Wholesale Funding Dry-Ups*

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Abstract

We empirically explore the fragility of wholesale funding of banks, using transaction level data on short-term, unsecured certificates of deposits in the European market. We do not observe any market-wide freeze during the 2008-2014 period. Yet, many banks suddenly experience funding dry-ups. Dry-ups predict, but do not cause, future deterioration of bank performance. Furthermore, in periods of market stress, banks with high future performance tend to increase reliance on wholesale funding. Thus, we fail to find evidence consistent with adverse selection models of funding market freezes. Our results are in line with theories highlighting heterogeneity between informed and uninformed lenders.

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1 Introduction

To finance themselves, banks rely on deposits and wholesale funding. The latter includes repurchase agreements, interbank loans, and debt securities sold on financial markets, often with short-term maturities. A prevailing view among economists and regulators is that wholesale funding is vulnerable to sudden stops, or dry-ups, during which banks lose funding regardless of their credit quality. Such breakdowns have major macroeconomic consequences, as they can force banks to cut lending (Iyer, Lopes, Peydro, and Schoar, 2014) and affect real outcomes such as unemployment (Chodorow-Reich, 2014). To mitigate this concern, new regulatory liquidity ratios penalize the use of wholesale funding (Tarullo, 2014).

In this paper, we empirically investigate the determinants of the fragility of wholesale funding markets. Most theories of market freezes are based on information asymmetries between lenders and borrowers. Among these theories, two classes of models make opposite predictions about the causes of wholesale funding market breakdowns. The first class of theories assumes that all lenders are equally uninformed. When lenders become concerned about the quality of borrowing banks, interest rates increase for both high and low-quality banks. This induces high-quality banks to self-select out of the market (Akerlof, 1970; Stiglitz and Weiss, 1981; Myers and Majluf, 1984). Therefore, when investors are uninformed but homogeneous, funding dry-ups are demand-driven: high-quality banks stop borrowing from the market.

A second strand of theory rests on the idea that some lenders are informed. In times of stress, uninformed participants expect informed lenders to cut funding to low-quality banks, and may then prefer to stop lending altogether (Gorton and Pennacchi, 1990; Calomiris and Kahn, 1991; Dang, Gorton, and Holmström, 2012). In these models, funding dry-ups are supply-driven: They predominantly affect low-quality banks, who lose funding from both informed and uninformed investors. High-quality banks may lose funding from uninformed investors, but manage to keep informed ones.

The two theories make opposite predictions about the quality of banks experiencing dry-ups. Distinguishing between these two theories is useful to understand the main

frictions at work in wholesale funding markets. But it can also have important policy implications, although it is beyond the scope of this paper to explore them in detail. While standard adverse selection models suggest that disclosure about issuer quality is beneficial, proponents of theories based on investor heterogeneity emphasize potential benefits of opacity on financial markets (Holmström, 2015). In our analysis, we find strong support for the second class of models, i.e., models with heterogeneously informed lenders.

We test the competing predictions of these two theories using novel data on a large, yet so far neglected, segment of the European wholesale funding market: the market for certificates of deposits (CDs). CDs are unsecured short-term debt securities issued by banks and bought mostly by money market funds.[1] Our sample consists of more than 80% of the market for euro-denominated CDs. It covers a large segment of the interbank market: The amount of debt outstanding is around EUR 400 Bn, comparable to the repo market, and about ten times as large as the unsecured interbank market. Our data include characteristics of 1.3 million issues by 276 banks from 2008 to 2014. We match these issuance data with issuer characteristics from Bankscope and market data from Bloomberg.

Using these data, we identify a number of events which we call *wholesale funding dry-ups*. We define them as instances where the outstanding amount of CDs of a given bank falls to zero (full dry-up), or drops by more than 50% in the course of 50 days (partial dry-up). We isolate 75 such events between 2008 and 2014, of which 29 are full dry-ups. Based on observable characteristics, banks that experience dry-ups have on average lower profitability, more impaired loans, higher book leverage, and a lower creditworthiness than other banks. This is in line with evidence from the market for asset-backed commercial paper (Covitz, Liang, and Suarez, 2013). Importantly, dry-ups do not have a strong aggregate component over our period. The CD market did not experience any global freeze. This is quite remarkable, given that CDs are unsecured and that our sample period includes both the financial crisis and the European sovereign debt crisis.

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

We then show that banks experiencing dry-ups are those whose performance is set to decrease in the future, controlling for current performance. This result casts doubt on the idea that high-quality banks self-select out of the CD market due to asymmetric information in their relation with lenders. It is instead consistent with the idea that low-quality banks lose funding from both informed and uninformed lenders. However, a generic concern when testing for the presence of asymmetric information is that the information set of market participants is not the same as our information set as econometricians. We address this issue by using market data, which arguably reflect the public information available to lenders in real time. We find that a drop in CD funding predicts a subsequent increase in CDS spreads, and to a lesser extent a negative excess stock return. Again, funding dry-ups do not seem to correspond to high-quality banks voluntarily exiting the wholesale funding market.

We reject an alternative interpretation of our findings which follows theories of runs as in Diamond and Dybvig (1983). Funding dry-ups may indeed be purely uninformed events that *cause* lower future performance, for instance because the lack of funding forces banks to liquidate assets below market prices, or to pass on valuable lending opportunities. We address this reverse causality concern by running several tests. First, a sharp reduction in CD funding also predicts a future increase in impaired loans, a measure less prone to reverse causality, as loans were extended prior to the dry-up. Second, the predictive power of dry-ups on performance is not driven by banks that heavily rely on CD funding – to which a drop in CD funding may cause more harm. Third, the total assets of banks facing dry-ups remain stable in the following year, suggesting that they do not engage in fire sales.

We also show that issuers facing a dry-up experience a decrease in the maturity of new CD issues several months before the drop in CD volume. This is consistent with significant heterogeneity across investors. Indeed, in the presence of informed investors, uninformed lenders value debt securities only as long as they remain information-insensitive (Gorton and Pennacchi, 1990). In times of stress, long-term debt becomes more information-sensitive, since it is repaid later. Uninformed investors can then refuse to buy longer-term

CDs (Holmström, 2015). Therefore, the only way to draw uninformed funding in times of stress is by reducing maturity. This mechanism explains the pattern found in the data.

Finally, we show that banks increasing funding in the CD market perform better in the future, conditional on current performance. This is particularly pronounced in times of market stress – as measured by the number and size of dry-ups. This second fact is more consistent with theories based on informed lenders. If pure adverse selection is driving the allocation of funds, high-quality banks should reduce reliance on wholesale funding, in particular when the market is stressed. As a result, increased CD reliance should predict *lower* future performance. We find this to be rejected by the data. In contrast, the positive predictive power of CD borrowing on future performance again points to the presence of informed lenders.

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, 2016; Mancini, Ranaldo, and Wrampelmeyer, 2015), and often find that they did not freeze during the recent financial crisis. In contrast to these studies, we focus on unsecured borrowing, which is arguably more fragile. 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. Closer to our own study, Afonso, Kovner, and Schoar (2011) analyze the unsecured U.S. Fed Funds market during the Lehman crisis. Also related are the papers by Kacperczyk and Schnabl (2010) and Covitz, Liang, and Suarez (2013), on the fragility of the asset-backed commercial paper market during the global financial crisis, as well as the case study by Shin (2009) on Northern Rock. In contrast, we study a large cross-section of wholesale funding dry-ups over several years.

Another contribution is to test which theories of funding market breakdowns are most consistent with the data. The CD market is a good laboratory to study competing theories of wholesale funding fragility. First, as CDs are unsecured, the only source of asymmetric

information between a borrower and its lender 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 by lenders, as they could in the interbank market.

To our knowledge, this paper is also the first to test whether asymmetric information plays a significant role in the allocation of wholesale funding (Bolton, Santos, and Scheinkman, 2011; Malherbe, 2014; Heider, Hoerova, and Holthausen, 2015). We show that pure adverse selection models – with no informed investors – have a hard time rationalizing actual patterns in wholesale funding markets: high-quality banks are both less likely to face a drop in CD funding, and more likely to attract additional funding in times of stress. Instead, we provide empirical evidence for theories in which the presence of informed lenders explains the fragility of bank funding structure, in particular Gorton and Pennacchi (1990) and Dang, Gorton, and Holmström (2012). Our results are also consistent with models in which short-term funding serves a disciplining role (Calomiris and Kahn, 1991; Flannery, 1994; Diamond and Rajan, 2001). By threatening to withdraw funding if creditworthiness deteriorates, informed lenders optimally induce high effort ex ante by the bank. By highlighting the presence of informed lenders, our findings help 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 dry-ups to be taken into account.

Finally, while we cannot formally test whether some dry-ups are due to coordination failures among lenders, as in Diamond and Dybvig (1983) or Goldstein and Pauzner (2005), we highlight that this is unlikely in our context. Indeed, for coordination failures to occur, the decision of a lender to cut funding must increase the probability that the bank will fail, therefore inducing other lenders to also cut funding. However, in our data, funding dry-ups do not induce banks to default. Finally, our results allow us to rule out the idea that dry-ups are random and equally likely to affect low- and high-quality banks,

as implied by Diamond and Dybvig (1983).

We proceed as follows. Section 2 presents the theoretical framework. Section 3 describes our data and the CD market. Section 4 documents the absence of system-wide market freeze, and describes bank-specific wholesale funding dry-ups. Section 5 shows that dry-ups 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 Theoretical discussion

There are two main strands of theory on wholesale funding fragility. In a first set of models, going back to Akerlof (1970), Stiglitz and Weiss (1981) and Myers and Majluf (1984), borrowers are informed and lenders are not. Market breakdowns result from adverse selection. When information asymmetries are more severe, 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. Preemptively, high-quality banks hoard cash or liquid assets to be able to exit the market (Heider, Hoerova, and Holthausen, 2015; Bolton, Santos, and Scheinkman, 2011). Heider, Hoerova, and Holthausen (2015) model adverse selection in the context of wholesale funding 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 no interest rate is compatible with trade in the funding market.[2]

An alternative set of theories highlights that the fragility of wholesale funding arises from the presence of some informed investors. With both informed and uninformed lenders, Gorton and Pennacchi (1990) show that issuing riskless debt is optimal to attract uninformed investors and protect them against informed investors. A key fea-

[2]Their model also features a full-trade equilibrium, in which asymmetric information is low, and all banks borrow at a low interest rate.

ture of riskless debt is that it is information-insensitive: whenever the borrower is far from default, informed lenders cannot benefit from their superior information. As mentioned by Holmström (2015), interbank debt, repos or CDs are prominent examples of information-insensitive securities. In this context, funding dry-ups occur when debt becomes information-sensitive, as modeled by Dang, Gorton, and Holmström (2012). Informed lenders make use of their superior knowledge and cut funding to low-quality banks. Uninformed lenders expect this to happen, and as a result may stop lending to all banks.[3] In the end, low-quality banks lose funding from both informed and uninformed lenders. High-quality banks remain financed by informed lenders. As a result, funding dry-ups predict lower future bank quality, and this indicates the presence of informed lenders.

A related theory in which heterogeneous information across lenders gives rise to funding fragility is Calomiris and Kahn (1991). In calm times, uninformed lenders benefit from the presence of informed lenders since the threat of funding cuts based on privileged information induces the bank to exert high effort. When fundamentals worsen, informed lenders are first to cut lending to low-quality banks and obtain a higher recovery value. Furthermore, while these funding cuts may be inefficient ex post, they are part of the optimal contract ex ante, due to the monitoring benefits they provide. Importantly, both Gorton and Pennacchi (1990) and Calomiris and Kahn (1991) share the same concept of liquidity: a security is liquid as long as it is issued or traded without imposing losses on uninformed investors (see Calomiris and Gorton, 1991, for a more detailed discussion). Funding can be cut for a given bank whenever its debt securities become more difficult to value, i.e., the debt is not riskless anymore.

The two classes of theories (without and with informed investors) make opposite predictions regarding the composition of the pool of borrowers in times of stress. Theories with only uninformed investors predict that the relative quality of the pool of borrowers *decreases* when money markets are stressed. This is because high-quality borrowers self-select out of the market to avoid pooling with low quality banks. In contrast, theories

[3]Reduced funding can also arise because uninformed investors face a situation similar to that described by Rock (1986). If they keep lending at prevailing market rates to banks which no longer obtain funds from informed lenders, they may earn a negative return. Anticipating that, they may stop lending.

relying on informed lenders predict that the relative quality of the pool of borrowers *increases* during stress episodes. Debt becomes information-sensitive following bad public information. Consequently, lenders have incentives to acquire information about bank quality. The presence of informed lenders implies that low-quality banks are more likely to lose funding and to be excluded from the market. Our main tests are directly tied to these opposite theoretical predictions.

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 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. According to the Banque de France, more than 90% of euro-denominated CDs are purchased by money market funds. Other potential buyers include pension funds or insurance companies. The minimum principal amount is set to EUR 150,000. Furthermore, CDs can be zero-coupon or bear a fixed or variable interest rate.

In order to issue CDs, banks must register with the regulator and set up a "CD program". The documentation of a program specifies a number of legal characteristics that all issuances must satisfy. The advantage of issuing CDs within a program is that no additional 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)). 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.

Our data represent a large share of the euro-denominated CD market. To show this, we rely on detailed ancillary data on the largest and most liquid subsegment of the European CD market, namely the Short-Term European Paper (STEP) market.[5] From the European Central Bank (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, 71% are

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

[5]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 29% are not, but they almost exclusively come from European countries (Italy, Germany, U.K., Netherlands, and Ireland). Non-French issuers account for 27.3% of all issuances. 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.

The dataset contains 1,360,272 observations, corresponding to 819,318 individual securities (ISINs). After initial issuance, additional observations correspond to events occurring during the lifetime of a security, including buybacks or re-issuances on the same ISIN, which are all observed. The breakdown of ISIN-level events is detailed in Panel B of Table 1. 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.

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 Refinancing Operations (MRO), and the unsecured interbank market, all measured at the

Eurozone level.[6]

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) – the main segment of the interbank market in Europe. 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.

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 3.5% of total liabilities and 21.5% of bank equity. Reliance on CD funding can be much larger, and represents 9% of total liabilities and 69% of equity at the 75th percentile.

3.5 Pricing

We access data on CD yields by rating-maturity buckets at a daily frequency. Data are volume-weighted and based on prices at primary issuance. An important characteristic of CD funding is that it is cheaper than its close substitutes for borrowers with a high creditworthiness. In Figure 2, we compare the CD yield against interest rates on other unsecured sources of funds, at comparable maturities. The CD yield data are for borrowers in the highest rating bucket (short-term ratings F1+ by Fitch, A-1 by S&P). As seen in Panel A, the interest rate on CDs is consistently lower than the ECB Main Refinancing Operations rate, over the whole sample period. Perhaps more surprisingly, 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.

[6] MROs are one-week liquidity-providing operations, denominated in euros. They take the form of repurchase agreements against eligible securities. Due to their short maturity, they are a closer potential substitute to CD funding than other central bank refinancing operations, such as Long-Term Refinancing Operations (LTROs).

4 Market freezes versus bank-specific dry-ups

In this section, we present our first main result: that there was no market freeze in the European CD market over the 2008-2014 period. We then define and describe the events which we treat as bank-specific wholesale funding dry-ups.

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 aggregate volume of CDs outstanding remained around EUR 400 Bn until mid 2012. This fact is remarkable because our sample period covers two periods of extreme banking stress (the subprime and European sovereign debt crises), while CDs are unsecured and therefore more susceptible to dry-ups than collateralized lending such as the repo market.

The sample period also contains two periods of relative decline in volume, but none of them is a freeze. The first period is a EUR 100 Bn contraction of outstanding volume in 2009. However, this does not correspond to a period of stress for banks. To show this, we superimpose in Figure 1 the 5-year EU Banks Credit Default Swap Index onto the aggregate CD volume. The drop in volume in 2009 corresponds to a period in which spreads on European banks were actually falling. The second period of relative decline in CD issuances is after July 2012. This decline is not a freeze but a reflection of the fact that the CD market lost attractivity as soon as the ECB lowered its deposit facility rate to 0%.[7] Furthermore, the progressive implementation of the Liquidity Coverage Ratio (LCR) for banks penalized short-term debt issuances.

As another sign of the aggregate resilience of the CD market, we find that CD yields remained stable and average maturity did not decrease during periods of stress. 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-

[7] Di Maggio and Kacperczyk (2016) 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.

wide reduction in the average maturity of new CD issues when bank CDS spreads increase. Similarly, average yields always remained below the ECB refinancing rate (see Figure 2, Panel A).

4.2 The identification of bank-specific dry-ups

While we do not observe any freeze in the CD market, we do observe a number of individual banks losing their CD funding. We call these events wholesale funding dry-ups. A *full dry-up* 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 dry-up* 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%. Our main results are robust to alternative definitions of dry-ups, either with a higher threshold (80%) or with a shorter time window (30 days).

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

Dry-ups are unlikely to capture events when a bank would deliberately shift to cheaper sources of funds, which we do not observe with the same granularity. First, as shown in Section 3.5, CDs are cheaper than close substitutes (both interbank debt and ECB funding) over the whole sample period for banks in the highest rating bucket. Relatedly, if an alternative source of funding was becoming more attractive than CDs, it would arguably be so for all issuers with a high rating. This is inconsistent with the fact that the occurrence of dry-ups is spread over our entire sample period. Furthermore, as we will see below, dry-ups tend to affect banks with higher leverage, worse profitability, and lower rating. To conclude, it is unlikely that substitution to cheaper funding instruments

is driving dry-ups. If there is substitution, it has to be towards *more expensive* sources of funds.

Panel A of Table 3 displays the number of dry-ups, broken down by year and by country. We identify 75 dry-ups, 29 of which are full. The year with the largest number of partial and full dry-ups 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 contraction in aggregate issuances during this year, which suggests investors reallocated their CD purchase to other banks – more on this below. Over the sample period, countries facing the highest number of full dry-ups 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 dry-ups. Full dry-ups are those on Banca Monte dei Paschi (BMPS) and on Allied Irish Banks (AIB). BMPS (dry-up 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 (dry-up 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 dry-ups 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. To get further assurance that dry-ups are associated with episodes of stress, we use Factiva to collect, for each event identified as a funding dry-up, newspaper articles dated from the weeks surrounding the event. For 27 out of 29 full dry-ups, we do find excerpts suggesting concerns about counterparty risk. They are collected in Appendix Table A2, together with an exhaustive list of dry-ups.

To analyze the magnitude of dry-ups and their dynamics, we measure the difference in CD amount outstanding before the dry-up starts until it ends.[8] Panel B of Table 3

[8]For full dry-ups, the magnitude is equal to the outstanding amount 50 days before it falls to zero. For partial dry-ups, the magnitude is equal to the difference between the outstanding amount 50 days

shows that there is large heterogeneity in size. On average, the magnitude of a drop in CD funding 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 dry-up is larger than their equity. Thus, these are large funding shocks.

To get an aggregate view on dry-ups, we compute a *Stress Index* at a monthly frequency as

$$Stress\ Index_t = \frac{\sum_i R_{i,t}}{CD_{m,t}}, \tag{1}$$

where $R_{i,t}$ is the euro amount of the dry-up faced by any issuer i in month t (conditional on i facing a dry-up; $R_{i,t} = 0$ otherwise) and $CD_{m,t}$ the aggregate size of the CD market at the beginning of that month. Both partial and full dry-ups 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 *Stress 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 Observable bank characteristics before dry-ups

To better describe dry-ups, we document which ex ante observable characteristics are associated with their occurrence. We compare the mean and median values of balance sheet characteristics for banks that face a full dry-up and for banks that do not, and we do so one year and two years before each dry-up. 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 4.

Banks facing a full dry-up and those not facing a full dry-up differ along several other important dimensions, including profitability, asset quality, capitalization, and credit risk.

before the dry-up and the post-dry-up amount.

Banks that are about to experience a dry-up 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 drop in CD funding. One year before the dry-up, 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 dry-up 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 drop in CD funding, and by a significantly lower credit rating up to two years before the drop.

Institutions that will experience a drop in CD funding also have a significantly lower ratio of equity to total assets, up to two years before the drop. 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 dry-ups. 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 dry-ups do not occur as sunspots, as would be the case if they were pure coordination failures among lenders (Diamond and Dybvig, 1983). Instead, the fact that dry-ups correlate with publicly observable fundamentals is consistent with historical evidence on depositor runs by Gorton (1988).

5 Informational content of funding dry-ups

In this section, we test whether funding dry-ups affect high- and low-quality banks equally. We measure quality that is not observable by the market at the time of dry-ups using future performance conditional on public information, and future market returns. Theories based on adverse selection predict a positive relation between funding dry-ups and

bank quality. A negative relation would instead point towards the existence of informed lenders. Our empirical evidence is consistent with theories in which the heterogeneity between informed and uninformed lenders is a source of fragility.

5.1 Funding dry-ups predict lower future bank quality

In this section, we show that funding dry-ups predict lower future bank quality. We start by using balance sheet data only, and extend the analysis to market data in the next subsection. For each drop in CD funding occurring during year t, only the balance sheet characteristics at the end of year $t-1$ are observable. We test whether the occurrence of dry-ups 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.[9] We estimate

$$\begin{aligned} \Delta Y_{i,t} &= \beta_0 DryUp_{i,t} + \beta_1 Size_{i,t-1} + \beta_2 Controls_{i,t-1} \\ &\quad + \beta_3 Controls_{c,t-1} + FE_c + FE_t + \varepsilon_{i,t}, \end{aligned} \tag{2}$$

where $DryUp_{i,t} = \mathbb{1}\{t-1 \leq \tau_{DryUp_i} < t\}$ and τ_{DryUp_i} is the time of the dry-up. $\mathbb{1}$ denotes the indicator function and takes a value of one when a dry-up affects issuer i between the end of year $t-1$ and the end of year t. $\Delta Y_{i,t} = Y_{i,t} - Y_{i,t-1}$ 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 dry-up). FE_c and FE_t are country and year fixed effects. We estimate regression coefficients separately for full and partial dry-ups. We use the change in ROA as our main dependent variable. Our coefficient of interest, β_0, is positive and significant if adverse selection is driving our results (i.e., better-performing banks withdraw from the market).

Regression coefficients are in Table 5. Panel A is for all dry-ups and Panel B for full dry-ups only. As seen in our main specifications (Columns 1 and 2), the occurrence of a

[9] 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.

drop in CD funding 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 dry-ups, 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 suggests that dry-ups contain information about future bank quality.

This baseline result can be extended along two dimensions. First, we provide evidence of the informational content of dry-ups at longer-term horizons. We re-estimate Equation (2) with $Y_{i,t+1} - Y_{i,t-1}$ as the dependent variable, i.e., we consider whether dry-ups predict future changes in ROA or impaired loans over a two-year period starting at the end of December of the year preceding a dry-up. Estimates are in Appendix Table A4. Dry-ups predict a longer-term decrease in ROA, even though this relationship is not statistically significant.

Second, we show that the informational content of dry-ups does not disappear in times of high market stress. Indeed, if market stress corresponds to more acute information asymmetries between lenders and borrowers, lenders are expected to find it more difficult to distinguish between high- and low-quality borrowers (Heider, Hoerova, and Holthausen, 2015). If this is the case, dry-ups may not be informative any longer during crises. In Tables 5 and 7, we re-estimate Equation (2) after including an interaction term between the *DryUp* dummy and a *Crisis* dummy that equals one in 2011 and 2012. These years correspond to the height of the European sovereign debt crisis. As seen in Figure 1, they are also the years in which the credit default swap spread of European banks reached its highest level. If the predictive power of dry-ups diminishes or disappears in times of crisis, the estimated coefficient on this interaction term should have opposite sign as that on the *DryUp* dummy and be significant. We do not find this in any of the specifications, highlighting the fact that dry-ups contain information even when market stress is high. In this section, we fail to find any evidence that adverse selection explains the dry-ups. Instead, it is consistent with the existence of informed lenders in the market, for which we provide more extensive evidence below.

5.2 Extension using market data

When testing for the presence of asymmetric information between lenders and borrowers, a generic concern arises. It could be that the information set of lenders is not the same as the information set that we, as econometricians, use in regressions. In particular, all regressions in the previous section rely on balance sheet data available at a yearly frequency. Thus, new information may be revealed between the end of the preceding year (to which balance sheet information pertains) and the time of the dry-up. If this is the case, dry-ups may not be informative about future characteristics but simply correlate with characteristics publicly observed by lenders but not yet reflected in balance sheet data.

We address this concern by using market data. Arguably, market data incorporate all public information available to market participants at the time of a dry-up. Switching to daily market data brings the benefit of a more stringent test but also comes at the cost of having data for a smaller sample. We re-estimate Equation (2), using both future realized excess stock returns and changes in credit default swap spreads as dependent variables.[10] In Table 6, results are provided for the 6-month and one-year periods that follow the occurrence of a dry-up. As seen in Panel A, the occurrence of a dry-up is associated with a future negative excess stock return at both horizons, which is statistically significant in one case. In Panel B, the occurrence of a dry-up 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 dry-ups does not only arise from observable characteristics not yet incorporated in balance sheet data. Dry-ups do predict future bank-specific outcomes, even after controlling for observable characteristics. Again, these regressions make it possible to reject the null hypothesis that dry-ups are uninformed about bank quality.

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

5.3 Addressing reverse causality concerns

While previous results cast doubt on the idea that adverse selection is driving funding dry-ups, they do not allow us yet to conclude that dry-ups are due to informed lenders. Indeed, a potential endogeneity concern when estimating Equation (2) is reverse causality: drops in bank performance could be *caused* by a reduction in funding. This can occur if dry-ups are due to coordination failures among lenders, as in Diamond and Dybvig (1983) and Goldstein and Pauzner (2005), which may force asset fire sales or prevent banks from investing in valuable projects. If this is the case, a negative relation between dry-ups and future performance could arise even if dry-ups are ex ante random. We address this reverse causality concern in three ways. Then, we discuss why coordination failures are unlikely in our context.

First, we replace changes in ROA by changes in the ratio of impaired loans over total loans as the dependent variable when estimating Equation (2). Changes in impaired loans arguably cannot be caused by funding shocks because they relate to a stock of pre-existing loans, which have been extended before the dry-up. They are thus exogenous with respect to the occurrence of the drop in CD funding. Estimation results in Table 7 are consistent with those obtained for changes in ROA. The occurrence of dry-ups 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. This result also extends at a two-year horizon, as seen in Appendix Table A4. Dry-ups predict a longer-term increase in the ratio of impaired loans, which is significant at the 1% level.

Second, if funding shocks were actually causing performance drops, this effect should be particularly severe for banks that depend a lot on CDs. Thus, we interact the *DryUp* 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 β_0 on the *DryUp* dummy variable, and increasing in magnitude. Estimation results are in Column 3 of Tables 5 (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. Dry-ups are also predictive of future profitability and asset quality even for banks with little CD funding. This result extends to a two-year horizon, as seen in Appendix Table A4. It casts serious doubt on the idea that endogeneity concerns are severe in our context. In contrast, it is consistent with lenders cutting funding based on information about future fundamentals, as the share of CD funding over total liabilities should not matter in this case.

Third, we show that dry-ups do not seem to force banks to downsize significantly. In the Appendix Table A3, we re-estimate Equation (2) 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 dry-ups 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 central bank funding.[11] The fact that dry-ups do not force banks to downsize significantly suggests that the reduction in ROA is not due to fire sales.

Finally, we stress that dry-ups arising from coordination failures are unlikely in our context. A necessary condition for coordination failures to arise is that strategic complementarities among lenders are present: the decision of a given lender to withdraw funding should depend on other lenders' decisions to maintain or withdraw funding. Such strategic complementarities can exist only if cutting funding can induce the borrowing bank to default. Instead, we do not find that dry-ups induce banks to default (since we observe their balance sheet after dry-ups), or even to downsize significantly (see Appendix Table A3). Moreover, if strategic complementarities were present, they should be stronger for banks which rely more on CD funding. Indeed, a funding shock is more likely to induce such banks to default or liquidate assets. Our finding that the predictive power of dry-ups on future performance is equally strong even for banks relying on CDs to a small extent (Column 3 of Tables 5 and 7) further suggests that coordination failures are unlikely to

[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.

explain dry-ups.

Taken together, all results in this section suggest that the observed funding dry-ups are driven by informed lenders monitoring and cutting funding to low-quality banks.

5.4 Heterogeneity across lenders and maturity shortening

We provide additional evidence consistent with theories based on heterogeneity across informed and uninformed lenders. In the presence of informed lenders, debt securities are valuable for uninformed lenders as long as they remain information-insensitive. However, for a given borrower, not all CDs become information-sensitive at the same time. When fundamentals deteriorate, theory predicts that longer-term CDs become information-sensitive before shorter-term CDs, since they get repaid later (Holmström, 2015).

We provide evidence for this mechanism by investigating 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 issues prior to the dry-up. We estimate

$$Maturity_{i,t} = \sum_{j=1}^{6} \beta_j DryUp_{i,\tau-j} + FE_i + FE_t + \varepsilon_{i,t}, \tag{3}$$

where $Maturity_{i,t}$ 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 dry-up and $DryUp_{i,\tau-j}$ a dummy variable that equals 1 for i if it faces a dry-up 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 8, for all types of dry-ups (Panel A) and for full dry-ups only (Panel B).

The average maturity of new issues starts to shorten about five months before the dry-up takes place, and the shortening becomes statistically significant at the 1% level three months before the dry-up. This is true for both full and partial dry-ups. 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 dry-ups and by 25 days before partial dry-ups. The monotonic drop in average maturity suggests that creditors become increasingly reluctant to buy CDs at longer maturities. Such maturity shortening is consistent with longer-term CDs turning information-sensitive before shorter-term CDs, therefore giving rise to dry-ups.[12] As a general feature of events which we treat as dry-ups, it is also hard to reconcile with a demand-driven explanation.

6 Reallocation of funds during stress episodes

The absence of market freeze (total market volume remains stable) and the occurrence of bank-specific dry-ups suggest that funds are reallocated in the cross-section during stress episodes. We study reallocation to provide additional evidence on the informational content of funding patterns.

6.1 Bank borrowing as a function of quality

We shift our attention from banks that face dry-ups to banks that increase their CD funding. If CD lenders value information-insensitive debt securities, they should reallocate their funds to such CDs when dry-ups occur. Therefore, high-quality banks should increase reliance on CD funding in times of stress. Instead, if adverse selection is driving the allocation of funds, high-quality banks should reduce reliance on wholesale funding during such episodes. We study whether banks whose CD funding grows faster than the aggregate market are high-quality banks, i.e., banks 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. This further suggests that monitoring by informed lenders, not adverse selection, explains the allocation of funds in the market.

We start by comparing the growth of CD issuance by each bank to the growth of

[12] A related interpretation is that some creditors engage in costly monitoring and use maturity shortening to strengthen their discipline over the bank several months prior to the dry-up (Calomiris and Kahn, 1991).

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,

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

where $CD_{i,t}$ is the amount of CD outstanding by issuer i at the end of month t and $CD_{m,t}$ 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, and for issuers that enter the CD market for the first time.

We proceed in two steps. First, we check whether high and positive values of $E_{i,t}$ 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 dry-ups or not in the market. Second, we test whether the reallocation of funds towards better-performing banks is stronger at times dry-ups occur in the market.

We construct a dummy variable $I_{i,t}$ that equals one for any issuer i in month t if $E_{i,t}$ is above some percentile α of the distribution of $E_{i,t}$ 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

$$\begin{aligned}&\Pr\left(I_{i,t} = 1 | X_t\right) = \\ &\quad \Phi\Big(\beta_0 \Delta ROA_{i,t} + \beta_1 Controls_{i,t-1} + \beta_2 Controls_{c,t-1} + FE_c + FE_m\Big),\end{aligned} \tag{5}$$

where $\Delta ROA_{i,t} = ROA_{i,t} - ROA_{i,t-1}$ is the change in ROA between the end of the previous year (observable at the time of the dry-up) and the ROA at the end of the current year (unobservable at the time of the dry-up). 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 dry-ups. 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 $\Delta ROA_{i,t}$ as an independent variable, and not as a dependent variable as in the previous section. Finally, Φ denotes the c.d.f. of the standard normal distribution.

Estimates are provided in Table 9 for threshold values $\alpha = 0.5$ (Column 1) and $\alpha = 0.25$ (Column 3). Estimated coefficients are positive and significant at the 1% or 5% level. This means that, regardless of whether bank-specific dry-ups 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 the reallocation effect is stronger during periods in which bank-specific dry-ups occur in the market. Theory suggests that information asymmetries are larger in times of stress, possibly increasing adverse selection and reducing the informational content of dry-ups. If this is the case, high-quality banks should reduce borrowing in times of stress, thus lowering the baseline coefficient on Table 9. In contrast, high-quality banks should increase borrowing if lenders reallocate funds to other information-insensitive securities. We re-estimate Equation (5) after including interaction terms between $\Delta ROA_{i,t}$ and dummy variables taking a value of one if the *Stress Index*, defined in Equation (1), is in the second, third or fourth quartile of its distribution (i.e., highest values of the *Stress Index*).

Estimates are in Columns 2 and 4 of Table 9. The base coefficient on ΔROA, corresponding to periods in which the *Stress 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 *Stress 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.[13]

This result is of particular interest for two reasons. First, it provides additional and strong evidence against adverse selection. Indeed, it goes against the main prediction of adverse selection models, that higher-quality banks self-select out of the market. In addition to finding that they do not exit the market, we also show that they instead increase funding. They do so particularly in times of high market stress, at times information asymmetries are arguably more severe.

Second, these results are compatible with a model in which lenders value debt securities as long as they remain information-insensitive, and reallocate funds accordingly.[14] This is consistent with the fact that reallocation towards high-quality banks is stronger in times of high market stress. However, the fact that increases in CD funding predict better future performance shows that reallocation is, at least partially, informed. It suggests that informed lenders do not only monitor low-quality issuers, but are also able to identify well-performing institutions, based on unobserved characteristics.

7 Conclusion

We draw three main conclusions from our study. First, we show that wholesale funding dry-ups are mostly bank-specific and driven by information about future bank quality. This is in contrast with the view that wholesale funding markets are inherently subject to market-wide disruptions. Second, the cross-sectional allocation of funds in wholesale funding markets is not primarily driven by adverse selection between lenders and borrow-

[13]Results in Table 9 are robust to endogeneity tests. As in Section 5.3, we find that the effect is similar in magnitude for banks that rely heavily on CD funding or not. It is also robust to changing the dependent variable to changes in non-performing loans. Since the endogeneity concern (i.e., that improvements in bank performance would be due to the inflow of CD funding) is less severe than in Section 5, we do not report these regression coefficients.

[14]This is not akin to a pure "flight-to-quality" phenomenon, since our tests pertain to *unobservable* quality.

ers in times of stress. Third, it is consistent with models based on heterogeneity between informed and uninformed investors. In such models, bank debt derives value from being information-insensitive, and dry-ups occur when debt turns information-sensitive. Such theories make it possible to explain basic patterns in the data: banks that face dry-ups are those whose performance will deteriorate in the future and banks receiving more funds during stress episodes are those whose profitability will improve.

Our findings, suggesting the existence of informed lenders in the wholesale funding market, provide a potential explanation as to why several segments of this market have proved more resilient than widely expected. As such, they do not support one of the main premises on which new regulation on liquidity coverage ratios is based. However, since our analysis disregards the negative externalities triggered by dry-ups, we cannot draw any definite conclusion about the soundness of these regulatory tools. Similarly, we leave the study of the implications of our results for optimal disclosure or opacity for future work.

From our analysis, one can also draw lessons for central banking. We show that high-quality banks are still able to access wholesale funding in times of stress, and eventually to increase funding. They are thus less likely to require funding from the central bank. This is in contrast with the received lender of last resort 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 displays information at the contract-level. 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 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. In Panel C, the minimun issued amount of EUR 100,000 corresponds to re-issuance on an existing ISIN. The minimum issued amount for new ISINs is EUR 150,000). 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 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	0.008	0.053	1.176	0.215	0.693	2.246	971
CD / (CD + Repo)	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 dry-ups

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

Panel A: Number of dry-ups

	Partial and full dry-ups		*Full dry-ups only*	
	Number of dry-ups	% Total	Number of dry-ups	% 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 dry-ups

	Min.	10th	25th	Mean	Median	75th	90th	Max.
Partial and full dry-ups:								
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 dry-ups 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 – Balance sheet characteristics before full dry-ups

This table compares balance sheet characteristics as of end of December of years $t-1$ and $t-2$ between banks that face a full dry-up during year t and banks that do not face a full dry-up. All reported statistics are differences in means and medians for banks that face a full dry-up during year t, relative to banks that do not face a full dry-up. 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 dry-up		Two years before dry-up		
	Diff. from mean	Diff. from median	Diff. from mean	Diff. from median	N. Obs.
			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 5 – Dry-ups forecast future changes in ROA

In this table, we estimate Equation (2), with changes in ROA as a dependent variable. Panel A is for both partial and full dry-ups. Panel B is for full dry-ups only. Changes in ROA are between the end of year $t-1$ (observable at the time of the dry-up) and the end of year t (unobservable at the time of the dry-up). *DryUp* is a dummy variable that takes a value of one for bank i if it faces a dry-up during year t. Time and country fixed effects are included. In Column (3), we interact the *DryUp* 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 *DryUp* 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 dry-ups			
DryUp	-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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			0.372	
			(0.407)	
DryUp $*$ Share CD $> 9\%$			0.351	
			(0.302)	
DryUp $*$ 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 dry-ups only			
DryUp	-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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			0.904	
			(0.411)	
DryUp $*$ Share CD $> 9\%$			0.524	
			(0.501)	
DryUp $*$ Crisis				0.466
				(0.605)
Adj. R^2	-0.006	0.400	0.401	0.399
N. Obs.	948	684	684	684

Table 6 – Dry-ups forecast future stock returns and CDS spread changes

In this table, we estimate Equation (2), 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 dry-up 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	
DryUp	-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	
DryUp	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 7 – Dry-ups forecast future changes in asset quality (Impaired loans / Loans)

In this table, we estimate Equation (2), with changes in the ratio of impaired loans to total loans as a dependent variable. Panel A is for both partial and full dry-ups. Panel B is for full dry-ups only. Changes in impaired loans are between the end of year $t-1$ (observable at the time of the dry-up) and the end of year t (unobservable at the time of the dry-up). *DryUp* is a dummy variable that takes a value of one for bank i if it faces a dry-up during year t. Time and country fixed effects are included. In Column (3), we interact the *DryUp* 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 *DryUp* 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 dry-ups			
DryUp	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)
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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			-0.490	
			(0.385)	
DryUp $*$ Share CD $> 9\%$			-0.233	
			(0.306)	
DryUp $*$ 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 dry-ups only			
DryUp	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)
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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			-0.507	
			(1.047)	
DryUp $*$ Share CD $> 9\%$			-0.499	
			(0.958)	
DryUp $*$ Crisis				-0.098
				(0.157)
Adj. R^2	0.131	0.172	0.182	0.193
N. Obs.	676	675	675	675

Table 8 – Maturity shortening before dry-ups

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 3). A dummy variable at date $\tau - t$ equals one if the bank faces a dry-up at date τ and zero otherwise, for $t \in \{1, ..., 6\}$, i.e., up to six quarters before the dry-up. Panel A is for both partial and full dry-ups. Panel B is for full dry-ups 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 dry-ups	*Panel B: Full dry-ups only*
Month $\tau - 1$	-25.360***	-29.511***
	(2.285)	(4.513)
Month $\tau - 2$	-17.345***	-30.001***
	(3.914)	(5.998)
Month $\tau - 3$	-12.134***	-14.664***
	(1.699)	(4.742)
Month $\tau - 4$	-7.628	-11.610
	(4.902)	(7.368)
Month $\tau - 5$	-7.506*	-3.930
	(3.750)	(5.243)
Month $\tau - 6$	-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 9 – Reallocation of funds after dry-ups

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 *Stress 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 * *Stress Index* in Quartile 2		-0.003		0.008
		(0.016)		(0.006)
Δ ROA * *Stress Index* in Quartile 3		0.033***		0.039
		(0.012)		(0.033)
Δ ROA * *Stress Index* in Quartile 4		0.048**		0.030**
		(0.020)		(0.015)
Controls	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes
Month fixed effect	Yes	Yes	Yes	Yes
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.

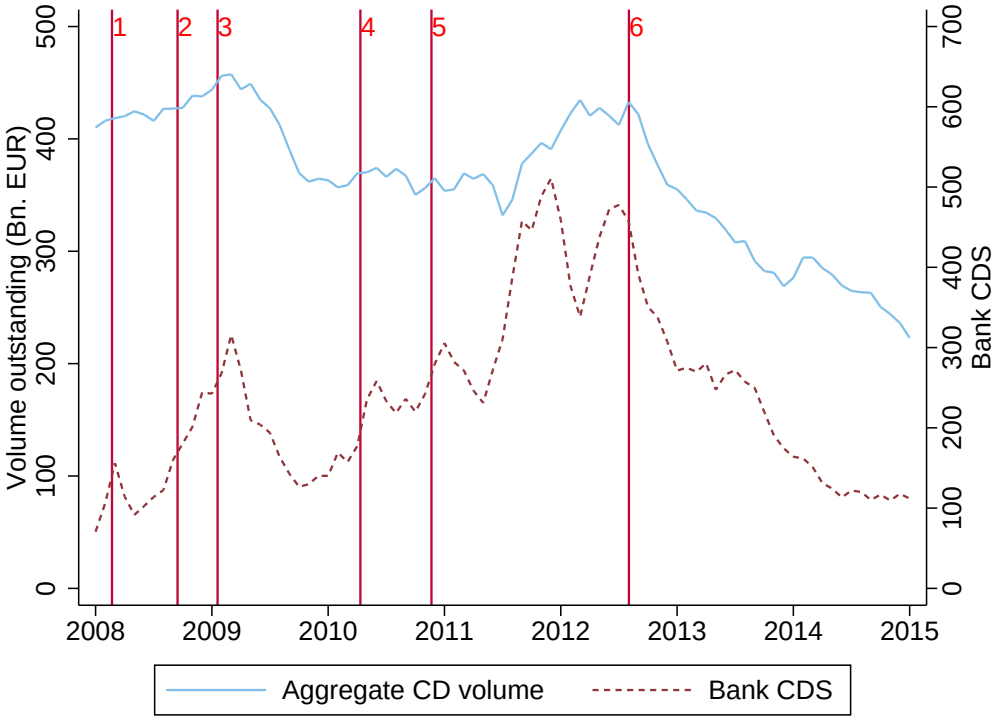
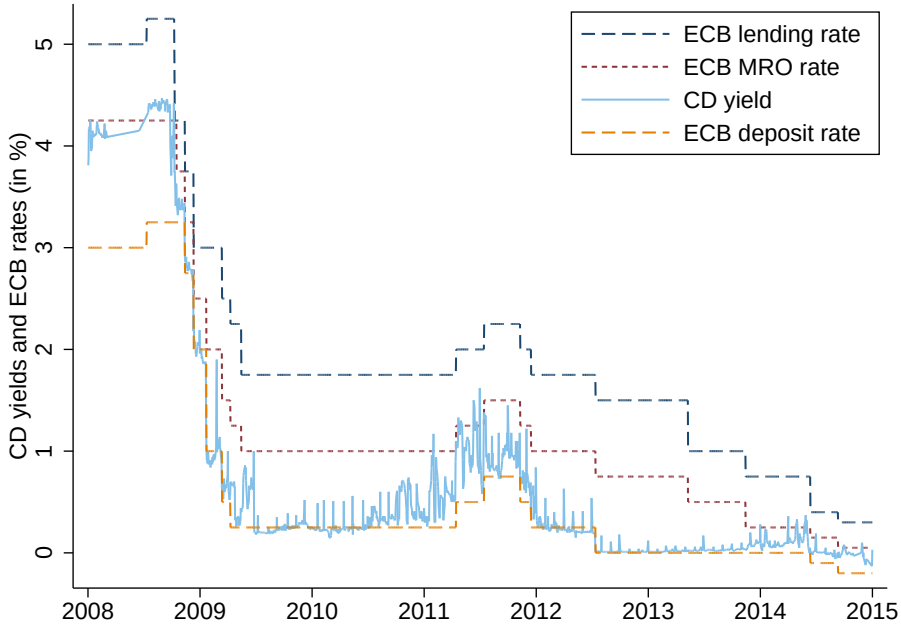


Figure 2 – Short-term interest rates

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

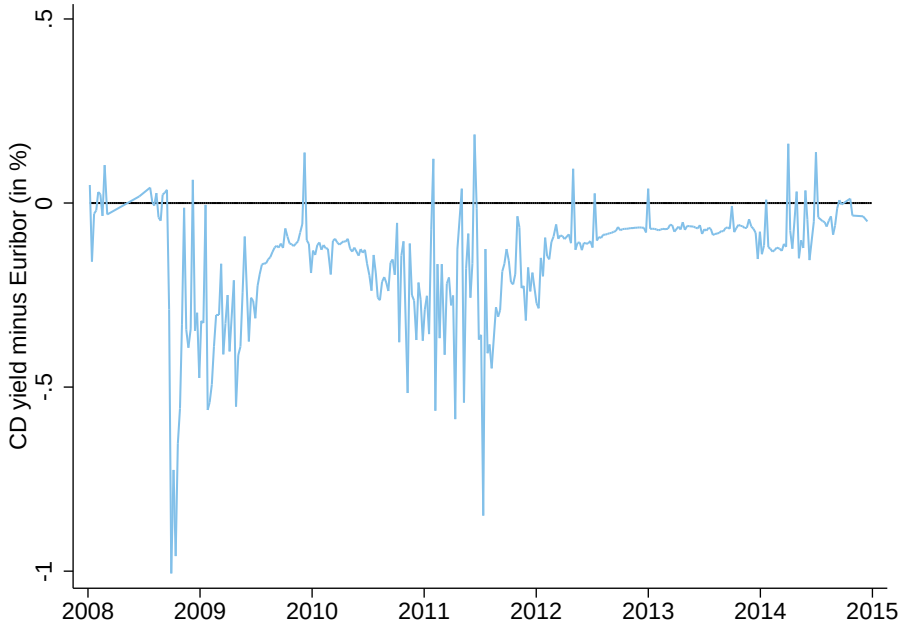


Figure 3 – Segments of the euro-denominated CD market

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 and the U.K. (European Commercial Paper) markets. Other markets include primarily the Belgian and the Luxembourgian markets. Data source: European Central Bank.

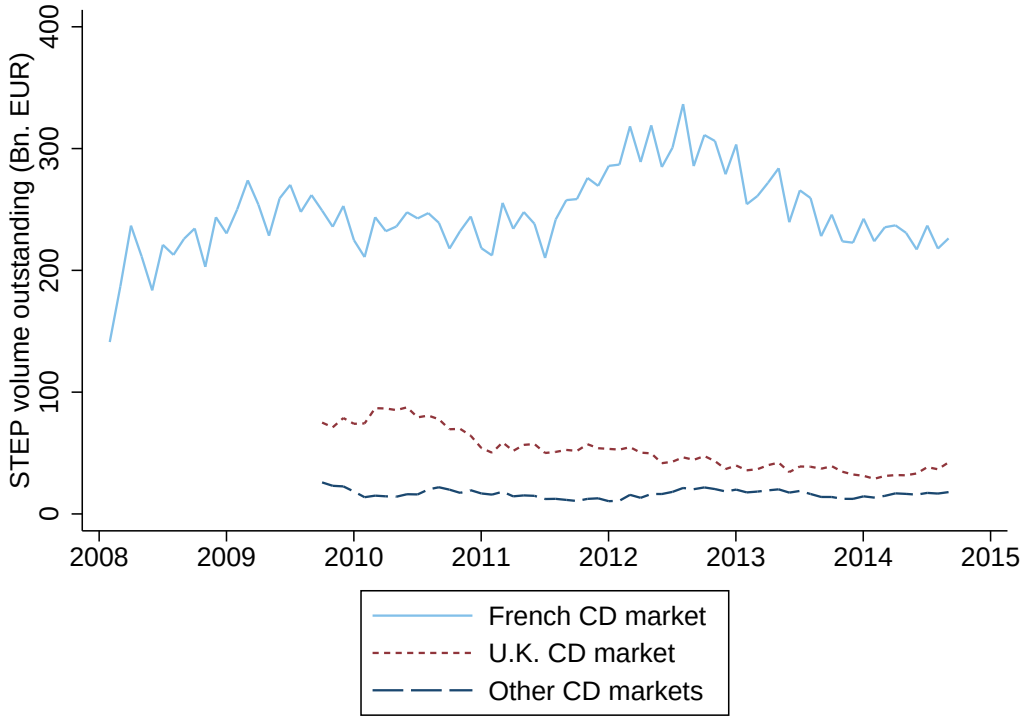
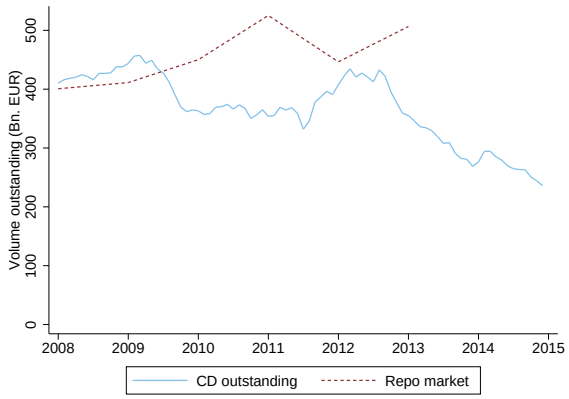


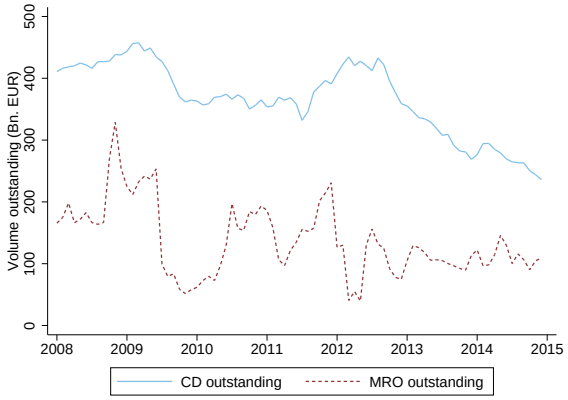
Figure 4 – Size of the CD market relative to other wholesale funding markets

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 have been 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

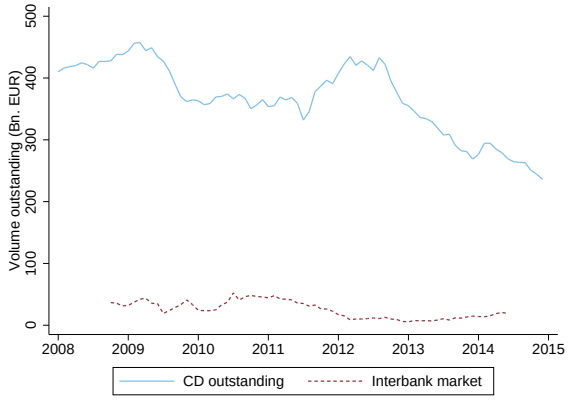


Figure 5 – Average maturity of new issues in the euro-denominated CD market

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.

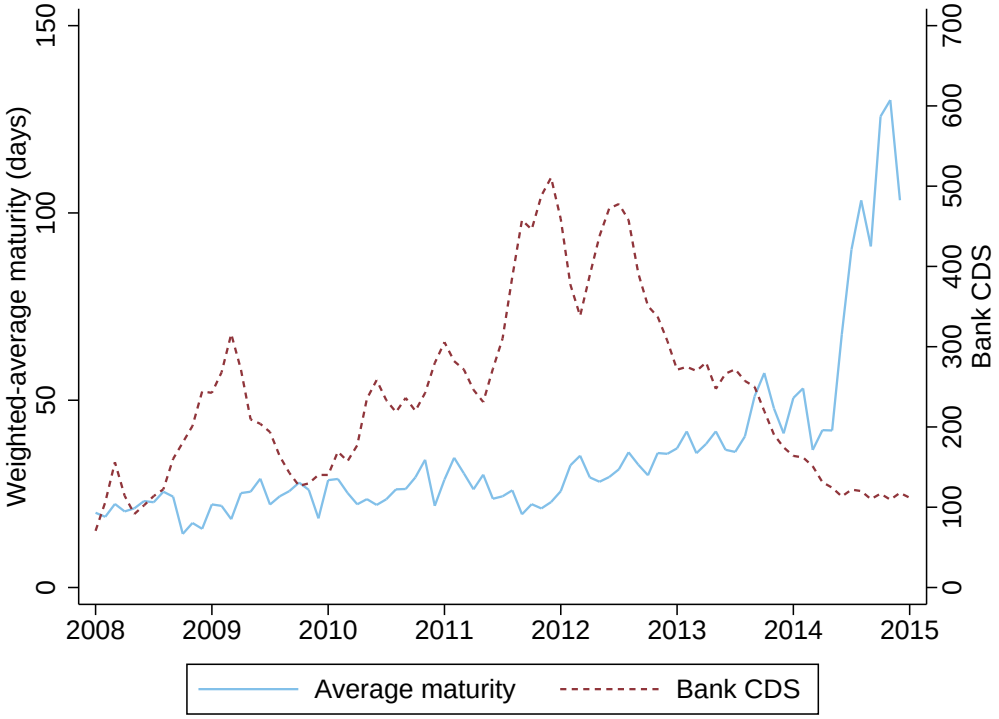
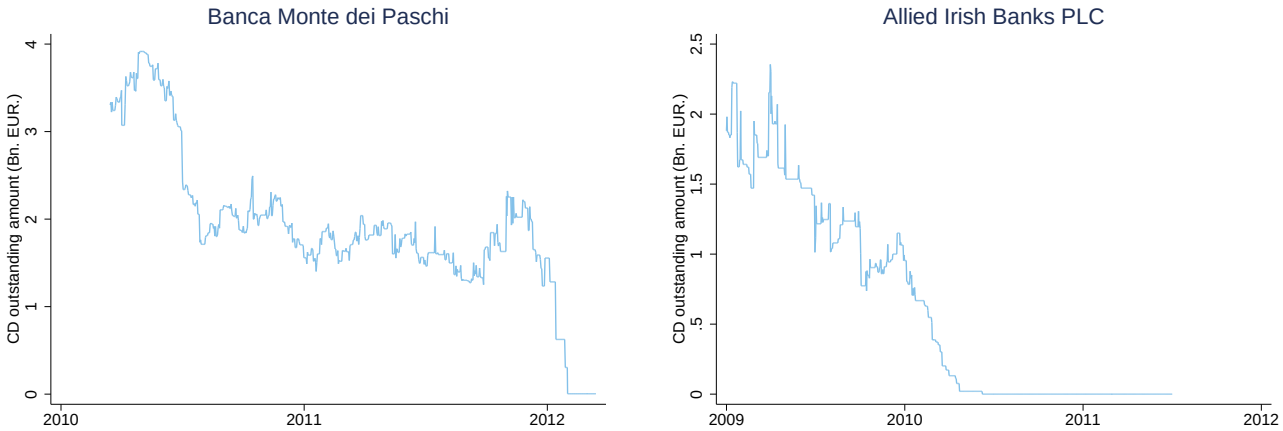


Figure 6 – Complete and partial dry-ups

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

Panel A: Full dry-ups



Panel B: Partial dry-ups

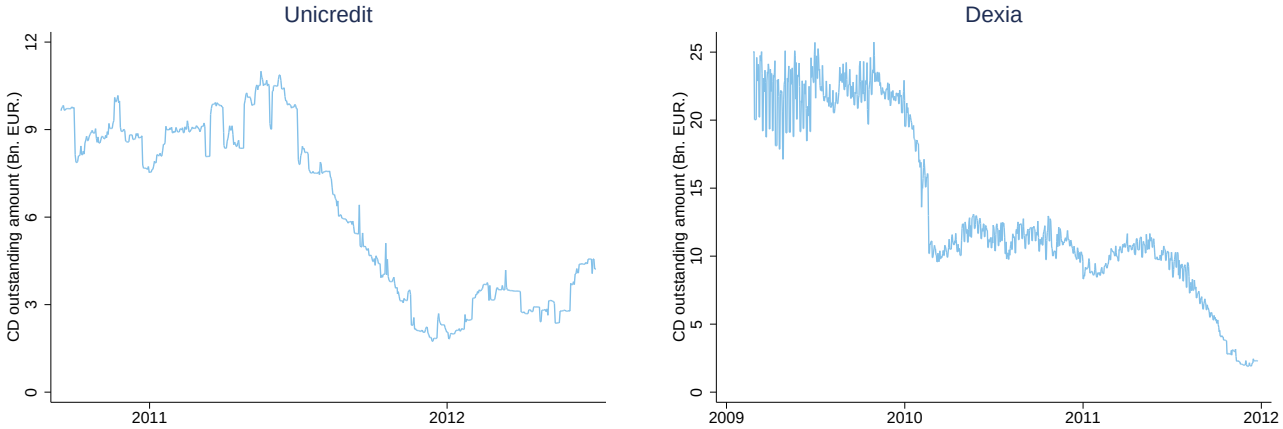
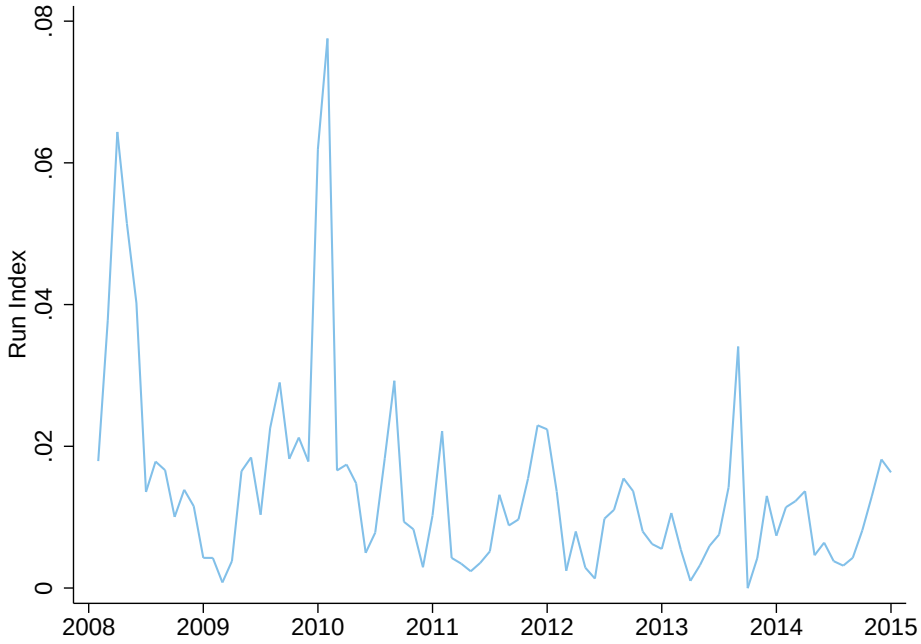


Figure 7 – Stress Index

This figure plots the *Stress Index* in the CD market at a monthly frequency. This index is defined as the sum of the euro amount of all sample dry-ups 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 dry-ups

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

	Bank name and country	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 Banks 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	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, 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, Irish Life & Permanent and EBS Building Society said they would also impose losses equivalent to around 80pc-90pc of the face value of some EUR1.1 Bn 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 Ireland became the only bank still listed on the Irish Stock Exchange on Tuesday when shares in 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 in 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, Irish Life & Permanent and EBS Building Society 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-owned ATEbank (which also failed last year's round) and EFG Eurobank and five Spanish regional savings banks - the Caixa d'Estalvis de Catalunya, Tarragona i Manresa, 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 parent BNP Paribas. In addition, 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 parent BNP Paribas. In addition, 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	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, Morgan Stanley 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 of 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 SC 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	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 parent 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 that DZ Bank 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; DZ Bank's coverage figure was higher at 49%. Raising both banks' coverage to 60% would require 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, Banco Espirito 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 since European Investment Bank priced a USD3bn 2.125% October 2021 in the last week of August, began to pall on Thursday as a seven year for Oesterreichische Kontrollbank fell just shy of full subscription.

Table A3 – Dry-ups do not forecast future changes in size or loans to total assets

In this table, we estimate Equation (2), 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 dry-up) and the end of year t (unobservable at the time of the dry-up). *DryUp* is a dummy variable that takes a value of one for bank i if it faces a partial or a full dry-up during year t. Time and country fixed effects are included. In Column (3), we interact the *DryUp* 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 *DryUp* 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		
DryUp	-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)
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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			-0.009	
			(0.041)	
DryUp $*$ Share CD $> 9\%$			-0.017	
			(0.030)	
DryUp $*$ 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		
DryUp	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)
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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			0.026	
			(0.023)	
DryUp $*$ Share CD $> 9\%$			0.014	
			(0.017)	
DryUp $*$ Crisis				-0.015
				(0.017)
Adj. R^2	0.015	0.073	0.072	0.073
N. Obs.	947	685	685	685

Table A4 – Dry-ups forecast future changes in longer-term profitability and asset quality

In this table, we estimate Equation (2), 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 dry-up) and the end of year $t+1$ (unobservable at the time of the dry-up). *DryUp* is a dummy variable that takes a value of one for bank i if it faces a partial of a full dry-up during year t. Time and country fixed effects are included. In Column (3), we interact the *DryUp* 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 *DryUp* 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: $ROA_{t+1} - ROA_{t-1}$			
DryUp	-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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			0.657	
			(0.528)	
DryUp $*$ Share CD $> 9\%$			0.559	
			(0.377)	
DryUp $*$ 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}			
DryUp	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)
DryUp $*$ Share CD $\in [4\%, 9\%]$			-1.236	
			(1.016)	
DryUp $*$ Share CD $> 9\%$			-0.858	
			(0.791)	
DryUp $*$ Crisis				-0.201
				(0.351)
Adj. R^2	0.110	0.166	0.167	0.174
N. Obs.	527	527	527	527