α of the distribution of E_{it} in the same month, and zero otherwise. We provide results for both $\alpha = 50\%$ and $\alpha = 25\%$, i.e., we only consider banks that are above the median and in the top quartile in terms of the growth of their CD funding

relative to the market. We estimate a probit model

$$\Pr\left(I_{it}=1|X_t\right)= \\ \Phi\Big(\beta_0\Delta ROA_{it}+\beta_1\text{Controls}_{i,t-1}+\beta_2\text{Controls}_{c,t-1}+FE_c+FE_m\Big), \tag{5}$$

where $\Delta ROA_{it}=ROA_{it}-ROA_{i,t-1}$ is the change in ROA between the end of the previous year (observable at the time of the run) and the ROA at the end of the current year (unobservable at the time of the run). We include bank-level and country-level controls, as well as country fixed effects. In contrast with previous regressions, we turn to the monthly frequency, because we want to isolate higher frequency changes in CD funding, in particular those taking place when the CD market is stressed – as measured by the occurrence of bank-specific runs. To account for the fact that past balance sheet characteristics may be more informative about early months of each year (and, symmetrically, that late quarters of a year may correlate more with future balance sheet characteristics), we include month fixed effects, FE_m, for eleven out of twelve months. The fact that we focus on monthly variations in CD funding is also the reason why we use ΔROA_{it} as an independent variable, and not as a dependent variable as in the previous section. Finally, Φ denotes the c.d.f. of a standard normal distribution. Our coefficient of interest, β_0, equals zero under the null hypothesis.

Estimates are provided in Table 9 for threshold values $\alpha = 0.5$ (Column 1) and $\alpha = 0.25$ (Column 3). As estimated coefficients are positive and significant at the 1% or 5% level, we can reject hypothesis H2. This means that, regardless of whether bank-specific runs occur in the market, banks whose CD funding grows faster than the market are banks that increase their future ROA, i.e., tend to make a more productive use of the funds they receive.

6.2 Focusing on times of high market stress

We test whether this effect is stronger during periods in which bank-specific runs occur in the market. To do so, we re-estimate Equation (5) after including interaction terms

between ΔROA_{it} and dummy variables taking a value of one if the Run Index – defined in Equation (1) – is in the second, third or fourth quartile of its distribution (i.e., highest values of the Run Index).

Estimates are in Columns 2 and 4 of Table 9. The base coefficient on ΔROA, corresponding to the periods in which the Run Index is the lowest, remains positive and significant. Coefficients on the interaction terms, however, indicate that this effect is much larger in magnitude at times the Run Index is high, i.e., when it is in its third or fourth quartile. This is indicative of the fact that the reallocation of funds towards banks that will increase performance in the future is amplified in times of financial stress. The economic magnitude of the effect is large; the estimated coefficient on the interaction term corresponding to highest market stress is twice as large as that on the unconditional coefficient β_0. Taken together, results in Table 9 allow us to reject hypothesis H2.

7 Conclusion

Our main conclusion is that the allocation of funds in wholesale markets in times of stress is not primarily affected by asymmetric information. Such periods are better described as accelerated reallocation of funds in the cross-section rather than as system-wide market freezes. In contrast with a leading view that sees wholesale markets as inherently subject to market-wide disruptions, we show that runs are mostly bank-specific and driven by information about future bank quality. We show that (i) banks that face runs are those performing poorly in the future and that (ii) banks receiving more funds during stress episodes are those increasing their profitability in the future.

The findings in this paper provide a potential explanation as to why wholesale funding markets have proved more resilient than widely expected. They do not support the premise on which new liquidity coverage ratios are based. However, since our analysis disregards the negative externalities triggered by runs, we cannot draw a definite conclusion about the soundness of these regulatory tools.

Our analysis also has implications for central banking. We show that high-quality

banks are still able to access wholesale funding in times of stress. They are thus less likely to require funding from the lender of last resort. This is in sharp contrast with the received theory, according to which central banks should only lend to solvent institutions facing temporary liquidity needs. However, it is consistent with recent empirical evidence by Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2015), who find that weakly-capitalized banks borrowed more from the ECB during the recent financial crisis.

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Table 1: Description of the dataset on CD issuance

This table describes our main dataset on CD issuance. Panel A describes issuers and provides a breakdown by country. Panel B describes the contract-level information. Each ISIN-level observation is associated with either an issuance, a buyback, or with the cancellation of any of these operations. Each ISIN can appear multiple times in the dataset, due to the buyback of previously issued CDs, or to the re-issuance on previously issued ISINs. Panel C describes the distribution of CD-level information for new issuances in the pooled sample. "Issued amount" is the euro amount of an individual CD in the pooled dataset. "Issuances by bank" is the total number of issuances by any bank from January 2008 to December 2014. CD data are from the Banque de France.

Panel A: Description of issuers

	N. issuers	% Issuers	% Issued amount	Largest issuer
All	276	100.00	100.00	—
Austria	2	0.72	0.15	Oesterreichische Kontrollbank
Belgium	2	0.72	6.21	Dexia Credit Local
China	2	0.72	0.12	Bank of China
Denmark	3	1.09	0.51	Jyske Bank
France	196	71.01	72.78	BNP Paribas
Germany	12	4.35	1.03	HypoVereinsbank
Ireland	7	2.54	0.43	Allied Irish Banks
Italy	14	5.07	3.13	Unicredit
Japan	3	1.09	0.38	Sumitomo Mitsui
Netherlands	8	2.90	5.37	Rabobank
Spain	2	0.72	0.53	BBVA
Sweden	4	1.45	0.84	Svenska Handelsbanken
Switzerland	2	0.72	0.44	UBS
United Kingdom	11	3.98	7.36	HSBC
Others	8	2.90	1.12	—

Panel B: Description of CD contracts

	N. Obs.	Frequency (%)
Number of CDs (ISINs)	819,318	—
Issuance	1,304,213	95.88
Buyback	44,482	3.27
Cancellation	11,577	0.85
Total	1,360,272	100

Panel C: Distribution of CD characteristics

	Min.	10th	25th	Mean	Median	75th	90th	Max.
Issued amount (EUR Th)	100	180	300	51,153	900	10,000	67,850	1.36e+07
CD maturity (days)	1	2	13	66.4	33	92	181	367
Issuances by bank	1	27	125	3,072	777	2,886	7,273	106,997
Issuances by bank / week	<0.01	0.07	0.34	8.44	2.13	7.93	19.98	293.94

Table 2: Balance sheet of CD issuers

Panel A provides descriptive statistics on the distribution of the balance sheet characteristics of CD issuers. Means and quantiles are as of end of December and are computed from the pooled sample over the period from 2008 to 2014. The number of issuer-year observations on which they are computed is provided in the last column. Panel B relates CD outstanding amounts as of end of December to other balance sheet characteristics, in the pooled sample. Statistics are conditional on the issuer having a non-zero amount of CD outstanding. Calculation of CD / (CD + Repo) is also conditional on the issuer having a non-zero amount of repurchase agreements outstanding. All variables are defined in Table A1. Balance sheet data are from Bankscope.

Panel A: Balance sheet characteristics

	10th	25th	Mean	Median	75th	90th	N. Obs.
Size (log Total assets)	20.834	22.077	23.503	23.338	24.708	26.669	1,452
Loans / Assets	0.270	0.485	0.634	0.699	0.820	0.882	1,448
Customer deposits / Assets	0.036	0.202	0.375	0.351	0.577	0.669	1,422
ROA (%)	-0.201	0.159	0.332	0.406	0.748	1.047	1,446
ROE (%)	-3.883	2.526	1.576	5.424	8.342	13.461	1,446
Net income / Assets	-0.002	0.002	0.003	0.004	0.007	0.010	1,446
Net interest margin / Assets	0.005	0.011	0.017	0.016	0.021	0.030	1,414
Impaired loans / Loans (%)	1.028	2.243	5.414	3.908	6.586	11.899	1,059
Impaired loans / Equity (%)	8.231	17.134	58.575	38.381	72.999	135.547	1,074
Equity / Assets	0.030	0.046	0.083	0.075	0.110	0.136	1,452
Tier 1 capital (%)	7.600	9.230	13.074	11.200	14.300	18.250	458
Total regulatory capital (%)	9.900	11.600	16.124	13.705	16.910	21.400	486

Panel B: Size of CD funding in balance sheets

CD / Equity (cond.)	0.008	0.053	1.176	0.215	0.693	2.246	971
CD / (CD + Repo) (cond.)	0.010	0.053	0.340	0.229	0.611	0.855	218
CD / Total liabilities	0.003	0.010	0.095	0.035	0.091	0.222	1,007

Table 3: Number and magnitude of runs

This table provides descriptive statistics on wholesale funding runs. Panel A gives the total number of runs, broken down by year, by type of run, and by home country of the bank. Panel B provides descriptive statistics on the magnitude of runs, both in absolute terms and relative to the bank's equity as of end of December of the preceding year. The magnitude of the run is defined as the euro amount of the difference between the volume outstanding on the day a run is identified and that 50 days before the run. Both partial and full runs are defined in Section 4.2.

Panel A: Number of runs

	Partial and full runs		*Full runs only*	
	Number of runs	% Total	Number of runs	% Total
2008	4	5.33	2	6.90
2009	6	8.00	3	10.34
2010	11	14.67	6	20.69
2011	18	24.00	8	27.59
2012	13	17.33	3	10.34
2013	13	17.33	3	10.34
2014	10	13.33	4	13.79
Total	75	100	29	100
By country:				
Austria	2	2.66	2	6.89
France	29	38.66	0	0.00
Denmark	3	4.00	0	0.00
Germany	3	4.00	3	10.34
Ireland	7	9.33	7	24.14
Italy	8	10.66	5	17.24
Netherland	3	4.00	2	6.89
Sweden	2	2.66	0	0.00
United Kingdom	8	10.66	5	17.24
Other	10	13.33	5	17.24

Panel B: Magnitude of runs

	Min.	10th	25th	Mean	Median	75th	90th	Max.
Partial and full runs:								
Magnitude (EUR Mn)	63	136	228	967	512	1,260	3,258	5,289
Δ CD / Equity	0.001	0.008	0.016	0.233	0.068	0.174	0.491	5.293
Full runs only:								
Magnitude (EUR Mn)	103	152	216	847	403	1,004	2,240	4,182
Δ CD / Equity	0.051	0.054	0.089	0.639	0.259	0.517	2.250	5.293

Table 4: Maturity shortening before runs

The volume-weighted average maturity of new issues at a monthly frequency is regressed on issuer and time fixed effects, and on a set of dummy variables (Equation 2). A dummy variable at date $\tau - t$ equals one if the bank faces a run at date τ and zero otherwise, for $t \in \{1, ..., 6\}$, i.e., up to six quarters before the run. Panel A is for both partial and full runs. Panel B is for full runs only. Standard errors, clustered at the bank level, are in parentheses. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	Dependent variable: Weighted average maturity of new issues	
	(1)	(2)
	Panel A: Partial and full runs	*Panel B: Full runs only*
$\tau - 1$	-25.360***	-29.511***
	(2.285)	(4.513)
$\tau - 2$	-17.345***	-30.001***
	(3.914)	(5.998)
$\tau - 3$	-12.134***	-14.664***
	(1.699)	(4.742)
$\tau - 4$	-7.628	-11.610
	(4.902)	(7.368)
$\tau - 5$	-7.506*	-3.930
	(3.750)	(5.243)
$\tau - 6$	-0.689	15.504***
	(4.132)	(3.858)
Issuer fixed effect	Yes	Yes
Month fixed effect	Yes	Yes
Adj. R^2	0.166	0.165
N. Obs.	11,420	11,420

Table 5: Balance sheet characteristics before full runs

This table compares balance sheet characteristics as of end of December of years $t-1$ and $t-2$ between banks that face a full run during year t and banks that do not face a full run. All reported statistics are differences in means and medians for banks that face a full run during year t, relative to banks that do not face a full run. All coefficients are computed after differencing out a year fixed effect, to control for time trends common to both groups. The equality of means is tested based on a two-sample t-test. The equality of medians is tested using the Wilcoxon-Mann-Whitney test. Balance sheet variables are defined in Table A1. The p-values are in square brackets. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	One year before run		Two years before run		N. Obs.
	Diff. from mean	Diff. from median	Diff. from mean	Diff. from median	
			Loans and deposits		
Loans / Assets	-0.015	-0.065	0.019	0.009	1,119
	[0.744]	[0.472]	[0.686]	[0.745]	
Deposits / assets	0.021	0.022	0.052	0.129	1,105
	[0.653]	[0.618]	[0.268]	[0.259]	
			Profitability		
ROA	-1.253***	-0.582***	-0.271	-0.150**	1,120
	[0.000]	[0.000]	[0.230]	[0.018]	
ROE	-24.299***	-11.832***	0.226	0.019	1,120
	[0.000]	[0.000]	[0.971]	[0.937]	
Net income / Assets	-0.015***	-0.007***	-0.003	-0.002**	1,120
	[0.000]	[0.000]	[0.301]	[0.018]	
Net interest margin / Assets	-0.007	-0.008***	-0.004	-0.005	1,088
	[0.107]	[0.007]	[0.273]	[0.118]	
			Asset quality		
Impaired loans / Total loans	1.827	1.325	0.064	0.485	825
	[0.206]	[0.259]	[0.962]	[0.574]	
Impaired loans / Equity	55.879***	52.790***	22.362	11.234*	836
	[0.001]	[0.006]	[0.174]	[0.054]	
			Capitalization		
Equity / Assets	-0.037***	-0.033***	-0.032**	-0.024***	1,122
	[0.007]	[0.000]	[0.015]	[0.000]	
Tier 1 / RWA	6.886*	-0.664	7.350*	0.590	380
	[0.054]	[0.718]	[0.034]	[0.181]	
Regulatory cap. / RWA	8.166*	-0.453	8.354*	0.331	404
	[0.088]	[0.910]	[0.072]	[0.216]	
			Credit risk		
CDS spread	82.180	110.245**	0.041	10.584	516
	[0.249]	[0.014]	[0.999]	[0.402]	
Short-term credit rating	-0.424***	-0.474**	-0.320**	-0.118	977
	[0.005]	[0.011]	[0.036]	[0.179]	

Table 6: Runs forecast future changes in ROA

In this table, we estimate Equation (3), with changes in ROA as a dependent variable. Panel A is for both partial and full runs. Panel B is for full runs only. Changes in ROA are between the end of year $t-1$ (observable at the time of the run) and the end of year t (unobservable at the time of the run). *Run* is a dummy variable that takes a value of one for bank i if it faces a run during year t. Time and country fixed effects are included. In Column (3), we interact the *Run* dummy with two dummy variables that equal one if a bank's share of CD funding to total liabilities is between 4% and 9% or is above 9%, respectively. In Column (4), we interact the *Run* dummy with a *Crisis* dummy that equals one in 2011 and 2012. Variables are defined in Table A1. Standard errors, clustered at the bank level, are in parentheses. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	Dependent variable: $\Delta ROA = ROA_t - ROA_{t-1}$			
	(1)	(2)	(3)	(4)
	Baseline		Share CD	Crisis
	Panel A: Partial and full runs			
Run	-0.352**	-0.525***	-0.913***	-0.633***
	(0.135)	(0.139)	(0.179)	(0.151)
Size_{t-1}		-0.018	-0.004	-0.017
		(0.025)	(0.025)	(0.025)
ROA_{t-1}		-0.713***	-0.717***	-0.715***
		(0.038)	(0.037)	(0.038)
Impaired / Loans_{t-1}		-0.025***	-0.026***	-0.026***
		(0.009)	(0.009)	(0.009)
GDP growth		38.957***	37.561***	38.732***
		(4.969)	(4.955)	(4.954)
Run $*$ Share CD $\in [4\%, 9\%]$			0.372	
			(0.407)	
Run $*$ Share CD $> 9\%$			0.351	
			(0.302)	
Run $*$ Crisis				0.133
				(0.192)
Adj. R^2	-0.001	0.407	0.415	0.411
N. Obs.	948	684	684	684
	Panel B: Full runs only			
Run	-0.417	-0.609**	-0.874***	-0.768**
	(0.292)	(0.281)	(0.315)	(0.341)
Size_{t-1}		-0.008	-0.003	-0.007
		(0.025)	(0.025)	(0.025)
ROA_{t-1}		-0.713***	-0.710***	-0.711***
		(0.038)	(0.038)	(0.038)
Impaired / Loans_{t-1}		-0.025***	-0.023**	-0.025***
		(0.009)	(0.009)	(0.009)
GDP growth		39.440***	38.459***	39.251***
		(4.999)	(5.028)	(5.007)
Run $*$ Share CD $\in [4\%, 9\%]$			0.904	
			(0.411)	
Run $*$ Share CD $> 9\%$			0.524	
			(0.501)	
Run $*$ Crisis				0.466
				(0.605)
Adj. R^2	-0.006	0.400	0.401	0.399
N. Obs.	948	684	684	684

Table 7: Runs forecast future changes in asset quality (Impaired loans / Loans)

In this table, we estimate Equation (3), with changes in the ratio of impaired loans to total loans as a dependent variable. Panel A is for both partial and full runs. Panel B is for full runs only. Changes in impaired loans are between the end of year $t-1$ (observable at the time of the run) and the end of year t (unobservable at the time of the run). *Run* is a dummy variable that takes a value of one for bank i if it faces a run during year t. Time and country fixed effects are included. In Column (3), we interact the *Run* dummy with two dummy variables that equal one if a bank's share of CD funding to total liabilities is between 4% and 9% or is above 9%, respectively. In Column (4), we interact the *Run* dummy with a *Crisis* dummy that equals one in 2011 and 2012. Variables are defined in Table A1. Standard errors, clustered at the bank level, are in parentheses. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	Dependent variable: Δ Impaired loans / Loans			
	(1)	(2)	(3)	(4)
	Baseline		Share CD	Crisis
	Panel A: Partial and full runs			
Run	0.554***	0.518***	0.661***	0.650***
	(0.137)	(0.138)	(0.181)	(0.154)
Size_{t-1}		-0.038	-0.042*	-0.040
		(0.025)	(0.025)	(0.025)
ROA_{t-1}		-0.011	-0.010	-0.007
		(0.038)	(0.038)	(0.038)
$\text{Impaired / Loans}_{t-1}$		-0.017*	-0.017*	-0.017*
		(0.009)	(0.009)	(0.009)
GDP growth		-24.918***	-24.463***	-24.706***
		(5.044)	(5.068)	(5.031)
Run ∗ Share CD ∈ [4%, 9%]			-0.490	
			(0.385)	
Run ∗ Share CD > 9%			-0.233	
			(0.306)	
Run ∗ Crisis				-0.052
				(0.093)
Adj. R^2	0.100	0.140	0.140	0.145
N. Obs.	676	675	675	675
	Panel B: Full runs only			
Run	1.787***	1.687***	2.111***	1.938***
	(0.275)	(0.270)	(0.300)	(0.272)
Size_{t-1}		-0.043*	-0.051**	-0.046*
		(0.024)	(0.024)	(0.024)
ROA_{t-1}		-0.003	-0.007	-0.013
		(0.037)	(0.037)	(0.037)
$\text{Impaired / Loans}_{t-1}$		-0.016*	-0.018*	-0.016*
		(0.009)	(0.009)	(0.009)
GDP growth		-24.717***	-23.316***	-23.638***
		(4.948)	(4.953)	(4.892)
Run ∗ Share CD ∈ [4%, 9%]			-0.507	
			(1.047)	
Run ∗ Share CD > 9%			-0.499	
			(0.958)	
Run ∗ Crisis				-0.098
				(0.157)
Adj. R^2	0.131	0.172	0.182	0.193
N. Obs.	676	675	675	675

Table 8: Runs forecast future stock returns and CDS spread changes

In this table, we estimate Equation (3), with changes in market data as the dependent variable. In Panel A, the dependent variable is the excess return of each bank's stock over the return of the market index. The latter is the return of an equally-weighted portfolio of all sample stocks. In Panel B, the dependent variable is the change in CDS spread. Regressions are estimated over two time horizons, respectively 6 months and 1 year after the run occurs. All regressions include time and country fixed effects. Data are at a quarterly frequency. Variables are defined in Table A1. Standard errors, clustered at the bank level, are in parentheses. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)
	Panel A: Excess stock return			
	6 months		1 year	
Run	-0.054	-0.041	-0.126*	-0.071
	(0.056)	(0.077)	(0.067)	(0.062)
Size_{t-1}		0.020**		0.024*
		(0.008)		(0.012)
ROA_{t-1}		0.068**		0.046*
		(0.029)		(0.026)
Impaired / Loans_{t-1}		-0.001		0.001
		(0.008)		(0.009)
GDP growth		0.242		0.796
		(1.558)		(0.185)
Adj. R^2	0.145	0.203	0.649	0.653
N. Obs.	1,092	536	1,052	536
	Panel B: Δ CDS spread			
	6 months		1 year	
Run	36.443**	49.033***	43.824*	61.896**
	(15.748)	(17.577)	(25.510)	(28.891)
Size_{t-1}		-0.707		-1.680
		(0.901)		(1.770)
ROA_{t-1}		-2.354		3.948
		(1.552)		(2.756)
Impaired / Loans_{t-1}		-2.041**		-2.410**
		(0.787)		(1.180)
GDP growth		-1214.823*		-2187.64
		(650.329)		(1437.262)
Adj. R^2	0.570	0.585	0.563	0.573
N. Obs.	2,099	956	1,937	956

Table 9: Reallocation of funds after runs

This table provides estimates of the probit model in Equation (5). The dependent variable equals one for an issuer in a given month if its excess issuance over the market (defined in Equation (4)) is above a threshold α. Columns (1) and (2) are for $\alpha = 0.5$ (50% of institutions with the largest excess issuance) and Columns (3) and (4) are for $\alpha = 0.25$ (25% of institutions with the largest excess issuance). In Columns (2) and (4), Δ ROA is interacted with dummy variables that equal one if the *Run Index* (defined in Equation (1)) is in the second, third or fourth quartile of its distribution. Each specification includes fixed effects for eleven out of twelve months. Standard errors, clustered at the bank level, are in parentheses. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	Dependent variable: Prob. of CD issuance in excess of the market			
	(1)	(2)	(3)	(4)
	$\alpha = 0.5$		$\alpha = 0.25$	
Δ ROA	0.025***	0.019**	0.033**	0.017***
	(0.005)	(0.009)	(0.014)	(0.006)
Δ ROA * Run Index in Quartile 2		-0.003		0.008
		(0.016)		(0.006)
Δ ROA * Run Index in Quartile 3		0.033***		0.039
		(0.012)		(0.033)
Δ ROA * Run Index in Quartile 4		0.048**		0.030**
		(0.020)		(0.015)
N. Obs.	10,979	10,979	10,979	10,979

Figure 1: Size of the euro-denominated CD market

This figure displays the aggregate size of the euro-denominated CD market (solid line), as constructed from our CD issuance data, from January 2008 to December 2014. It also plots (dashed line) the spread on the 5-year EU Banks credit default swap (CDS) Index. Vertical lines represent six events associated with market stress: Event 1 – Nationalization of Northern Rock (February 22, 2008); Event 2 – Failure of Lehman Brothers (September 15, 2008); Event 3 – Blue Monday crash in the U.K., with the fall of Royal Bank of Scotland (January 19, 2009); Event 4 – First bailout of Greece (April 11, 2010); Event 5 – Bailout of Ireland (November 21, 2010); Event 6 – Announcement of the Outright Monetary Transactions (OMT) by the ECB (August 2, 2012). Data are averaged at a monthly frequency.

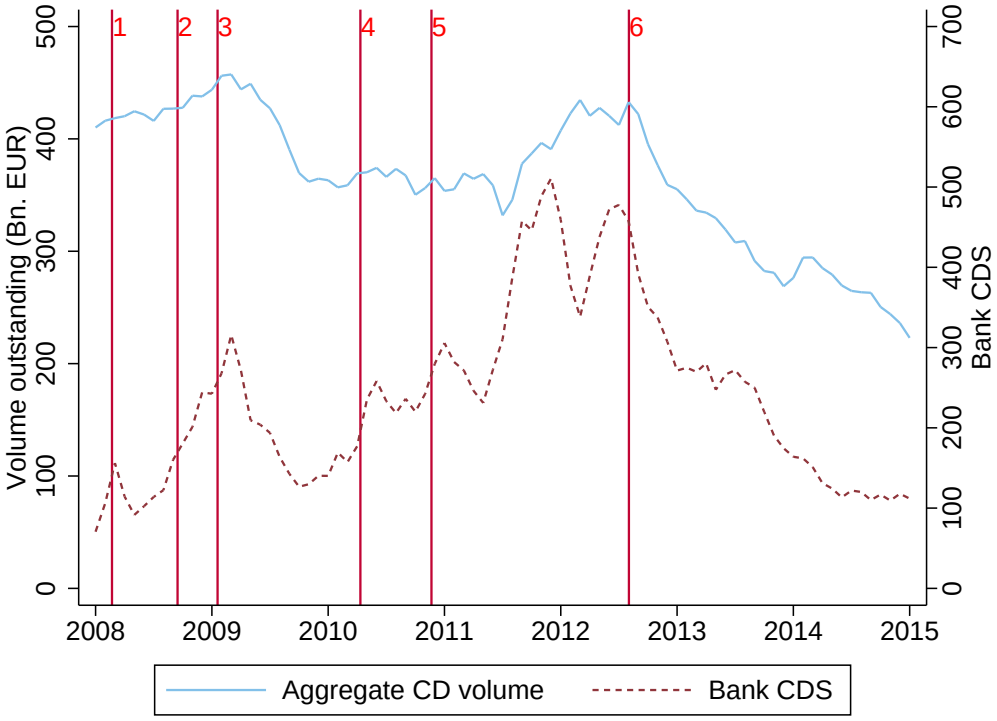
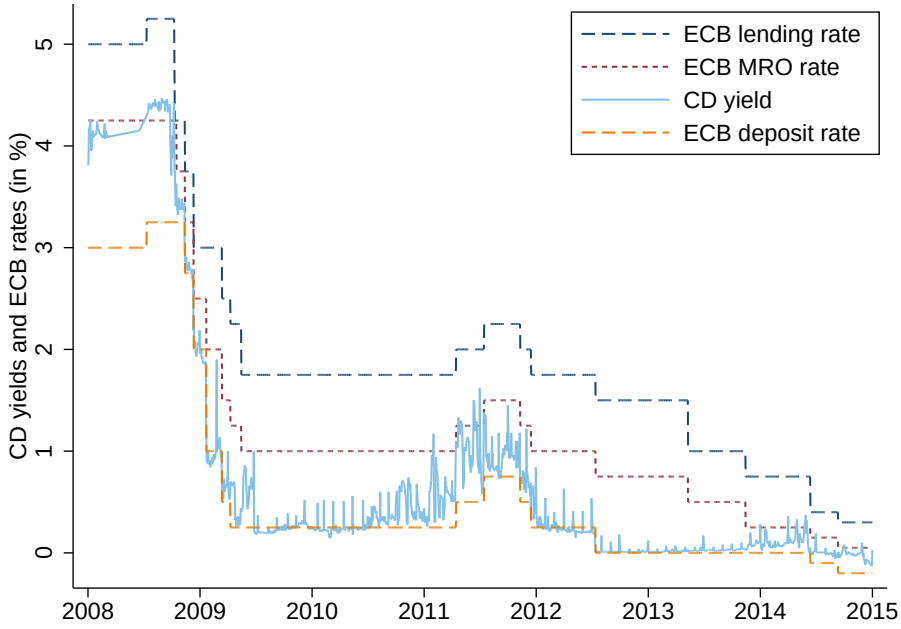


Figure 2: Short-term interest rates

Panel A displays the volume-weighted average yield on CDs issued by banks in the highest short-term rating bucket, from January 2008 to December 2014. The rate is for CDs with an initial maturity up to 7 days. The figure also shows the three policy rates set by the ECB. The ECB rate for its Main Refinancing Operations (MROs) is in red. The deposit facility rate and the lending facility rate are, respectively, in orange (bottom) and blue (top). Panel B plots the difference between the one-week CD yield and the one-week Euribor (rate for unsecured interbank lending in euros). Data source: European Central Bank.

Panel A: CD yield and ECB rates



Panel B: Spread between CD yield and Euribor

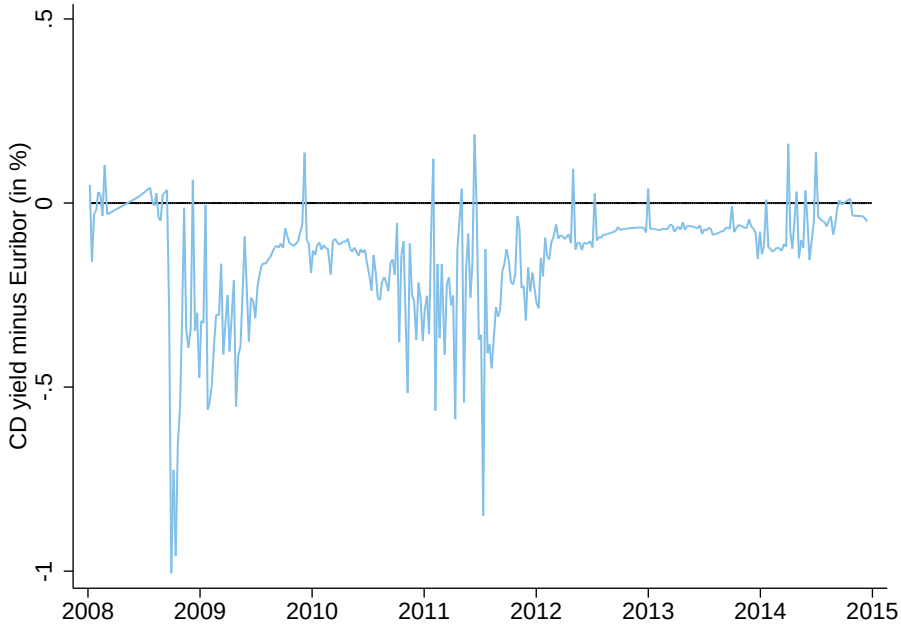


Figure 3: Segments of the euro-denominated CD market

This figure displays the decomposition of the euro-denominated CD market by jurisdiction of issuance. These data are only for the subset of issuers that benefit from the Short-Term European Paper (STEP) label, i.e., primarily the largest issuers that raise funds on a European scale. The two main markets are the French market and the U.K. (European Commercial Paper) market. Other markets include primarily the Belgian and the Luxembourgian markets. Data source: European Central Bank.

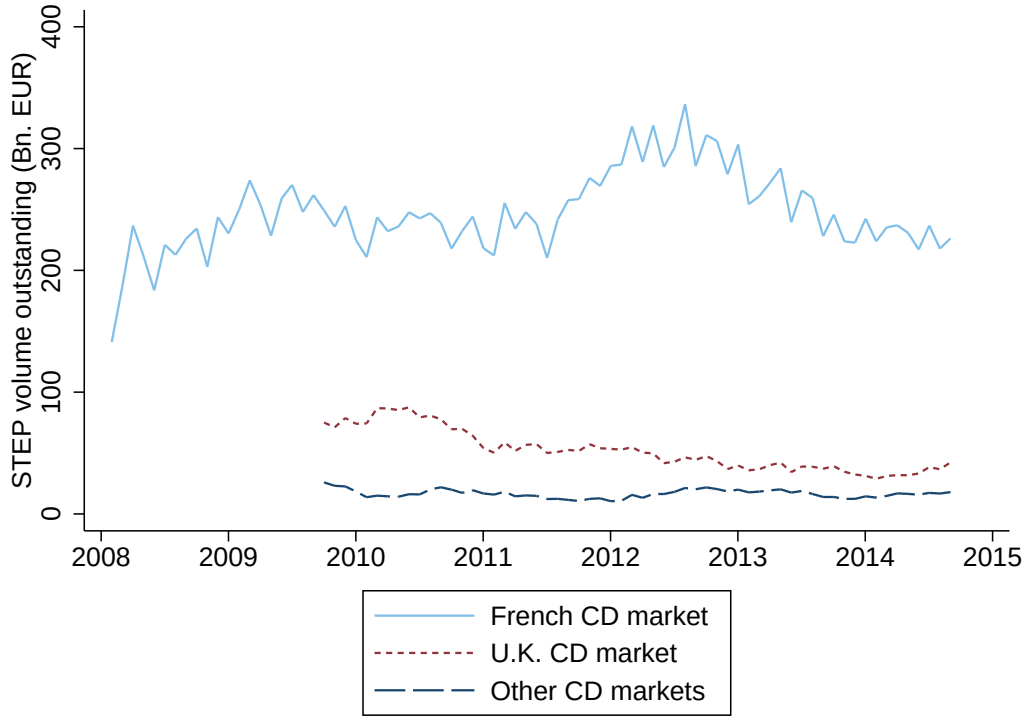
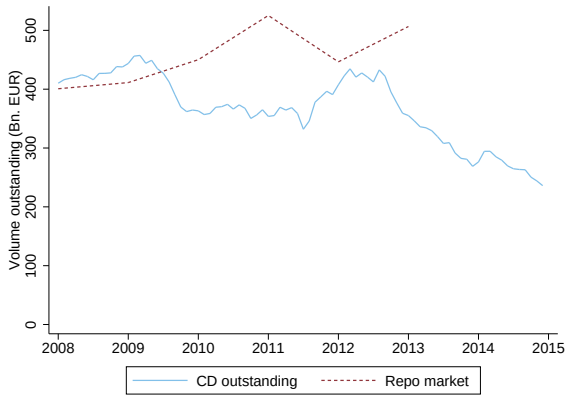


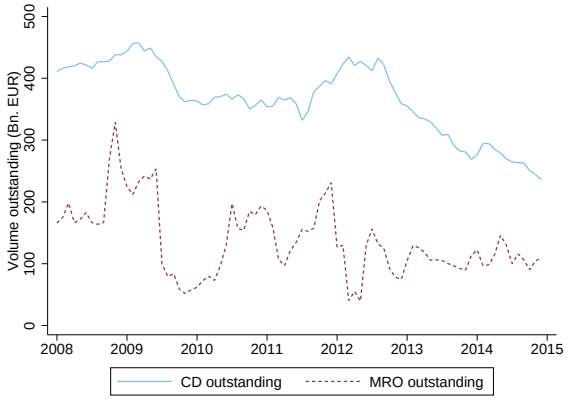
Figure 4: Size of the CD market relative to other wholesale funding markets

This figure compares the amount of euro-denominated CDs outstanding with three other segments of European wholesale funding markets. Panel A compares CDs with private repurchase agreements (CCP-based + bilateral + triparty). Data on the European repo market have been provided by Mancini, Ranaldo, and Wrampelmeyer (2015) for the 2008-2013 period. The repo data involve partial double-counting. Panel B compares CDs with the outstanding amount of euro-denominated funding provided by the ECB to European banks through its Main Refinancing Operations (MROs). MROs have a maturity of one week and are provided in the form of repurchase agreements against eligible assets. Data on MROs are obtained from the European Central Bank. Panel C compares CDs with overnight interbank loans. Data on the European interbank market have been provided by de Andoain, Heider, Hoerova, and Manganelli (2015). For repo and interbank loan data, we proxy the amount outstanding with the daily turnover, because most contracts on these markets are overnight. All time series are monthly averages, except the repo series, which is at an annual frequency.

Panel A: CDs versus repurchase agreements



Panel B: CDs versus ECB refinancing operations



Panel C: CDs versus interbank loans

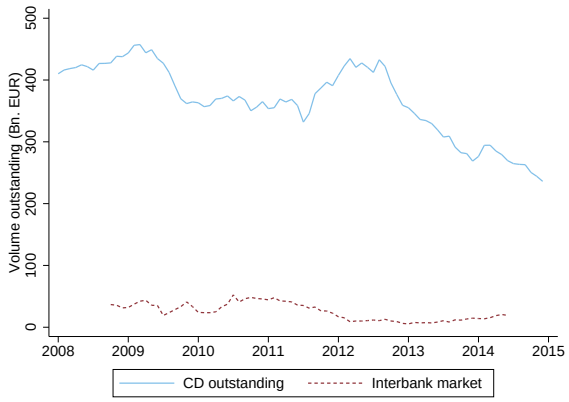


Figure 5: Average maturity of new issues in the euro-denominated CD market

This figure displays the volume-weighted maturity of new issues in the CD market (solid line), from January 2008 to December 2014. It also plots (dashed line) the spread on the 5-year EU Banks CDS Index. Data are averaged at a monthly frequency.

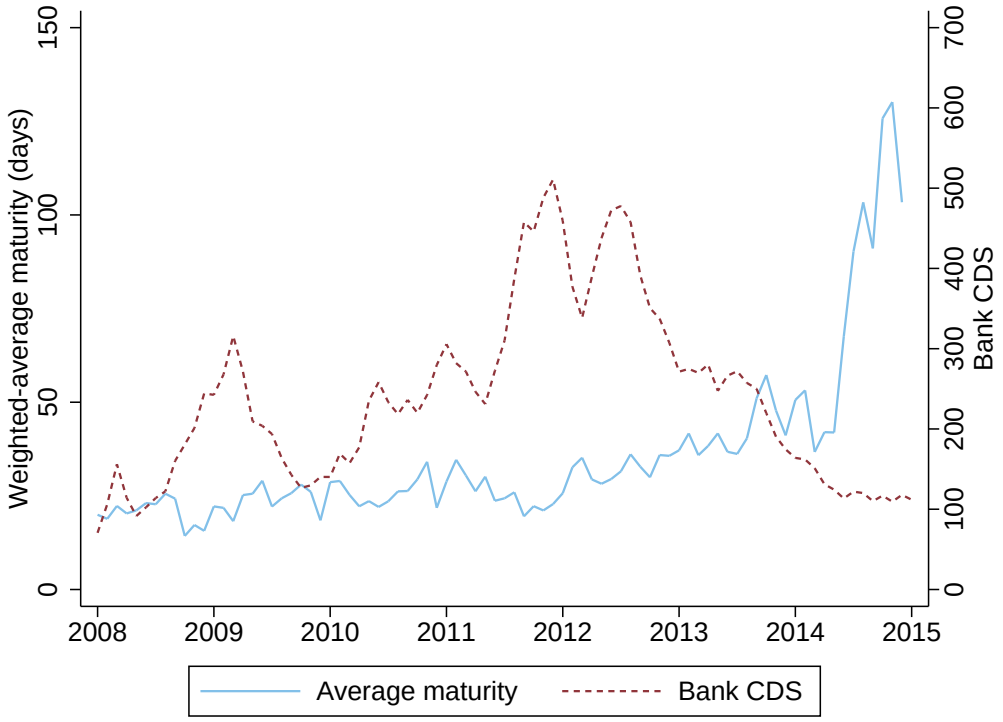
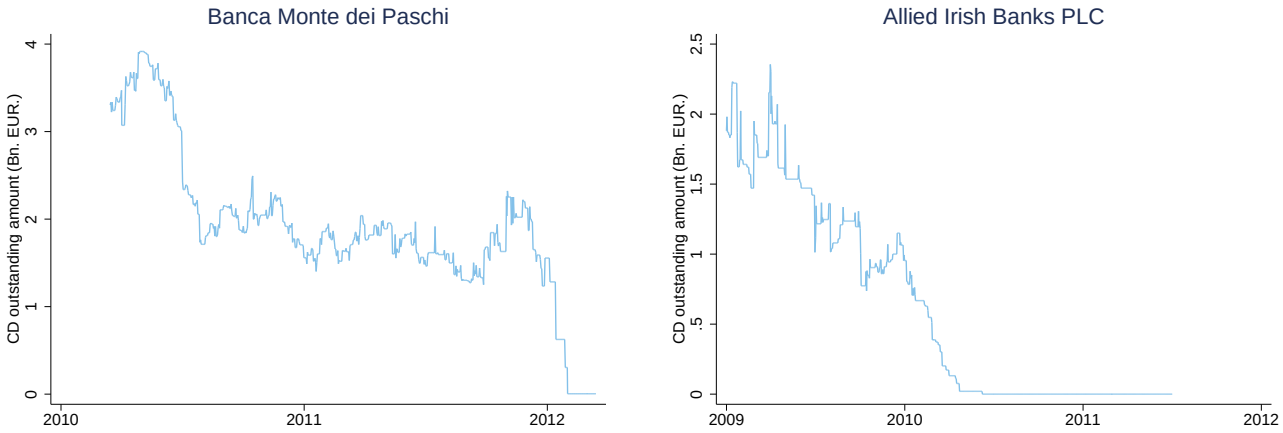


Figure 6: Complete and partial runs

This figure gives four examples of full and partial runs. It plots the amount of CDs outstanding for four selected European banks, at a daily frequency. Panel A provides two examples of full runs (Banca Monte dei Paschi and Allied Irish Banks), i.e., the amount of CDs outstanding after the run falls to zero. Panel B provides two examples of partial runs (Unicredit and Dexia), i.e., the amount of CDs outstanding falls by 50% or more over 50-day period.

Panel A: Full runs



Panel B: Partial runs

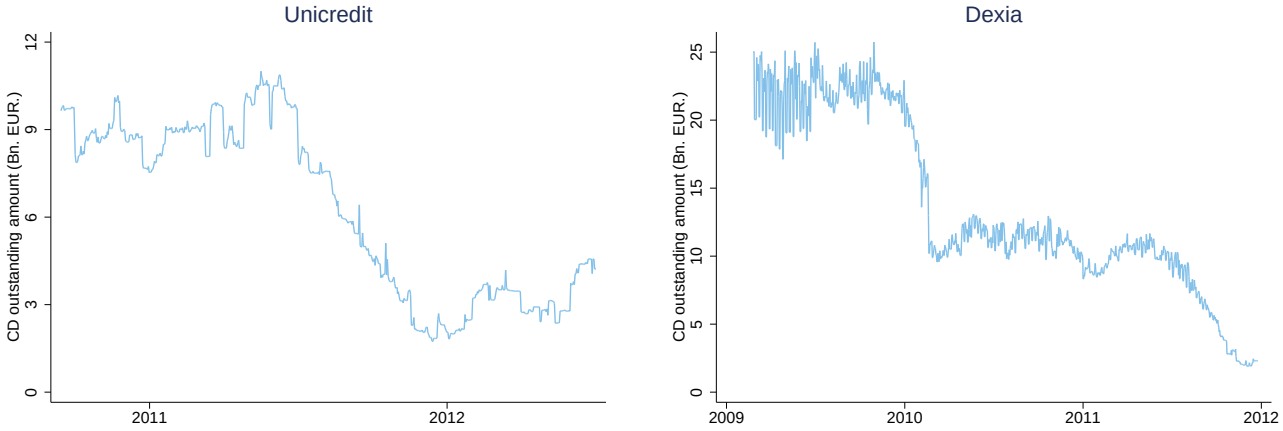
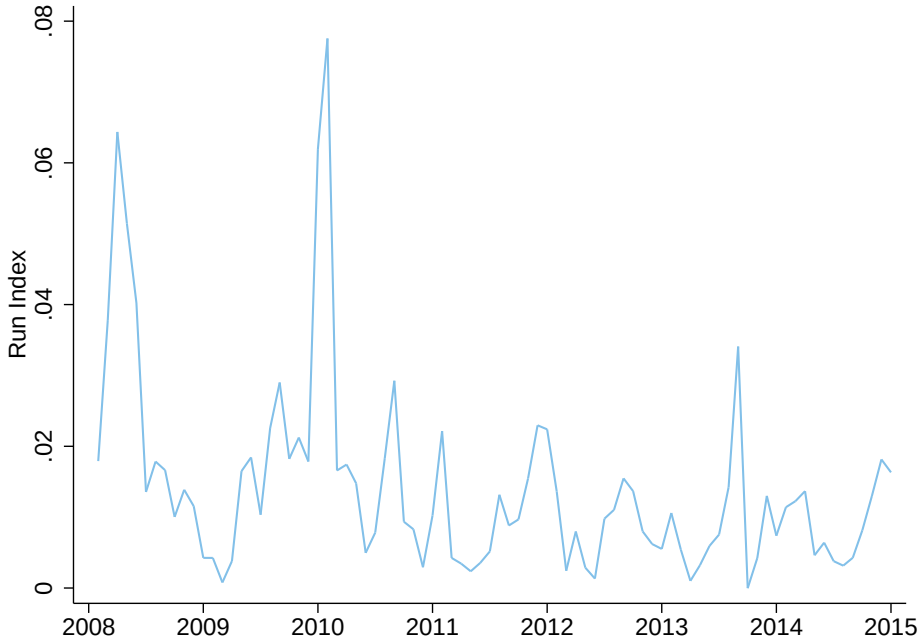


Figure 7: Run Index

This figure plots the Run Index at a monthly frequency. This index is defined as the sum of the euro amount of all sample runs within a given month, scaled by the aggregate size of the CD market at the beginning of that month (Equation 1). See Section 4.2 for details.



Online appendix - Not for publication

Table A1: Variable definitions

This table defines the variables used in the empirical analysis. The CD data, obtained from the Banque de France, are complemented with data from Bankscope. The definitions of the balance sheet variables are obtained from the Bankscope user guide. The "id" code is the index number in Bankscope. Variables related to issuer profitability and asset quality are winsorized at the 1st and 99th percentiles.

Variable	Definition	Data source
	Issuer balance sheet	
Assets	Total assets (id: 11350).	Bankscope
Equity	Common Equity (id: 11800).	Bankscope
Tier 1 capital	Tier 1 capital, as a percentage of risk-weighted assets (id: 18150).	Bankscope
Total regulatory capital	Tier 1 + Tier 2 capital, as a percentage of risk-weighted assets (id: 18155).	Bankscope
Loans	Gross loans (id: 11100).	Bankscope
Customer deposits	Total customer deposits: Current + Savings + Term (id: 11550).	Bankscope
Repos and cash collateral	Includes all securities designated for repurchase or cash received as collateral as part of securities lending (id: 11565).	Bankscope
	Issuer profitability and asset quality	
Net interest margin	Net interest margin, i.e., net interest income as a percentage of earning assets (id: 4018).	Bankscope
Net income	Net income (id: 10285).	Bankscope
ROA	Return on average assets (id: 4024).	Bankscope
ROE	Return on average equity (id: 4025).	Bankscope
Impaired loans / Gross loans	Impaired Loans over Gross Loans (id: 18200).	Bankscope
Impaired loans / Equity	Impaired Loans over Equity (id:4037).	Bankscope
	Market data	
Short-term credit rating	Encoded on a scale from 1 to 5 ("B"=1; "F3"=2; "F2"=3; "F1"=4; "F1+"=5)	Fitch Ratings / Moody's or S&P if Fitch unavailable
CDS spread	CDS spread (mid-quote)	Bloomberg
Stock price	End-of-day stock price	Bloomberg

Table A2: List of wholesale funding runs

This table is a chronological list of the 29 full wholesale funding runs. For each run, we use Factiva to search for press articles or news releases about the banks around the time of the run. For 27 individual runs, we display an excerpt of such news in the last column.

	Bank name and country	Run date	Source	Excerpt
1	Hypo Public Finance Bank (DE)	Jul. 2008	*Business World*, "Hypo writes off E2.5bn at Depfa Bank", 12 November 2008	Troubled German property lender Hypo Real Estate has this morning posted a pretax loss of 3.1 billion euro for the third quarter, more than analysts had expected. Hypo is the parent of two big operations in Dublin's docklands - Depfa Bank and Hypo Public Finance Bank - which employ 300 people between them.
2	Hypo Real Estate Bank Intl. AG (DE)	Oct. 2008	*Business World*, "Hypo writes off E2.5bn at Depfa Bank", 12 November 2008	Troubled German property lender Hypo Real Estate has this morning posted a pretax loss of 3.1 billion euro for the third quarter, more than analysts had expected. Hypo is the parent of two big operations in Dublin's docklands - Depfa Bank and Hypo Public Finance Bank - which employ 300 people between them.
3	Alliance & Leicester PLC (UK)	Mar. 2009	*The Guardian*, "City fears A&L may need Bank rescue", 28 November 2007	Fears that Alliance & Leicester may have to seek emergency funds from the Bank of England circulated in the City last night as ratings agency Standard & Poor's said the bank could suffer from the lending freeze that triggered Northern Rock's downfall. [Subsequently acquired by Santander, but kept operating until after the run under the A&L name. See Factiva, Financial Times, "Abbey, Alliance & Leicester and B&B to disappear from the high street", 27 May 2009.]
4	Depfa Bank plc (IR)	Mar. 2009	*Business World*, "Hypo writes off EUR2.5bn at Depfa Bank", 12 November 2008	Troubled German property lender Hypo Real Estate has this morning posted a pretax loss of 3.1 billion euro for the third quarter, more than analysts had expected. Hypo is the parent of two big operations in Dublin's docklands - Depfa Bank and Hypo Public Finance Bank - which employ 300 people between them.
5	Banca Intesa (France) (IT) [Subsidiary of Intesa Sanpaolo]	Aug. 2009	*Financial Times*, "Intesa Sanpaolo seeks EUR4bn in state aid", 20 March 2009	Intesa Sanpaolo, one of Italy's top two banks, announced on Friday it would seek EUR4bn in government support by issuing bonds to the Italian Treasury, just days after its chief executive, Corrado Passera, denounced conditions attached to the bonds as "demagogic".
6	Allied Irish Banks p.l.c. (IR)	Jun. 2010	*The Sunday Times*, "The moment of truth approaches for AIB", 12 December 2010	Allied Irish BanksÂ is approaching some manner of kismet. Will it be nationalised at the same time as the government brings forward its long-overdue banking resolutions legislation? Investors in the bank's subordinated bonds think so. These bonds are trading at levels where a forced write-down is inevitable.
7	Swedbank Mortgage AB (SW)	Aug. 2010	*Moody's Investors Service*, "Moody's places Swedbank AB and Swedbank Mortgage AB's ratings on review for possible upgrade", 16 November 2010	During the financial crisis, the asset quality of Swedbank AB's Baltic operations deteriorated rapidly, with non-performing loans (NPLs) as a percentage of gross loans increasing to 14% YE 2009 from 3% (YE 2008). In line with other Nordic banks that have Baltic operations, Swedbank AB responded by significantly reducing its exposure to the Baltic countries, achieving around a 35% decrease in its Baltic loan portfolio since Q4 2008.

Table A2 (continued)

	Bank name and country	Run date	Source	Excerpt
8	Anglo Irish Bank Corp. Ltd (UK)	Nov. 2010	*Economist Intelligence Unit*, "Ireland economy: A painful outcome", 22 October 2010	With the government desperately seeking a conclusion to Ireland's acute banking crisis, as bailout costs continue to spiral higher, the country's most troubled financial institution,Â Anglo Irish Bank, has proposed a contentious "burden-sharing" scheme that could see most of its junior bondholders suffer losses of at least 80%.
9	EBS Building Society (IR)	Nov. 2010	*The Daily Telegraph*, "Irish bondholders face heavy losses", 1 June 2011	Meanwhile,Â Irish Life & PermanentÂ andÂ EBS Building SocietyÂ said they would also impose losses equivalent to around 80pc-90pc of the face value of some EUR1.1bn in junior bonds. The banks said if investors did not accept the offers, the Irish government would take whatever steps necessary to "maximise burden sharing".
10	The Governor & Co. of the Bank of Ireland (IR)	Dec. 2010	*Financial Times*, "Time running out for the last Irish independent", 26 January 2011	Bank of IrelandÂ became the only bank still listed on the Irish Stock Exchange on Tuesday when shares inÂ Allied Irish Banks, which is set to be 92 per cent-state owned in the next few weeks, were delisted. The question now is whether Bank of Ireland can avoid a similar fate. That depends on whether it will have to turn to the government for extra funding in order to meet the core tier one capital ratio of 12 per cent set by the regulators.
11	Banco di Brescia S.p.A. (IT) [Subsidiary of UBI Banca]	Dec. 2010	*Financial Times*, "UBI Banca's share price fall raises concern", 17 June 2011	Shares inÂ UBI Banca, an Italian regional lender, slumped 8 per cent on Thursday complicating its EUR1bn (USD1.4bn) rights issue and raising concerns about investor appetite for capital raisings by other Italian banks in the coming weeks. [...] However, the debt crisis in southern Europe together with low economic growth forecasts and political instability in Italy have undermined investor confidence, particularly in the mid-sized Italian banks, say industry analysts and senior bankers.
12	Irish Life & Permanent P.L.C. (IR)	Dec. 2010	*The Daily Telegraph*, "Irish bondholders face heavy losses", 1 June 2011	Meanwhile,Â Irish Life & PermanentÂ andÂ EBS Building SocietyÂ said they would also impose losses equivalent to around 80pc-90pc of the face value of some EUR1.1bn in junior bonds. The banks said if investors did not accept the offers, the Irish government would take whatever steps necessary to "maximise burden sharing".
13	Caixa D'Estalvis De Catalunya Tarragona i Manresa (SP)	Apr. 2011	*Europolitics*, "Banking: Stress tests results welcomed as eight banks fail", 19 July 2011	Eight banks failed to show they could meet the 5% capital requirement: Austria's Oesterreichische Volksbanken, Greece's state-ownedÂ ATEbankÂ (which also failed last year's round) and EFG Eurobank and five Spanish regional savings banks - theÂ Caixa d'Estalvis de Catalunya, Tarragona i Manresa,Â Banco Pastor, Caixa d'Estalvis Unio de Caixes de Manlleu, Sabadell i Terrassa, Grupo Caja3 and the Caja de Ahorros del Mediterraneo.
14	Fortis Banque France (BE)	May 2011	*Moody's Investors Service*, "Moody's downgrades BNP Paribas's long-term ratings to Aa3, concluding review", 9 December 2011	The outlooks on the debt and deposit ratings are now negative, in reflection of the negative outlook assigned to the debt and deposit ratings of parentÂ BNP Paribas. In addition,Â Fortis Bank SA/NV's Tier 1 instruments were confirmed at Baa1 (hyb) and assigned a negative outlook.
15	Fortis Bank (Nederland) NV (NL)	May 2011	*Moody's Investors Service*, "Moody's downgrades BNP Paribas's long-term ratings to Aa3, concluding review", 9 December 2011	The outlooks on the debt and deposit ratings are now negative, in reflection of the negative outlook assigned to the debt and deposit ratings of parentÂ BNP Paribas. In addition,Â Fortis Bank SA/NV's Tier 1 instruments were confirmed at Baa1 (hyb) and assigned a negative outlook.

Table A2 (continued)

	Bank name and country	Run date	Source	Excerpt
16	Ulster Bank Ireland Ltd (IR)	May 2011	*The Guardian*, "RBS still hamstrung by Ulster Bank impairments in Ireland", 6 May 2011	The troubles in the Ulster Bank arm [...] are being felt across the rest of the group. Ulster is 10% of the group's total gross customer loans or 9% of the gross customer loans in the core division. But the impairment charge represents 80% of the charge in the non-core division and 40% of the impairment charge in the core division. The group's total impairment charge is GBP1.9bn - some GBP1.2bn is related to Ireland.
17	Mediobanca International S.A. (IT)	Sep. 2011	*ADPnews Italy*, "Morgan Stanley sees economy slowdown, higher funding costs affecting Italian banks' profits", 18 November 2011	The expected 1% drop in Italy gross domestic product (GDP) in 2012 and the rising of financing costs could threaten the profits of Italian banks,Â Morgan StanleyÂ said on Friday. [...] Intesa Sanpaolo (BIT:ISP) and Mediobanca (BIT:MB) can best face rising funding costs, according to Morgan Stanley.
18	Oesterreichische Volksbanken AG (AT)	Nov. 2011	*Europolitics*, "Banking: Stress tests results welcomed as eight banks fail", 19 July 2011	Eight banks failed to show they could meet the 5% capital requirement: Austria's Oesterreichische Volksbanken.
19	FIH Erhvervsbank A/S (DK)	Dec. 2011	*Agence Europe*, "State aid: Public support for Danish bank FIH Erhvervsbank A/S", 30 June 2012	On Friday 29 June, the European Commission temporarily authorised an impaired asset measure and an asset relief measure in favour ofÂ FIH Erhvervsbank A/S. The public support measures were approved for a period of six months in order to preserve financial stability. In parallel, the Commission opened a formal investigation because it is concerned that the State may not be adequately remunerated for its support and because of the risks remaining in FIH's balance sheet.
20	Nationwide Building Society (UK)	Sep. 2012	*SNL European Financials Daily*, "S&P lowers outlook on Nationwide Building Society", 20 December 2012	S&P's Ratings Services on Dec. 18 revised its outlook on the long-term rating of Nationwide Building Society to negative from stable. S&P said the revision follows its change to the outlook of the U.K.'s AAA long-term sovereign credit rating to negative from stable. It also attributed the move to a decline in the building society's risk-adjusted capital ratio arising from a net actuarial loss in its employee pension scheme.
21	Banco Popolare Societa Cooperativa (IT)	Nov. 2012	*SNL European Financials Daily*, "Banco Popolare in initial talks to sell bad loans", 9 December 2013 [AND] *ICN.com Financial Markets*, "Banco Popolare Posts Sharp Drop In 2Q Net Profit", 28 August 2013	Banco Popolare SC is in initial discussions with investors over the bad debt portfolio in a vehicle controlled by the lender, Reuters reported Dec. 5. [AND] Banco Popolare SCÂ said on Tuesday that its second-quarter net profit slipped on the back of a rise in loan-loss provisions. Net profit reached 64.3 million euros in the three months through June, compared to 138 million euros a year earlier. Loan-loss provisions climbed to 211.6 million euros from 185.6 million euros in the same period a year ago.
22	Banca Monte Dei Paschi di Siena S.p.A. (IT)	Nov. 2012	*SNL European Financials Daily*, "Monte dei Paschi scandal bursts onto Italian politics", 28 January 2013	Banca Monte dei Paschi di Siena SpA's decision to hide hundreds of millions of euros of losses from investors could take its toll on the left's chances in February's Italian parliamentary election. News that the lender could book losses of at least EUR720 million as a result of derivatives deals allegedly kept secret from investors and regulators has provoked a media storm in Italy and caused investors to dump its stock.

Table A2 (continued)

	Bank name and country	Run date	Source	Excerpt
23	The Royal Bank of Scotland N.V. (UK)	Apr. 2013	*BBC News*, "RBS shares fall after biggest loss since financial crisis", 27 February 2014	Shares in Royal Bank of Scotland (RBS) have fallen sharply after the troubled company reported its biggest annual loss since being rescued by the UK government during the financial crisis. The bank's pre-tax loss for 2013 was GBP8.2bn, compared with GBP5.2bn in 2012.
24	Bank of Scotland PLC (UK)	Jun. 2013	n.a.	n.a.
25	SNS Bank N.V. (NL)	Jul. 2013	*Euroweek*, "SNS haircut worries ease but bondholder outcomes still murky", 6 February 2013	SNS Bank's 11.25% EUR 320m tier one perpetual has fallen around 20 points over the last two weeks according to one investor. It bounced up, and then down this week, trading in the low 50% of par region, analysts said. Subordinated bondholders are likely to be called on to help generate capital, the bank's parentÂ SNS Reaal said. How much they are set to lose, however, is highly uncertain.
26	Landesbank Baden-Wurttemberg (DE)	Mar. 2014	n.a.	n.a.
27	DZ Bank Ireland PLC (IR) [Subsidiary of DZ Bank, which failed the ECB stress tests a few months later]	Apr. 2014	*SNL European Financials Daily*, "4 German banks in ECB failure stress", 20 October 2014	However, it is notable thatÂ DZ BankÂ reported at year-end 2013 a low Basel III ratio of 7.1% compared to a cut-off point of 8.0%. NORD/LB showed an 8.6% ratio at the same juncture and a 41% coverage ratio;Â DZ Bank's coverage figure was higher at 49%. Raising both banks' coverage to 60% would requireÂ DZ Bank to lift reserves by EUR500 million and NORD/LB by EUR1.1 billion.
28	Banque Espirito Santo et de la Venetie (PT)	Jul. 2014	*Dow Jones Newswires*, "Behind the Collapse of Portugal's Espirito Santo Empire ", 16 August 2014	Now the empire is in ruins. The family's prized asset and Portugal's second-biggest bank,Â Banco EspÃrito Santo SA, collapsed this month, and Espirito Santo's main holding companies have filed for bankruptcy amid allegations of accounting problems and fraud.
29	Oesterreichische Kontrollbank AG (AT)	Sep. 2014	*Euroweek*, "OeKB hits dud note in week of oversubscribed SSA dollar benchmarks", 25 September 2014	But the outlook for seven year issuance, which has been strong sinceÂ European Investment BankÂ priced a USD3bn 2.125% October 2021 in the last week of August, began to pall on Thursday as a seven year forÂ Oesterreichische KontrollbankÂ fell just shy of full subscription.

Table A3: Runs do not forecast future changes in size or loans to total assets

In this table, we estimate Equation (3), with changes in bank size (Panel A) and in loans to total assets (Panel B) as a dependent variable. Bank size is defined as the logarithm of total assets. Changes in both size and loans are between the end of year $t-1$ (observable at the time of the run) and the end of year t (unobservable at the time of the run). *Run* is a dummy variable that takes a value of one for bank i if it faces a partial or a full run during year t. Time and country fixed effects are included. In Column (3), we interact the *Run* dummy with two dummy variables that equal one if a bank's share of CD funding to total liabilities is between 4% and 9% or is above 9%, respectively. In Column (4), we interact the *Run* dummy with a *Crisis* dummy that equals one in 2011 and 2012. Variables are defined in Table A1. Standard errors, clustered at the bank level, are in parentheses. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)
	Baseline		Share CD	Crisis
			Panel A: Δ Size	
Run	-0.037	-0.013	-0.008	-0.017
	(0.035)	(0.013)	(0.017)	(0.018)
Size_{t-1}		-0.005**	-0.005**	-0.005**
		(0.003)	(0.002)	(0.002)
ROA_{t-1}		0.008**	0.008**	0.008**
		(0.003)	(0.003)	(0.003)
$\text{Impaired / Loans}_{t-1}$		-0.000	-0.000	-0.000
		(0.001)	(0.001)	(0.001)
GDP growth		0.028	0.054	0.014
		(0.497)	(0.500)	(0.497)
Run ∗ Share CD ∈ [4%, 9%]			-0.009	
			(0.041)	
Run ∗ Share CD > 9%			-0.017	
			(0.030)	
Run ∗ Crisis				0.008
				(0.007)
Adj. R^2	0.031	0.197	0.195	0.198
N. Obs.	950	685	685	685
			Panel B: Δ Loans / Assets	
Run	0.003	0.008	0.000	0.012
	(0.007)	(0.008)	(0.010)	(0.009)
Size_{t-1}		-0.004**	-0.003**	-0.004**
		(0.002)	(0.002)	(0.001)
ROA_{t-1}		-0.002	-0.002	-0.002
		(0.002)	(0.002)	(0.002)
$\text{Impaired / Loans}_{t-1}$		-0.001***	-0.001***	-0.001***
		(0.000)	(0.000)	(0.001)
GDP growth		0.584**	0.560**	0.589**
		(0.282)	(0.283)	(0.282)
Run ∗ Share CD ∈ [4%, 9%]			0.026	
			(0.023)	
Run ∗ Share CD > 9%			0.014	
			(0.017)	
Run ∗ Crisis				-0.015
				(0.017)
Adj. R^2	0.015	0.073	0.072	0.073
N. Obs.	947	685	685	685

Table A4: Runs forecast future changes in longer-term profitability and asset quality

In this table, we estimate Equation (3), with changes in ROA (Panel A) and in impaired loans to total loans (Panel B) as a dependent variable. Changes in ROA are between the end of year $t-1$ (observable at the time of the run) and the end of year $t+1$ (unobservable at the time of the run). *Run* is a dummy variable that takes a value of one for bank i if it faces a partial of a full run during year t. Time and country fixed effects are included. In Column (3), we interact the *Run* dummy with two dummy variables that equal one if a bank's share of CD funding to total liabilities is between 4% and 9% or is above 9%, respectively. In Column (4), we interact the *Run* dummy with a *Crisis* dummy that equals one in 2011 and 2012. Variables are defined in Table A1. Standard errors, clustered at the bank level, are in parentheses. *, **, and *** denote respectively statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)
	Baseline		Share CD	Crisis
	Panel A: $ROA_{t+1} - ROA_{t-1}$			
Run	-0.105	-0.228	-0.464**	-0.407*
	(0.150)	(0.174)	(0.221)	(0.209)
Size_{t-1}		0.007	0.016	0.007
		(0.032)	(0.032)	(0.032)
ROA_{t-1}		-0.829***	-0.839***	-0.835***
		(0.064)	(0.065)	(0.064)
Impaired / Loans_{t-1}		0.000	-0.001	-0.000
		(0.012)	(0.012)	(0.012)
GDP growth		28.729***	26.968***	28.355***
		(7.479)	(7.546)	(7.473)
Run $*$ Share CD $\in [4\%, 9\%]$			0.657	
			(0.528)	
Run $*$ Share CD $> 9\%$			0.559	
			(0.377)	
Run $*$ Crisis				0.123
				(0.370)
Adj. R^2	0.004	0.278	0.279	0.280
N. Obs.	772	538	538	538
	Panel B: Δ *Impaired loans*$_{t+1}$			
Run	1.456***	1.178***	1.555***	1.578***
	(0.366)	(0.369)	(0.451)	(0.444)
Size_{t-1}		-0.104	-0.118*	-0.104
		(0.066)	(0.067)	(0.066)
ROA_{t-1}		0.105	0.120	0.132
		(0.141)	(0.141)	(0.141)
Impaired / Loans_{t-1}		-0.089***	-0.088***	-0.087***
		(0.026)	(0.027)	(0.026)
GDP growth		-67.570***	-64.602***	-66.471***
		(15.399)	(15.569)	(15.338)
Run $*$ Share CD $\in [4\%, 9\%]$			-1.236	
			(1.016)	
Run $*$ Share CD $> 9\%$			-0.858	
			(0.791)	
Run $*$ Crisis				-0.201
				(0.351)
Adj. R^2	0.110	0.166	0.167	0.174
N. Obs.	527	527	527	527