Safe Asset Shortages:
Evidence from the European Government Bond Lending Market

Reena Aggarwal
McDonough School of Business, Georgetown University
aggarwal@georgetown.edu

Jennie Bai
McDonough School of Business, Georgetown University
jennie.bai@georgetown.edu

Luc Laeven
European Central Bank
luc.laeven@ecb.europa.eu

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Abstract

We identify the unique role of the government bond lending market in accessing safe assets during periods of market stress. Using a novel database, we provide original evidence that safe assets in the lending market have higher demand and higher borrowing cost relative to non-safe assets during stressed market conditions. Moreover, we find that market participants are able to obtain safe assets using relatively low-quality non-cash collateral, allowing for collateral transformation. These attributes are important since they increase the velocity of safe assets and hence alleviate the pressure of safe asset shortages. We show that policy interventions by central banks can help reduce safe asset shortages by returning sought-after safe assets to the lending market.

JEL: E44, E58, G24
Keywords: safe asset, securities lending, velocity, government bonds, collateral upgrading

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1. Introduction

Following the U.S. and European financial crises, a major challenge facing the global economy has been the shortage of safe assets. Safe assets play a critical role in the economy. They act as a store of value, serve as collateral in financial transactions, and form the basis of monetary policy operations (Gorton 2016, and International Monetary Fund 2012). During the recent crisis, trillions of dollars' worth of traditionally safe assets, including government debt of highly-indebted euro area countries, commercial paper of financial companies, and highly-rated tranches of asset-backed securities and mortgage-backed securities were no longer viewed as safe (Lane 2012, Covitz et al. 2013, Acharya et al. 2013, and Krishnamurthy et al. 2014). Investors have since piled into selective assets still perceived as risk-free, such as German and U.S. government bonds. The drop in the supply of safe assets combined with an increase in investors' risk aversion has pushed the yields on safe assets to record lows, increasing the risk premium (Krishnamurthy and Vissing-Jorgensen 2015, and Caballero et al. 2017).

We study a largely ignored short-term funding market, the government bond lending market, to provide new evidence of safe asset shortages, and to investigate the unique role of this market in alleviating safe asset shortages. This is the first paper to examine the role of the securities lending in addressing safe asset shortages. We construct a novel database covering bond-level lending transactions of government bonds from 11 Eurozone countries during the period 2006 to 2017. As of the end of our sample period, the lendable inventory is $838 billion dollars for

European government bonds, and the outstanding amount of bonds on loan is $236 billion dollars.[1] The activity in the lending market is sizeable relative to the outstanding amount of government bonds. For example, the daily amount borrowed in German government bonds averages about 10% of its total outstanding amount. To identify the shift in the demand for safe assets in the government bond lending market, we exploit periods of crisis. Specifically, we simultaneously examine the borrowing amount, borrowing cost, and borrowing collateral for acquiring safe assets relative to non-safe assets in normal times compared to those in stressed times.

The securities lending market offers an unparalleled function: collateral transformation, which allows the possibility of using *non-cash* collateral to borrow a specific asset. In contrast, repo transactions that involve the exchange of assets are settled in cash (Duffie 1996, Corradin and Maddaloni 2015). The ability to use non-cash collateral becomes increasingly attractive in stressed market times, when "cash is king." Imagine an investor with a high demand for safe bonds during a period of market stress. She could acquire the bonds in the secondary market, borrow the bonds in the reverse repo market with cash collateral, or borrow the bonds in the securities lending market with a combination of cash and non-cash collateral. The first two options require the investor to have enough cash at hand, which may be a constraint in stressed market conditions. More likely, the investor may not have sufficient cash to support her demand for safe bonds that have become increasingly expensive. However, the investor may hold other pledgeable securities such as investment-grade corporate bonds. In such a scenario, the lending market becomes an appealing

[1] For comparison, the lendable inventory is $1.06 trillion dollars for the U.S. government bonds, and the amount of bonds on loan is $427 billion dollars as of December 2016.

source to access safe bonds using relatively lower-quality non-cash collateral. With this distinguishing feature of collateral transformation, the government bond lending market may increase the velocity of safe assets by shifting the temporary ownership from long-term passive investors (such as pension funds and insurance companies) to investors with short-term demand (such as banks, broker-dealers, and hedge funds). Consequently, the quantity of safe assets available depends not only on the volume of safe assets but also on their availability for re-use in the financial markets.[2]

The European government bond lending market is particularly appropriate to study the demand for safe assets. First, the European sovereign debt crisis in 2011 led to a triage of safe bonds in core economies and risky bonds in peripheral countries, providing a natural condition for assessing the significance of the demand-for-safety effect. Second, the European government bond lending market is primarily non-cash collateral driven, as opposed to the U.S. government bond market which is primarily cash driven, making it an ideal testing ground for assessing the role of collateral transformation.

We provide strong evidence of an increase in the demand to borrow safe assets in the government bond lending market during crisis times. In normal times, borrowing amount is lower for safe relative to non-safe government bonds. However, in times of market stress, daily borrowing amount for safe bonds is significantly higher than that for non-safe government bonds. The difference is 1.4% of amounts outstanding, which is large compared to the average daily

[2] See Singh (2014) for a discussion on financial plumbing and collateral.

borrowing amount of 3.3% of amount outstanding. The large increase in borrowing amount is due to the increased demand for safe bonds during market stress when safety is most highly valued.

Borrowing amount and borrowing cost are jointly determined. To isolate demand and supply impact, we first adopt the methodology in Cohen, Diether, and Malloy (2007) to examine the changes in borrowing amount and borrowing cost at the bond level before and during the peak of the European sovereign debt crisis period. We find that the most common combination for safe bonds is an increase in both borrowing cost and borrowing amount (42.4% out of all safe bonds), consistent with an outward shift in demand. The results imply that market participants are willing to pay a higher borrowing fee to borrow safe assets. In contrast, the most common combination for non-safe bonds is an increase in borrowing cost accompanied by a decrease in borrowing amount (66.7% of all non-safe bonds), consistent with an inward shift in supply. The lending market for non-safe bonds is primarily driven by short selling. These results provide preliminary evidence of both an increase in demand for safe assets and a flight away from non-safe assets during the European crisis.

To separate the supply and demand shifts formally, we estimate a demand equation by instrumenting borrowing cost with the country-level public debt to GDP ratio. This instrument has predictive power for borrowing cost. By instrumenting borrowing cost, which in turn is affected by supply shifts, we are able to focus on demand. The identifying assumption is that a country's public debt does not directly affect investors' demand for borrowing bonds. This is akin to the view that the supply of government bonds affect bond yields but do not react to demand shocks, as argued in Krishnamurthy and Vissing-Jorgensen (2012). The instrumental variable regressions confirm our earlier results, showing that the demand for safe bonds increases relatively more than that of non-safe assets during stressed market conditions, even after controlling for borrowing cost.

A second major contribution of our paper is to show that borrowers are more likely to pledge non-cash collateral to borrow safe bonds, especially during periods of market stress when cash becomes scarce. This finding is consistent with collateral upgrading being a key motivation for borrowing in the securities lending market during a crisis. The economic effect of our finding is substantial: a one-standard deviation increase in our proxy for market stress, the Euribor-OIS spread, implies an increase of about 12% to 15% in the use of non-cash collateral to borrow safe government bonds during the peak of the European debt crisis. This is a large effect compared to the average non-cash collateral ratio of 67.6%. Our findings suggest that the European government bond lending market plays a crucial role during market stress in allowing borrowers to use relatively lower-quality (non-cash) collateral to access high-quality safe assets, which increases the velocity of safe assets and hence improves the "pass-through efficiency" (Duffie and Krishnamurthy 2016 and Singh 2014).

Finally, we study the role of central bank interventions in alleviating safe asset shortages. Following the European sovereign debt crisis, regulatory requirements have raised the demand for safe assets. For example, the Basel III regulatory framework introduced the liquidity coverage ratio (LCR) requiring banks to hold sufficient high-quality liquid assets, and the European Markets Infrastructure Regulation (EMIR) requires the use of central counterparty (CCP) for derivatives transactions that only accept cash and selected government bonds as eligible collateral.

We specifically examine the impact of two significant programs instituted by central banks. First, the Eurosystem of central banks introduced the Securities Markets Programme (SMP) in May 2010, to purchase low-quality government bonds in order to ensure depth and liquidity in the cash market of government bonds. We do not find any material impact of this program on the government bond lending market, which does not necessarily question the effectiveness of the program's primary objective in the cash market. Second, the Deutsche Bundesbank together with other Eurosystem central banks introduced a securities lending program in April 2015, to make securities purchased under the Public Sector Purchase Programme (PSPP) available for lending. The monthly average balance of PSPP securities lending for the Eurosystem as a whole stood at 52.8 billion euros in April 2017, two years following its launch. We find that the access to borrow safe assets from the Bundesbank reduce the demand to borrow these bonds in the private lending market. The combined findings from the two programs shed light on understanding the types of central banks interventions that can be effective in alleviating safe asset shortages.

Our contributions to the literature are twofold. First, we provide direct evidence of safe asset shortages in the government bond lending market. Most of the literature on safe assets is theoretical (see Gorton (2016) for an overview), with scant empirical evidence on the existence of safe asset shortages. Gorton and Ordoñez (2014) show that the production of safe government debt provides large incentives for the private sector to produce information about the quality of collateral, while Caballero and Farhi (2016) argue that the shortage of safe assets is tantamount to a liquidity trap. Gorton and Muir (2015) analyze the scarcity of safe debt and its impact on availability of collateral, and Duffie, Scheicher, and Vuillemey (2015) examine the impact of new regulations on the demand for high-quality collateral. We contribute to this literature by providing new evidence of safe asset shortages by studying the largely ignored government bond lending market, and we show that this market allows more reuse of safe assets, albeit at a cost, and thus can palliate the shortage of safe assets.

Second, we show that central bank interventions such as securities lending programs can alleviate safe asset shortages by increasing the velocity of collateral. This complements alternative solutions of creating safe assets proposed in the literature, including the issuance of more safe assets by the government (e.g., Gorton and Ordoñez 2014, Krishnamurthy and Vissing-Jorgensen 2012, and Brunnermeier et al. 2016) and boosting the supply of privately produced safe assets through securitization (e.g., Gennaioli, Shleifer, and Vishny 2012, and Gorton and Metrick 2012). In reality, privately created safe assets only have transitory "safeness" as evidenced during the financial crisis (see also the theoretical support in Moreira and Savov 2016). Private debt instruments, therefore, cannot fully solve the problem of safe asset shortages. Increasing the issuance of government safe assets, though a theoretical possibility, has not been empirically supported in the euro area, where conservative fiscal policy, notably by Germany, has resulted in a slight decline in bond issuances despite historically low yields and soaring demand (see Figure 1).

Our paper also dovetails into the literature that studies the impact of unconventional monetary policies and post-crisis regulations on market outcomes (e.g., Acharya et al. 2016, Duygan-Bump et al. 2013, Eser and Schwaab 2016, Mancini et al. 2016, and Duffie et al. 2015). These studies quantify the impact of unconventional monetary policies and regulations mainly through bond yields and market liquidity channels. We propose a new channel for central bank interventions, that is, to use securities lending programs to restore the proper functioning of short-term funding markets that are critical in alleviating the shortage of safe assets.

2. Institutional Background

2.1 Safe Assets in the Euro Area

We first provide background on the magnitude and evolution of safe assets in the euro area. A "safe asset" is a high-quality liquid asset expected to hold value intertemporally. A safe asset should be information insensitive, that is, "it is immune to adverse selection in trading because agents have no desire to acquire private information about the issuer" (Gorton, Lewellen, and Metrick, 2012). Gorton et al. (2012) categorize safe assets into two types: government-issued and privately-produced. Government-issued safe assets include debt issued or guaranteed by sovereign governments with AAA rating. Privately-produced safe assets take different contractual forms over time, for example, money market mutual funds, commercial paper, high-quality corporate debt, AAA tranches of asset-backed securities (ABS), mortgage-backed securities (MBS) and collateralized debt/loan obligations (CDO/CLO).

Figure 1 shows the evolution of safe assets in the euro area. We split safe assets into three categories: i) German government bonds (Germany is the largest economy in the euro area and has kept its AAA rating throughout the sample period), ii) non-German government bonds rated

AAA or AA+ by Standard & Poor's,[3] and iii) privately-produced safe assets including AAA tranches of structured financial products such as ABS, MBS, and CDO/CLO. During and after the U.S. financial crisis, safe assets in the euro area continued to grow. However, in 2010, when the European sovereign debt crisis started, the total amount of safe assets in the euro area dropped by about half a trillion dollars. In 2012 when the European sovereign debt crisis deepened, the amount of safe assets fell by about $2.3 trillion. By the end of our sample, 2017Q1, the total amount of safe assets in the euro area was $3.48 trillion, only half of its peak value of $6.90 trillion reached in 2009Q2.

It is worth noting that in spite of increasing shortage of safe assets in the euro area, Germany, the primary supplier of safe assets, did not respond by issuing more bonds. Germany kept its outstanding amount of debt at a stable level and even slightly reduced its bond supply. From 2012Q4 to 2016Q2, the average quarterly growth rate of German government bonds was negative at -1.75%. In the meantime, the demand for safe assets has increased significantly due to market participants intensified risk aversion and regulatory changes. Specifically, the European Markets Infrastructure Regulation (EMIR), adopted on July 4, 2012, requires the use of CCP clearing for derivatives transactions, which only accept cash and selected government bonds as

[3] We classify government bonds with a rating of both AAA and AA+ to be safe, given the fact that the United States was downgraded to AA+ by Standard & Poor's on August 5, 2011 and yet the U.S. Treasury bonds continue to enjoy the safe asset status. Ratings are often slow to adjust to changes in underlying credit risk. Given this concern, we modify the rating labels by keeping the rating for two quarters after its release, then assuming the future rating until the release of a new rating. For example, France was downgraded to AA+ with negative watch on January 13, 2012, and further downgraded to AA on November 8, 2013. To determine France's 'safe' status, we assign the rating of AA+ from January 13, 2012 to July 13, 2012 (two quarters after the rating release), and then assign a rating of AA from July 14, 2012 to November 8, 2013. Thus, France loses its 'safe' status after July 13, 2012, even though it still has a rating of AA+. Our results do not change due to this adjustment.

safe collateral. Also under Basel III regulations, banks need to hold sufficient safe assets to meet the new requirement of liquidity coverage ratio. These and other developments have increased the demand for safe assets, and hence have increased the shortage of safe assets.

2.2 European Government Bond Lending Market

The securities lending market for government bonds is a short-term funding market. Beyond facilitating repo and cash markets, it has a unique role in allowing the collateral swap so that one can borrow safe assets, for example German bunds, using non-safe assets as collateral. In this section, we introduce the institutional setting of the securities lending market, and discuss the differences as well as connection of this market to the repo market.

2.2.1 Market Participants

Figure 2 shows a schematic description of the securities lending market for government bonds. There are typically three parties in a loan contract of government bond: a) the lenders or beneficial owners such as large institutional investors such as pension funds, insurance companies, mutual funds, or sovereign wealth funds; b) the borrowers such as banks or hedge funds; and c) the financial intermediaries such as brokers and dealers, and custodian banks. The lender agrees to lend the holding securities to the borrower in exchange for collateral consisting of cash, other securities, or both. Although lenders refer to these lending securities as being "on loan," the lender actually transfers ownership, and therefore the borrowed securities can be transferred to a third party. The lender gets the coupons or dividends on securities loaned, while the borrower retains the right to the coupons or dividends on securities posted as collateral. According to Finglas (2015), sovereign wealth funds and central banks account for 22% of all government bond loans in Europe, mutual funds and pension funds account for 31%, and insurance companies account for 10%.

Financial intermediaries, or agent lenders, play an important role in the securities lending market. Except for some of the largest beneficial owners who have their own in-house lending desk, the majority of beneficial owners rely on agent lenders to find potential borrowers and lend out their securities. There is often an agreement between beneficial owners and agent lenders on the distribution of lending profit. Lenders instruct the agents on acceptable list of potential borrowers and eligible non-cash collaterals.[4] Borrowers of securities also use agents to identify lenders and borrow securities in this opaque and fragmented market.

2.2.2 Motivation for Lending and Borrowing

The motivation for lending securities is to increase the return on holding assets by earning a lending fee (or borrowing cost from the perspective of borrowers). When cash collateral is used, the lender can further earn a spread by investing the cash. However, the lender needs to rebate part of the spread to the borrower. Securities lending contracts are generally standardized with a stable haircut ranging from 102% for domestic securities to 105% for international securities. The borrowing cost captures the risks embedded in collateral and counterparties. Baklanova, Copeland, and McCaughrin (2015) provide a reference guide for the U.S. market. The risks for the lender in

[4] Given its relationship to beneficial owners and the concern of its own reputation, the agents generally scrutinize potential borrowers, hence the borrower default risk in securities lending is extremely low. For example, one of the largest agent lenders, BlackRock, only saw three borrowers with active loans defaulted since it started its securities lending business in 1982. The biggest custodian bank, State Street, also has merely several borrower defaults in its whole lending history.

receiving cash or non-cash collateral are similar because the transactions are marked to market daily and collateralized by more than 100% of the value. A cash-collateralized transaction adds reinvestment risk for the lender, which is the risk that the value of the invested cash may be less than the principal amount invested. In a noncash-collateralized transaction, the lender charges a fee and does not pay a rebate.

The motivation for borrowing securities, in particular government bonds, is mainly twofold: short selling and accessing safe assets. Our objective is to examine the motive of obtaining safe assets, the primary reason for borrowing in the government bond lending market during periods of market stress. Both motivations are state-dependent. In normal times, the lending market primarily serves to meet the demand for short selling. In times of economic stress, however, the demand for safe assets increases as there is demand for safety. The motivation for borrowing government bonds can be quite different from that for borrowing equities or corporate bonds that is primarily driven by short selling. The lending market in government bonds also has high utilization rate, far more active than the market for other securities.

2.2.3 Risks in Securities Lending

The primary risks of lending securities are counterparty, collateral, and reinvestment risk. Counterparty risk relates to the possibility that the borrower may fail to return the securities in a timely manner. However, borrower defaults are rare (see footnote 4). Collateral risk relates to loss of valuation and liquidity. These risks materialized during the financial crisis. To protect beneficial owners and to minimize the risk of borrower default, agent lenders assess and monitor borrowers over time and only accept qualified collaterals. For example, in order to obtain safe assets such as German government bonds during the sovereign debt crisis, borrowers were required to pledge investment-grade corporate bonds and other relatively high quality but less liquid assets. Re-investment risk only occurs when cash is pledged as collateral. The re-investment of cash collateral exposes the lenders to risk because the lenders need to rebate a contract-determined fee to the borrower but reinvestment is not guaranteed to deliver sufficient income to cover the rebate fee. Take the example of American International Group (AIG), the company reinvested cash collateral pledged in securities lending mainly to high-risk mortgage products, which generated negative income during the subprime crisis and resulted in AIG defaulting on returning cash collateral and associated rebate fees.

2.2.4 Securities Lending vs Repo

The securities lending market has similarities to but also important differences from the repo market. Most repo transactions are motivated by the need to borrow and lend cash, whereas securities lending is typically driven by the need to borrow securities. In a repo transaction using bonds, the borrower provides a bond as collateral for the lender, whereas in the lending transaction, the borrower receives the bond from the lender. One key distinction is the usage of non-cash collateral in the securities lending market. There is a lot more flexibility in the type of collaterals accepted in the securities lending market, such as investment-grade corporate bonds, AAA tranches of asset-backed securities, and other assets. Repo transactions, however, are primarily settled in cash. Borrowers such as banks can use relatively low quality (compared to safe government bonds) or high quality but lower liquidity securities on their balance sheets as collaterals to upgrade to government bonds in the securities lending market.

Non-cash collateral is the dominant form of collateral used in the European government bond lending market. The percentage of European government bonds on loan against non-cash collateral has increased from 52.4% in 2006 to almost 80% in 2017. In contrast, non-cash collateral amounted only to 4.6% of government bond loans in 2006 and 26.1% in 2017 in the United States.[5] The securities lending market therefore plays an even bigger role in Europe.

3. Data

Our analysis focuses on government bonds from 11 countries in Eurozone: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain. We exclude the following countries in the Eurozone who have insufficient activities in the lending market: Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta, Poland, Slovakia, and Slovenia. Our sample of government bonds include sovereign bonds issued by central governments, regions, states, central banks, and government-owned institutions.

We focus on high-quality safe assets. We define a dummy variable, $SAFE_{jt}$, that equals one if a bond is issued by country-j with a sovereign rating of AAA or AA+ at time t, and zero if

[5] The use of cash collateral has been the norm in the U.S., partly driven by regulations including the Employee Retirement Income Security Act and 1940 Act, and partly by the incentive to gain yield pickup by reinvesting the cash collateral. However, even in the U.S., the use of noncash collateral is increasing.

the issuing country has a rating lower than AA+ at time *t*. When a country is downgraded below AA+, its bonds will lose their safety status.

3.1 Government Bond Lending

We obtain European government bond lending data from Markit for the period July 1, 2006, to March 15, 2017. Markit collects securities lending information daily from 125 large custodians and 32 prime brokers, covering more than 85% of the securities lending market. The raw lending data consists of 5,285,573 bond-day observations representing 8,379 unique government bonds.

The activity in the government bond lending market is captured by a few key variables. *FEE* is the transaction-weighted cost for borrowing one euro of a particular bond, expressed in basis points and annualized. *ONLOAN* is the total value on loan as a percentage of the amount outstanding of a particular bond. The scaling by the amount outstanding allows comparability of borrowing amounts across bonds under different issue sizes. We also know the daily inventory available for lending for each bond. We scale by amount outstanding rather than available inventory to avoid confounding the variation in the bond supply that reflects lender preferences. All our results however are unaltered when we scale by inventory instead of bond outstanding. For the total value on loan, we know the proportion of the value borrowed using cash versus non-cash collateral. For each bond, we define *NONCASH* as the ratio of non-cash collateral to the sum of both cash and non-cash collateral, expressed in percentage. We also collect other loan characteristics including *LOAN TENURE*, the weighted average number of days from the initiation of the contract to present for all open transactions, and *LOAN SPREAD*, the difference between the daily highest and lowest lending fees.

3.2 Bond-Level Control Variables

We obtain the information of government bond characteristics from Datastream including bond type (straight bonds or strip bonds), issue amount, issue date, maturity date, coupon rate, and coupon type (floating, fixed, and zero). We supplement this data using secondary-market bond close prices from Bloomberg. The reporting currency in the security lending data is U.S. dollars, and the issue amount from Datastream is in the issuance currency, often in euros. For consistency, we convert the value of relevant securities lending variables and bond characteristics into euros.

Compared to the equity or corporate bond lending market, there is almost no formal study on what bond characteristics determine the borrowing cost and borrowing amount in the government bond lending market. We instead follow the literature on corporate bond pricing (e.g., Collin-Dufresne, Goldstein, and Martin, 2001) and corporate bond lending (e.g., Asquith et al., 2013), to construct bond-level variables that potentially affect the borrowing cost and borrowing amount in the government bond lending market. We include the following variables: *BOND SIZE*, which is the logarithm of the value of bond outstanding; *TIME TO MATURITY*, which is a bond's remaining years to maturity; *FLOATING DUMMY* which equals one if the bond has a floating-rate coupon, and zero otherwise; and *BOND YIELD*, which is the yield-to-maturity of a bond constructed from its close prices, coupon rates and coupon dates.

After merging the bond lending data with bond characteristics and bond pricing data, we remove bonds without valid ISIN, bonds issued in non-Eurozone (international bonds), stripped bonds, and bonds with missing issue size. The final sample consists of 4,084,011 bond-day observations representing 6,342 unique bonds. To avoid market noise in the daily data, we use the weekly values averaged from daily observations for all variables in the empirical analyses.

3.3 Proxies for Market Stress

A key variable in our tests is market stress. We consider three proxies. The first and baseline proxy is *EURIBOR-OIS*, the spread between the three-month euro interbank offer rate (Euribor) and the overnight interest rate swap in euro (OIS). The Euribor-OIS spread is a closely watched indicator of market stress in short-term funding markets. It is similar to its U.S. counterpart, the Libor-OIS spread, which is often used to measure the U.S. market stress (e.g. Gorton and Metrick 2012). The second proxy is the VIX counterpart in the euro market, the volatility index of the European stock market, or the VSTOXX index, which we label as *EURO VIX*. This index covers stress in capital markets more generally, instead of specific stress in short-term funding markets. The third proxy of market stress is the spread of the 10-year government bond yields between Germany and Italy, *GYIELD.* This measure captures sovereign stress, which was a key contributor to stress in short-term funding markets. All three measures of market stress widened significantly over the European sovereign debt crisis, reflecting the economic stress situation in European markets. The data for the three market stress proxies is from Bloomberg.

We also collect data on MSCI stock market indices, and calculate local stock market returns, *STOCK MKT RETURN*, for each of the 11 countries in the sample. We use this variable together with the overnight interest rate, *OIS*, as additional country-level control variables.

3.4 Summary Statistics

Table 1 reports summary statistics for the European government bond lending market. There are 6,342 bonds in our sample. The country with the largest number of government bonds available to lend is Germany (2,569), followed by France, Italy, the Netherlands, and Spain. Greece and Ireland have the smallest number of lendable government bonds, 140 and 53, respectively. On a daily average, Germany has 619 government bonds available for lending, with a lendable inventory of €176.3 billion and a value on loan of €81.7 billion; Ireland only has 12 bonds available, with a lendable inventory of €3.9 billion and a value on loan of €0.62 billion. The activity in the lending market is sizeable relative to the total amount of government bonds outstanding. For example, the daily borrowing amount of German government bonds averages about 10% of its total outstanding amount.

The utilization rate, defined as the percentage of value on loan to lendable inventory, varies from 30% to 46% for bonds issued in core countries (Austria, Belgium, Finland, France, Germany, and the Netherlands) to 13% to 20% in peripheral countries (Greece, Ireland, Italy, Portugal, and Spain). Utilization rates for European government bonds are in general much higher than for corporate bonds and equity. For comparison, based on the U.S. data, utilization rates average 7%

for corporate bonds (Asquith, Au, and Covert, 2013) and 18% for equities (Aggarwal, Saffi, and Sturgess, 2015).

Bonds issued by the core countries also have relatively low and stable borrowing costs, ranging from 13 to 19 basis points (bps), whereas bonds issued by peripheral countries except Italy have higher and more volatile borrowing costs. For example, Greek bonds on average have a cost of 247 bps, with a standard deviation of 317 bps. In the case of Italy, the sheer size of its bond market, being the largest in Europe, contributes to relatively low fees.

Table 2 presents the summary statistics of key variables. The borrowing amount is on average 3.30% of a bond's outstanding amount. The borrowing cost is 19.52 bps. The borrowing collateral adopts 67.58% of its value via non-cash assets. The average loan duration is about 127 days, which is much longer than the typical duration in the repo market. The average time-to-maturity for bonds borrowed is 5.3 years, and the average bond yield is 2.31%.

4. Demand for Safe Assets

In this section, we first discuss the forces driving the demand to borrow European government bonds and provide evidence that the increased demand for safe bonds during a crisis is driven by demand for safety and not by short selling considerations. We then employ the price-quantity "pairs" approach proposed by Cohen, Diether, and Malloy (2007) to examine the shifts in supply and demand for European government bonds during the European sovereign debt crisis.

4.1 Demand for Safety versus Short Selling

The main motivation for borrowing stocks and corporate bonds in the securities lending market is short selling (Duffie et al. 2002). A different and additional motivation, in particular for borrowing high-quality government bonds, is the need of market participants to temporarily access safe assets. The need to borrow safe assets is particularly critical during periods of market stress. We refer to this motivation as demand for safety. As discussed in the introduction, there are typically three markets available to obtain a particular safe asset: the secondary cash market, the repo market, and the lending market. In order to get a safe asset in the secondary cash market or the repo market, the prerequisite is to have sufficient cash. However, the borrower may not have enough cash or may not prefer to use cash because cash becomes extremely valuable during periods of market stress. In such situation, the lending market allows the borrower to use non-cash collateral such as investment-grade corporate bonds and stocks on their balance sheets to borrow safe assets, such as German bunds.

Meanwhile, government bonds may also be borrowed in the lending market for short selling. The challenge is how to distinguish the two borrowing motivations. We disentangle short selling and demand for safety by examining the lending market and the secondary cash market jointly. The essential difference between two motivations lies in their opposite predictions for the underlying asset's price movement. If the motivation is short selling then the future bond price (yield) should go down (up), whereas under the demand-for-safety motivation, the future bond price (yield) should go up (down) due to the shortage of safe assets. Figure 3 provides evidence consistent with the demand-for-safety motivation. We plot the 10-year government bond yield with borrowing cost and borrowing amount for Germany (proxy for safe asset) in Panel A, and for Italy (proxy for non-safe asset) in Panel B.

Starting in May 2010 and continuing during the period of the European crisis, the 10-year German government bond yield had a steady downward drift, while both borrowing cost and borrowing amount trended upward. The movement in yields and the lending market variables show that when the price of German bonds increased, their borrowing cost and borrowing amount simultaneously went up. The correlation of bond yields with borrowing cost and borrowing amount was (negative) 0.87 and (negative) 0.70, respectively. In contrast, lower-quality Italian government bonds had the opposite relationship with their corresponding borrowing cost and borrowing amount. The 10-year Italian government bond yields increased during the same period, and its borrowing cost similarly trended upwards, with a positive correlation of 0.68. However, the amount of Italian government bonds borrowed steadily decreased, with a correlation of (negative) 0.76 with bond yield. These two sets of facts suggest that during the European crisis period, the borrowing of Italian government bonds is driven by short-selling demand when their bond prices fall, whereas the borrowing of German bonds are driven by demand for safety according to the positive co-movement of bond prices with both borrowing cost and borrowing amount. These observations indicate that it is important to examine borrowing cost and borrowing amount jointly.

4.2 Supply and Demand Shifts for Safe Assets

Given that borrowing cost and borrowing amount are endogenously related, it is challenging to disentangle them and identify the real demand. During periods of stress, demand to borrow safe assets increases but borrowing cost also increases which may curtail demand. Before employing instrumental variable techniques in the next section, we first use the approach in Cohen, Diether, and Malloy (2007) to isolate supply and demand shifts in the government bond lending market, separately for safe and non-safe bonds.

This approach exploits price-quantity pairs. We construct pairs of borrowing cost (price) and borrowing amount (quantity) to differentiate shifts in supply and demand. For each government bond in our sample, we calculate its average borrowing cost and borrowing amount in the subsample immediately before the European sovereign debt crisis (July 2009 to April 2010) and during the peak of the crisis (August 2011 to June 2012). The difference in borrowing cost and borrowing amount between the two periods reflects the shift in supply or demand for this particular bond. According to Cohen, Diether, and Malloy (2007), an increase (decrease) in borrowing cost coupled with an increase (decrease) in borrowing amount implies that an increase (decrease) in borrowing demand *must* have occurred and hence an outward (inward) shift in demand, denoted as *DOUT* (*DIN*). Similarly, if we observe an increase (decrease) in borrowing cost coupled with an decrease (increase) in borrowing amount, there should be a decrease (increase) in supply, and an inward (outward) shift in lendable inventory, denoted as *SIN* (*SOUT*). If there is an increase in the demand for safe assets during the European sovereign debt crisis, we should observe an outward shift in demand for safe bonds, as indicated by a simultaneous increase in borrowing cost and borrowing amount.

We calculate the total number of bonds for each supply-demand type (*DOUT*, *DIN*, *SIN*, and *SOUT*) for safe and non-safe bonds separately. Table 3 presents the results with Panel A using mean values and panel B using median values of the differences between the two subsample periods. Panel A shows that 43.18% of safe bonds experience both an increase in borrowing cost and an increase in borrowing amount during the European sovereign debt crisis, indicating a definite increase in demand for safe bonds. The number of price-quantity pairs displaying this increased demand is much larger for safe bonds than for non-safe bonds, 209 safe bonds versus 24 non-safe bonds, with the latter mainly from bonds rated AA. In addition, *DOUT* dominates the other three types of shifts for safe bonds, consistent with the demand-for-safety story.

For non-safe bonds, the dominating shift during the European sovereign debt crisis is *SIN*, an inward shift in supply: 67.02% of non-safe bonds have an increase in borrowing cost and a decrease in borrowing amount during the European debt crisis. For safe bonds, an inward shift in supply is less frequent than an outward shift in demand. Results based on differences in median values are similar as shown in Panel B of Table 3. These results for safe and non-safe bonds provide evidence consistent with an increase in demand to borrow safe government bonds during the crisis. In the next section, we analyze these effects more formally in a regression framework.

5. Safe Assets, Lending Market, and Collateral Transformation

We now examine the role of the government bond lending market in alleviating the shortage of safe assets during the European crisis.

5.1 Demand for Safe Assets during Crisis

We adopt the following specification to examine the borrowing demand for safe bonds relative to non-safe bonds during periods of market stress:

$$ONLOAN_{ijt} = \alpha + \beta_1 \, Market\ Stress_t + \beta_2 \, Market\ Stress_t * SAFE_{jt} + \beta_3 \, SAFE_{jt} + \Sigma\theta_k * CONTROL_{ijt} + \varepsilon_{ijt} \, , \quad (1)$$

where $ONLOAN_{ijt}$ denotes the borrowing amount of bond *i* in country *j* at time *t*, scaled by the bond's outstanding amount. $SAFE_{jt}$ is a dummy variable that equals one if a bond is issued by a country with a sovereign rating of AAA or AA+ at the time of the loan, and zero if the issuing country has a rating lower than AA+. $SAFE_{jt}$ varies across country and over time. $Market\ Stress_t$ is proxied by the three-month Euribor-OIS spread at time *t*. Control variables comprise macro variables such as the OIS rate and local stock market returns for each country, loan characteristics such as loan tenure and loan spread, and bond characteristics such as size, time-to-maturity, coupon type dummy, and bond yield. All control variables are defined in Section 3. To get a clean identification, we focus on the period before and during the European debt crisis and use the subsample from July 2009 to June 2012.

Table 4 presents the regression results. The main explanatory variables are $EURIBOR\text{-}OIS_t * SAFE_{jt}$, $EURIBOR\text{-}OIS_t$, and $SAFE_{jt}$, shown in Column (1). Column (2) adds OIS_t and $STOCK\ MKT\ RETURN_{jt}$, and Columns (3)-(5) include bond characteristics as additional control variables. Due to missing data on bond yields, we run regressions both with and without this variable (Columns (4) and (5)). All specifications include country fixed effects and cluster standard errors at the country level. The use of country fixed effects, instead of bond fixed effects, is motivated by the collateral rules of central counterparties under EMIR, which categorize government bonds at the country level. That is, any government bond issued by a sovereign country receives the same treatment in serving as eligible collateral.[6] Clustering at the country-level increases the dispersion and hence lowers the *t*-statistic, which raises the bar for statistical significance for our tests compared to clustering at the bond level. For a stringent robustness check, we also report the results by adding bond fixed effects in Column (5). Finally, all results are also robust to including year-week fixed effects (see Table A1 in the appendix).

The coefficient on $SAFE_{jt}$ in each model is insignificant, suggesting that demand for safe and non-safe government bonds is not significantly different over the full sample period. The coefficient on $EURIBOR\text{-}OIS_t$ is negative and significant implying that borrowing demand overall decreases during periods of market stress.

The key coefficient of interest is the interaction term, $EURIBOR\text{-}OIS_t{*}SAFE_{jt}$, which is significant and positive in each specification. This result implies that when the Euribor-OIS spread is large, i.e., during market stress, demand is higher for safe government bonds relative to non-safe bonds. The economic effect of this result is substantial: a one-standard deviation increase in the Euribor-OIS spread implies an average increase in the daily amount borrowed of 1.3% to 1.5% of total amount outstanding for safe bonds relative to non-safe. This is a large effect given that the average daily amount borrowed is 3.3% of total amount outstanding.

5.2 Instrumental Variable Framework

[6] For the list of eligible collateral, see https://www.theice.com/publicdocs/clear_europe/list-of-permitted-covers.pdf

Our empirical strategy examines the difference in borrowing demand for safe and non-safe government bonds during market stress. This setup however does not consider the endogenous impact of borrowing cost on borrowing demand. The demand for a bond may increase (decrease) when the price to borrow the bond goes down (up). In this subsection, we employ instrument variables estimation to control for the price sensitivity of $ONLOAN_{ijt}$. If lower borrowing cost results in higher demand, standard OLS estimates that ignore endogeneity will result in upward bias in estimates for demand shifts during periods of market stress. Therefore, we estimate the following IV regression for borrowing demand ($ONLOAN_{ijt}$):

1ST Stage: $$FEE_{ijt} = \alpha + \beta\ INSTRU_{jt} + \Sigma\theta_k * CONTROL_{ijt} + \varepsilon_{ijt} \quad (2)$$

2nd Stage: $$ONLOAN_{ijt} = \alpha + \beta_1\ Market\ Stress_t + \beta_2\ Market\ Stress_t * SAFE_{jt} + \beta_3\ SAFE_{jt} + \lambda * FEE_{ijt}\ (INSTRU) + \Sigma\theta_k * CONTROL_{ijt} + \varepsilon_{ijt}\ . \quad (3)$$

Here FEE_{ijt} and $ONLOAN_{ijt}$ denote the borrowing cost and borrowing amount of bond *i* in country *j* at time *t*. *INSTRU* is the exogenous instrument used to identify FEE_{ijt} in the second stage for $ONLOAN_{ijt}$ and $FEE_{ijt}(INSTRU)$ is the fitted value of fee using the instrument that is estimated in the first stage. As in Equation (1), we also include all control variables and include country fixed effects. Standard errors are clustered at the country level.

IV identification requires finding instruments that are exogenously related to FEE_{ijt} but unrelated to the error term in the $ONLOAN_{ijt}$ equation. This approach requires valid instruments that satisfy the exclusion restriction, i.e., the instrument must not have any direct impact on the dependent variable or through omitted variables. Thus, we need to identify a variable that affects FEE_{ijt} through changes in bond supply but is unrelated to bond demand $ONLOAN_{ijt}$. Our first instrument is the country-level outstanding government debt scaled by gross domestic product, *DEBT/GDP*$_{jt}$. The choice of this instrument is motivated by Krishnamurthy and Vissing-Jorgensen (2012), who use the ratio of public debt to GDP as a measure of supply of safe assets in the U.S. and show (in their Table 2) that this variable negatively affects bond yield spreads. Similarly, in our case public debt to GDP should influence borrowing costs and capture the supply of bonds but not its demand. The second instrument we employ is the growth rate of government debt amount, *DEBT-GROWTH*$_{jt}$. The intuition is that an increase in public debt has a negative influence on borrowing cost by primarily increasing bond supply but not bond demand.

Table 5 presents our first and second stage results using borrowing cost instrumented by *DEBT/GDP*$_{jt}$. In the first stage, the coefficient of *INSTRU* is statistically significant and negative in each specification, confirming that increasing supply leads to the decrease of borrowing cost. In the second stage, we continue to find that the coefficient of our main variable, *EURIBOR-OIS*$_t$**SAFE*$_{jt}$ is positive and significant in each specification, indicating that demand for safe government bonds increases during the periods of market stress regardless of borrowing cost. We conduct a series of statistical tests on the instrument variable. The Kleibergen-Paap Lagrange Multiplier (LM) statistic tests whether the instruments are sufficiently correlated with the included endogenous regressors. The LM statistic is 136.6 with a *p*-value of 0.000, which implies that we can safely reject the null hypothesis that endogenous variables are underidentified. The Cragg-Donald Wald *F*-statistic of weakly identified instruments has a value of 136.7. This is significantly larger than the Stock-Yogo critical values at all significance levels, rejecting the null hypothesis of weak identification. Our findings are robust when using $DEBT\text{-}GROWTH_{jt}$ as an alternative instrumental variable. Table A2 of the appendix presents the results.

5.3 Robustness Check

We repeat the main analysis in subsection 5.1 by substituting $ONLOAN_{ijt}$ with two alternative proxies for borrowing demand: $LOG(ONLOAN_{ijt})$, the logarithm of value on loan in million euros, and $UTILIZATION_{ijt}$, the percentage of value on loan to lendable inventory. $LOG(ONLOAN_{ijt})$ is not adjusted for the total amount of bond outstanding and since the value on loan is highly skewed, we take the natural logarithm. $UTILIZATION_{ijt}$ scales the value on loan by lendable inventory instead of total amount outstanding, and thus captures frictions in bond supply.

Table 6 shows that the results from using alternative demand proxies are qualitatively robust. In both cases, we find that safe bonds have higher borrowing amounts relative to non-safe bonds during periods of market stress, and the difference is statistically significant. Economically, a one-standard deviation increase in the Euribor-OIS spread implies an increase of €3.8 millions (log(3.8)=1.337) in the value on loan for safe bonds relative to non-safe bonds based on the estimates in specification (3) of panel A, and implies an increase of 4.35% in the value on loan relative to the lendable inventory based on the estimated in specification (3) of panel B.

In a second robustness check, we repeat the main analysis by using two alternative proxies for market stress, $EURO\ VIX_{jt}$ and $GYIELD_{jt}$. Table A3 in the Appendix presents the results. We obtain qualitatively similar results using these alternative proxies of market stress: demand is higher for safe government bonds relative to non-safe bonds during periods of market stress.

All robustness checks confirm that the European sovereign crisis has led to an increase in demand to borrow safe government bonds. The main takeaway from our findings is that the European government bond lending market serves an important role in making safe assets available for borrowing, especially during periods of market stress.

5.4 The Use of Non-Cash Collateral in Market Stress

We have shown that borrowing amount and borrowing cost both increase for safe government bonds during a crisis due to demand for safety. In order to borrow any securities, borrowers need to pledge collateral. We next examine whether borrowers change the type of collateral posted for safe versus non-safe bonds during a crisis.

The answer is theoretically ambiguous. Borrowers in the lending market, for example, hedge funds and banks, hold assets including stocks, corporate bonds, and asset-backed securities on their balance sheets. These borrowers need high-quality collateral such as German bunds for purposes including obtaining financing in the repo market, conducting derivative transactions, and meeting regulatory capital requirements. During a crisis, borrowers may be reluctant to use cash as collateral to borrow safe assets, since cash becomes more precious. Therefore, they may be more willing to pledge assets already on their balance sheets, that is non-cash collateral. Given safe assets clearly have higher quality than those assets used as collateral, this process results in collateral transformation, or collateral upgrading. During the European sovereign debt crisis, risky government bonds issued by peripheral countries were also used as collateral, particularly after the ECB’s intervention that helps raise confidence in peripheral countries.

Lenders holding safe assets on the other hand, may become more risk averse and may not be willing to accept non-cash collateral. However, if they accept cash collateral, they have to worry about the risk of investing the cash collateral and the reinvestment risk increases significantly during a crisis.[7] Therefore, lenders might not want cash collateral. Lenders weigh the decision to accept non-cash collateral versus the risk of investing cash collateral.

Our hypothesis is that during stressed market conditions, the use of non-cash collateral increases with a view to upgrade low-quality collateral to high-quality government bonds when the primary motivation to borrow a safe asset is demand-for-safety instead of short selling. Here low quality is relative to ultra-safe assets such as AAA/AA+ government bonds; to serve as collateral for safe assets, the 'low-quality' collateral indeed are usually highly rated corporate bonds, covered bonds, or equities. Given these considerations, we modify the regression specification (1) and examine the use of non-cash collateral in the following specification:

$$NONCASH_{ijt} = \alpha + \beta_1\, Market\ Stress_t + \beta_2\, Market\ Stress_t * SAFE_{jt} + \beta_3\, SAFE_{jt} + \Sigma\theta_k * CONTROL_{ijt} + \varepsilon_{ijt}\,, \quad (4)$$

Where $NONCASH_{ijt}$ is the ratio of non-cash collateral to the sum of both cash and non-cash collateral, expressed in percentage. $SAFE_{jt}$ is a dummy variable that equals one if a bond is issued

[7] As documented in Peirce (2014) and McDonald and Paulson (2015), AIG's securities lending program played an important role in its downfall. Through the securities lending program, AIG and its life insurance subsidiaries reinvested its cash collateral from securities lending in residential mortgage-backed securities, resulting in large exposure to these toxic securities in the subprime crisis. At the height of the 2008 crisis, the program experienced a run, and AIG could not meet the repayment demands. The losses in the securities lending program were severe and played a major role in AIG's collapse.

by a country with sovereign rating of AAA or AA+ at the time of the loan, and zero if the issuing country has a rating lower than AA+.

Table 7 shows the results. All estimations include country fixed effects and cluster standard errors at the country level. We find that the coefficient of $EURIBOR\text{-}OIS_t{*}SAFE_{jt}$ is positive and significant, suggesting that the use of non-cash collateral for borrowing safe bonds increases during stressed market conditions relative to that for borrowing non-safe bonds. The economic effect of this result is substantial. Based on the results in Column (3), a one-standard deviation increase in the Euribor-OIS spread implies an increase in the non-cash collateral ratio for borrowing safe government bonds that is 8.9 percentage points larger than the increase for non-safe bonds.

These results suggest that the European government bond lending market plays a crucial role during market stress in allowing borrowers to use relatively lower quality (non-cash) collateral to access safe assets, which increases the velocity of safe assets and hence improves the "pass-through efficiency" (Duffie and Krishnamurthy, 2016; Singh 2014).

6. Central Banks, Safe Assets, and Government Bond Lending

So far we discussed the importance of the securities lending market and its role in contributing to collateral upgrading, and in helping meet the demand for safe assets, particularly during a crisis. In this section, we examine whether actions by central banks can change the dynamics of the government bond lending market. We examine two specific programs instituted by central banks. First, we examine the influence of the ECB's Securities Market Programme

(SMP), which involved central bank direct purchase of government bonds, on securities lending activities. The ECB also adopted other unconventional monetary policies such as main refinancing operations (MRO) and long-term refinancing operation (LTRO). However, these operations targeted on banks and not directly aimed at government bonds, and thus they do not directly relate to the government bond lending market. Second, we examine the impact of the Bundesbank's public lending program on the demand to borrow safe assets. This public lending channel allows the central bank to return sought-after safe assets purchased by the central bank back to the market.

6.1 Eurosystem's Securities Market Programme

In May 2010, several European financial markets including money markets, foreign exchange markets, and peripheral country bond markets became increasingly impaired.[8] In particular, the yield spreads of sovereign bonds from peripheral countries relative to German bunds widened, liquidity evaporated, and volatility increased sharply. In response to these market distortion, the ECB announced several unconventional policies, among which the SMP involved direct purchase of government bonds in the secondary market by the Eurosystem central banks. In the first phase of the program, starting in May 2010, purchase was limited to Greek, Irish, and Portuguese government bonds. As the crisis worsened, in the second phase starting from August 2011, the ECB extended the SMP to Italian and Spanish government bonds. The Eurosystem's purchase of these bonds served as an important signaling device and increased confidence in government bonds of countries whose ratings were downgraded and were considered non-safe by

[8] See ECB Monthly Bulletin, June 2010.

the market. As the markets stabilized, the Eurosystem stopped purchasing bonds in March 2012. Eser and Schwaab (2016) analyze the impact of the SMP on bond yields and find that the SMP substantially compressed bond yields in the targeted countries. The impact of the SMP on the government bond lending market, in particular the borrowing of safe bonds, is theoretically ambiguous. On the one hand, the compression in yields could stimulate the borrowing of non-safe bonds that are now considered less risky. On the other hand, the de-risking of government bonds could restore market functioning and stimulate overall activity, including for safe bonds.

We examine the impact of SMP purchase on the borrowing demand in the government bond lending market using the following specification:

$$ONLOAN_{ijt} = \alpha + \beta_1\, SMP_{jt} + \beta_2\, EURIBOR\text{-}OIS_t * SMP_{jt} + \beta_3\, SAFE_{jt} + \beta_4\, EURIBOR\text{-}OIS_t * SAFE_{jt} + \beta_5\, EURIBOR\text{-}OIS_t + \Sigma\theta_k * CONTROL_{ijt} + \varepsilon_{ijt}\,, \quad (5)$$

where SMP_{jt} is the Eurosystem's weekly purchase amount of government bonds issued by country j, expressed in billions of euros.[9] The SMP was characterized by a high degree of opacity, with little or no disclosure about the size decomposition or maturity structure of the purchase. Only the aggregate amounts of purchase across targeted countries were disclosed. We employ confidential data on SMP purchase at the country level. A positive coefficient on β_1 would imply that the SMP boost borrowing amount and a positive coefficient on β_2 would imply that the boost is more pronounced during periods of market stress. As alternative proxy for SMP purchase, we use *SMP(%)* which is the Eurosystem's weekly total purchase amount of sovereign bonds issued by

[9] We thank Bernd Schwaab for sharing the ECB's country-level SMP data used in Eser and Schwaab (2016).

country *j* as a percentage of the country's total bond outstanding. Both *SMP* and *SMP(%)* are set to zero for countries not targeted by the SMP.

As seen in Table 8, the coefficient of SMP_{jt} and $EURIBOR\text{-}OIS_t*SMP_{jt}$ are both insignificant, indicating that the SMP did not materially alter the borrowing amount in government bond lending market, either in stressed or normal times. Importantly, our main results on $EURIBOR\text{-}OIS_t*SAFE_{jt}$ is robust after controlling for the impact of the SMP. These findings do not question whether the SMP is effective in compressing government bond yields, which was its primary objective. Instead, they imply that SMP bond purchase did not have a major side effect on the functioning of the government bond lending market.

6.2 Bundesbank Public Lending

Following the introduction of the Public Sector Purchase Programme by the Eurosystem of central banks in January 2015, the Deutsche Bundesbank started making some German government bonds purchased under this program available for securities lending, starting in April 2, 2015. This public lending channel complements the private lending market, and its aim was to partly alleviate safe asset shortages in German government bonds. We examine whether the public lending program had any impact in reducing the demand for safe assets in the private lending market. We focus on the Bundesbank program because Germany is the primary supplier of safe assets in the euro area. Moreover, different from the SMP program, the introduction of the securities lending program falls outside the period of our main analysis, which provides a clean environment to test the policy impact.

We collect the list of government bonds eligible in the public lending program from the website of the Bundesbank.[10] The list is released every week. For all German government bonds in the private lending market, we examine whether bonds eligible in the public lending channel experience changes in borrowing amount in the private market following the onset of the program. Our hypothesis is that lending by the Bundesbank directly provides an additional channel to borrow safe assets, and hence should reduce the demand to borrow these assets in the private market. To distinguish the demand in the private market from the total demand (which is fulfilled in both the public and the private markets), we focus on the excess demand in the private market.

To calculate excess demand in the private market, we adopt a two-step approach. First, we use all control variables together with Euribor-OIS during week *t* to predict borrowing demand, *ONLOAN* at week *t+1*, based on an estimation window six months before the implementation of the public lending program, *i.e.,* October 2014 to March 2015. We record the estimated coefficients. Second, for the period April 2015 to March 2017 when the public lending program is active, we use the realized value of the predictors and the estimated coefficients from the estimation window to calculate the predicted demand. We define $EXCESS\ DEMAND_{it}$ as the spread between realized demand and predicted demand. We then estimate the relationship between excess demand and the eligibility of bonds in the public lending program using the following regression specification:

$$EXCESS\ DEMAND_{it} = \alpha + \gamma\ ELIGIBLE_{it} + \alpha_t + \varepsilon_{it} \qquad (6)$$

[10]https://www.bundesbank.de/Redaktion/EN/Standardartikel/Tasks/Monetary_policy/outright_transactions_active_programmes.html?notFirst=true&docId=335702#doc335702bodyText6

The dummy variable $ELIGIBLE_{it}$ equals one for a bond eligible at time t, and zero otherwise. We include year-week fixed effects α_{t}.

Table 9 presents the results. We first show the predictive regression results under different sets of predictors in Columns (1) – (3), using weekly data from October 2014 to March 2015. The predictive power is large when including the full set of predictors in Column (3), with an adjusted R-squared of 0.43. Based on the coefficient estimates and the historical value of the predictors during April 2015 to March 2017, we compute $EXCESS\ DEMAND_{it}$ for all German government bonds available in the private lending market. In the second step, we then find that eligibility in the public lending program is strongly negatively related to $EXCESS\ DEMAND_{it}$ across all specifications. These negative and statically significant coefficients suggest that the demand to borrow safe bonds in the private lending market goes down when the central bank starts lending these bonds directly. The economic magnitude of the results is large. Based on the estimates in Column (1), the excess demand for eligible bonds reduces by 2.0 percentage points. This is large compared to the standard deviation of excess demand, 8.45%. These results provide evidence that public lending programs help to relieve pressure on the demand for safe bonds in the private market by making such bonds available to the market, hence reducing concerns about the shortage of safe assets.

The combined findings from the two programs shed light on understanding the types of central banks interventions that can be effective in alleviating safe asset shortages.

7. Conclusion

The European government bond lending market is a core short-term funding market that facilitates short selling and market making. In this paper, we show that the market also plays a unique role in allowing borrowers to access safe assets using relatively low-quality non-cash collateral, particularly during periods of market stress. This function is crucial since it increases the velocity of safe assets and hence helps relieve the concern of safe assets shortages, which is accelerated by post-crisis regulations such as EMIR, the Dodd-Frank Act, and Basel III.

Using a novel data of European government bond loans, we provide strong evidence that safe assets have higher demand, higher borrowing cost, and higher usage of non-cash collateral during stressed market conditions. We also show that market participants can obtain safe assets using relatively low-quality non-cash collateral, a process called collateral transformation. Our findings shed light on the effective central banks interventions that can reduce safe asset shortages, which is through returning sought-after safe assets to the lending market.

There are several venues for future research. For example, why securities lenders are willing to engage in collateral upgrading trades? Why low-quality securities are acceptable in the lending market but not in the repo market? One possible reason is that lenders are compensated sufficiently for taking the risks. In addition, large asset managers may be willing to accept low-quality bonds at a higher borrowing cost because they face longer investment horizons and are less subject to regulatory constraints. Additional research on the role of counterparty risk and haircuts would also be beneficial.

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Figure 1
The Evolution of Safe Assets in the Euro Zone

Safe assets are divided into three categories: i) German government bonds (Germany kept its AAA rating throughout the sample), ii) other government bonds rated AAA or AA+ by Standard & Poor's, and iii) European privately-produced safe assets such as the AAA tranches of structured financial products including ABS, MBS, and CDO/CLO. To address the concern of rating staleness, we modify the rating labels by holding the rating for two quarters after release, then taking the future rating until the next rating release. The outstanding amounts of government bonds and structured product are collected from Debt Securities Statistics of Bank for International Settlements for the period of 2000 to 2016.

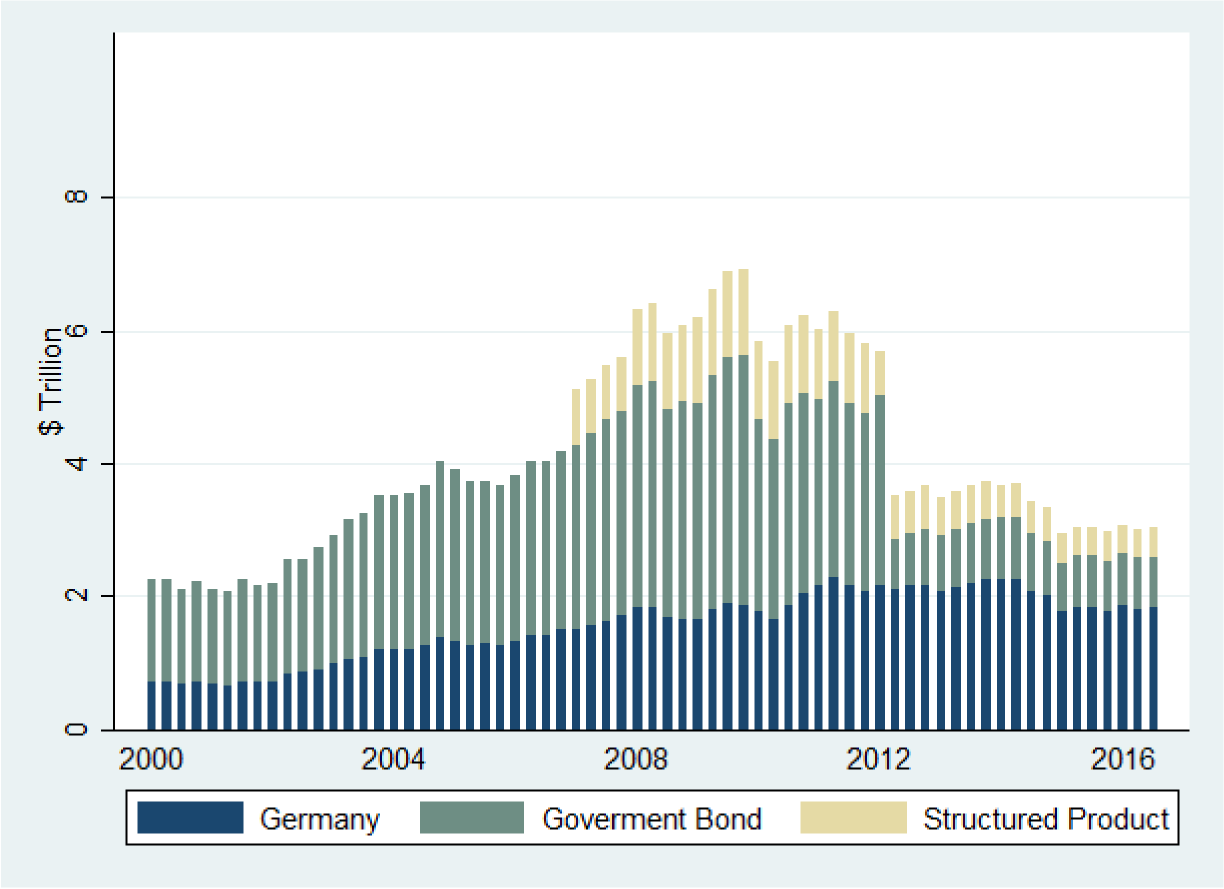


Figure 2
Illustration of the Securities Lending Market for Government Bonds

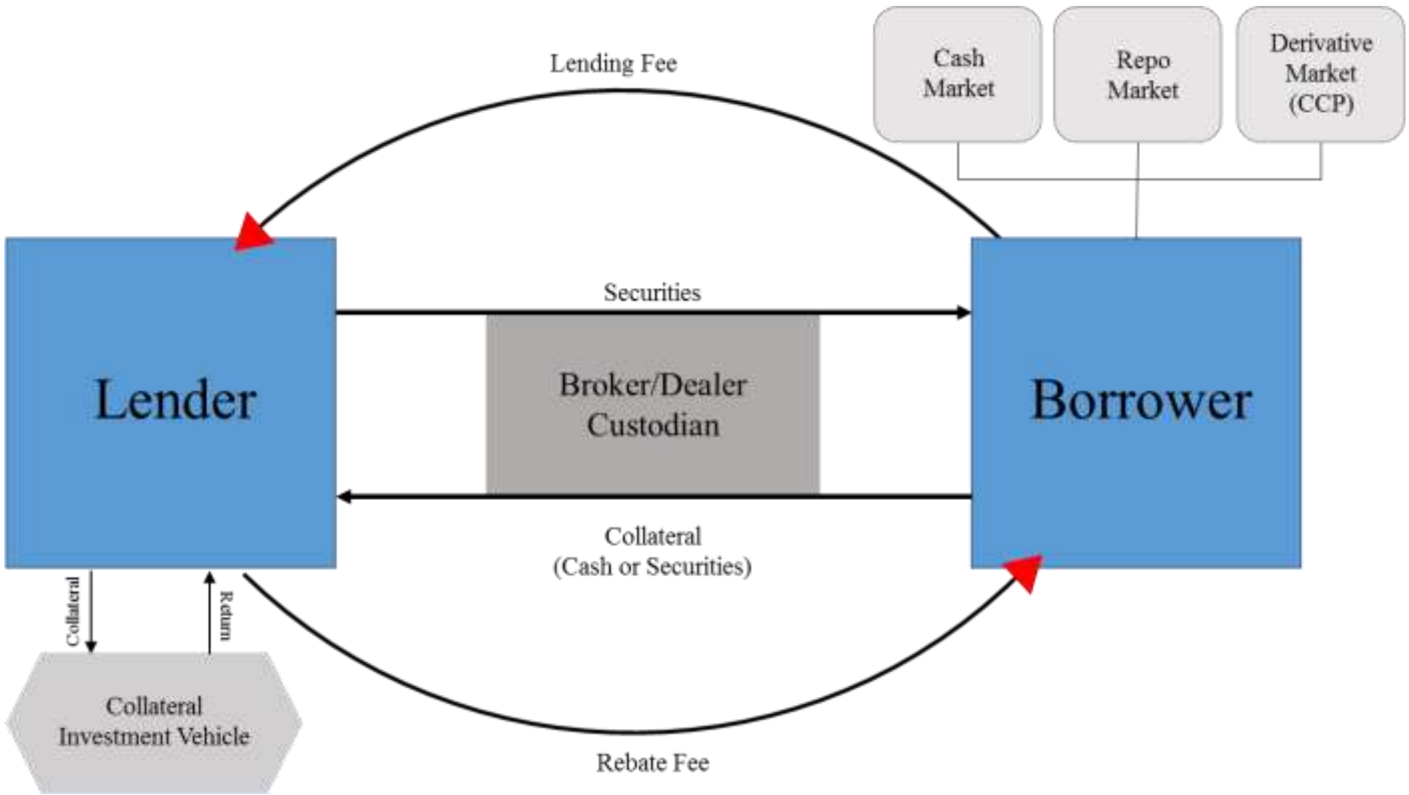
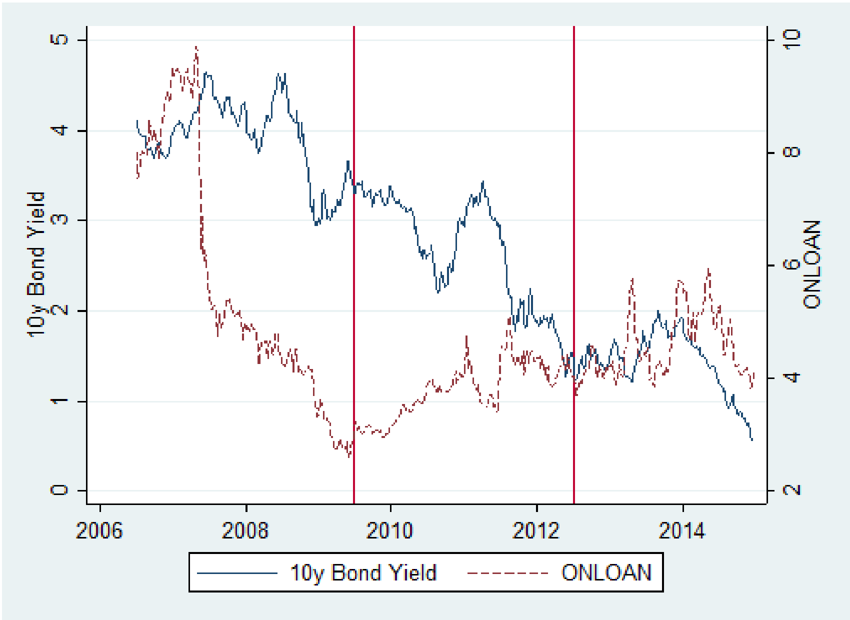


Figure 3
Government Bond Yields, Borrowing Amount, and Borrowing Cost

The figures plot the relationship of government bond yields in the secondary market and borrowing cost as well as borrowing amount in the government bond lending market. We use 10-year government bond yield for Germany and Italy. *ONLOAN* is the value on loan as a percentage of bond outstanding amount. *FEE* is the transaction-weighted cost for borrowing one euro of a particular bond expressed in basis points. The left vertical line refers to the end of the U.S. crisis, 6/30/2009, and the right line refers to the end of the European crisis, 6/31/2012.

Panel A: Germany



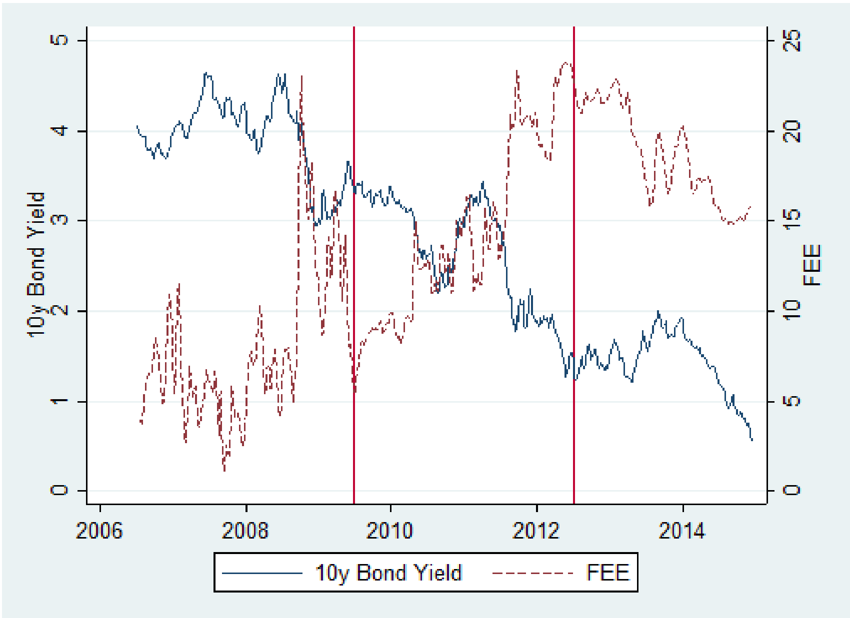
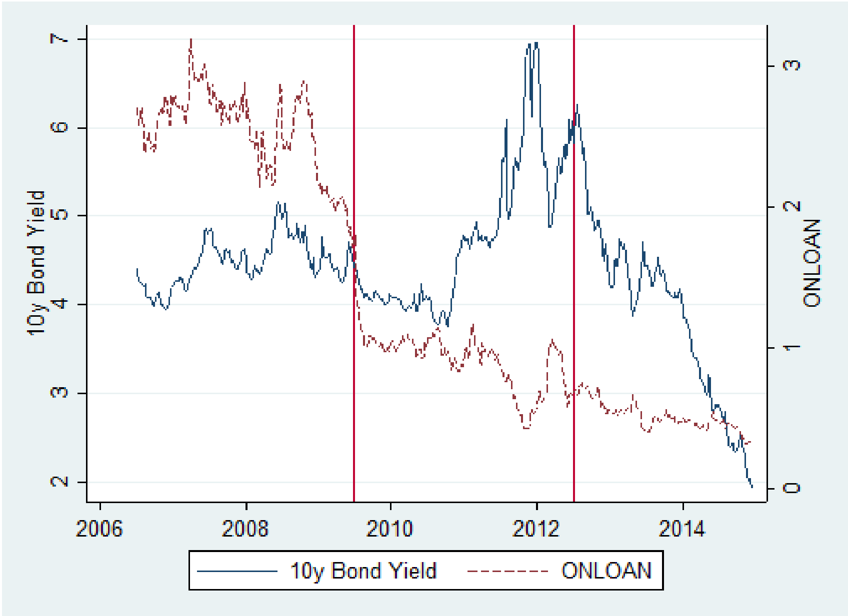


Figure 3 (Cont'd)

Government Bond Yields, Borrowing Amount, and Borrowing Cost

Panel B: Italy



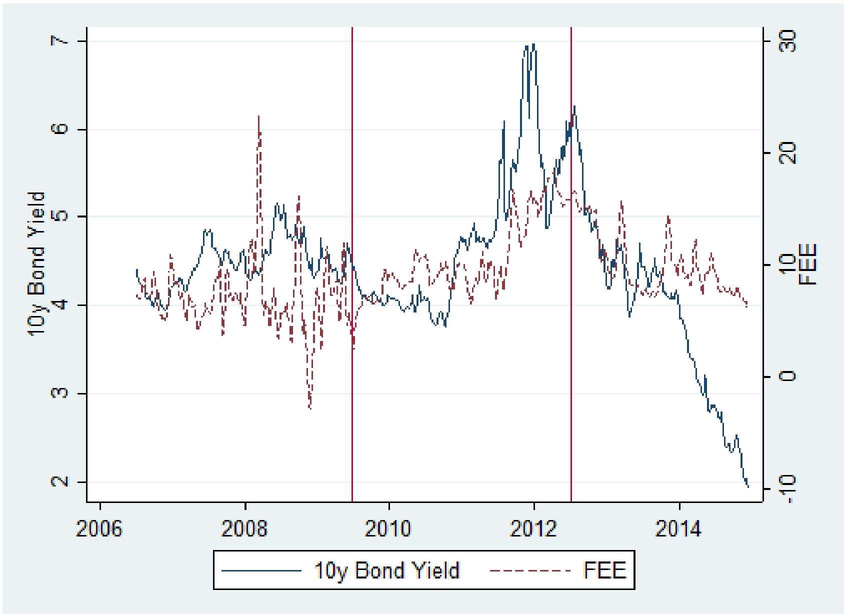


Table 1
Securities Lending Market in European Government Bonds

Our sample includes 6,342 government bonds issued by 11 European countries that are available for lending in the securities lending market during the period July 2006 to March 2017. For each country, Panel A reports the daily average values and time-series standard deviation (SD) for lending inventory, value on loan, utilization which is defined as the percentage of value on loan to lendable inventory, and lending fee which is the transaction-weighted average cost to borrow one euro of a particular bond expressed in basis points (bps).

Country	2006-2017 Total # of Lendable Bonds	Daily Average								
		# of Lendable Bonds	Lendable Inventory (€billion)		Value on Loan (€billion)		Utilization (%)		Fee (bps)	
		MEAN	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Austria	270	76	21.68	6.56	6.61	1.84	31.64	8.91	17.03	4.66
Belgium	186	38	19.27	3.52	5.72	2.53	30.11	12.17	12.80	5.98
Netherlands	561	133	43.53	9.72	16.25	5.89	37.57	12.27	16.11	7.44
Finland	164	35	6.84	0.93	2.27	0.63	33.20	8.49	16.27	7.22
France	1112	243	118.53	30.32	43.35	10.74	37.32	8.23	14.94	6.88
Germany	2569	619	176.29	24.22	81.72	15.79	46.23	6.39	18.83	6.50
Greece	140	31	7.06	7.75	1.82	2.31	13.29	11.38	247.41	317.30
Ireland	53	12	3.90	1.71	0.62	0.37	17.83	10.74	30.15	33.71
Italy	638	127	60.96	19.42	12.54	10.40	18.36	11.72	10.14	4.63
Portugal	111	23	5.63	3.37	1.02	1.10	18.25	17.94	36.35	36.87
Spain	538	125	24.95	6.63	4.73	3.84	20.14	17.72	20.44	9.96
All Countries	6342		43.83	6.98	15.91	4.11	27.60	9.661	37.18	31.23

Table 2
Summary Statistics of Key Variables

The table reports summary statistics on the key variables. The loan characteristics include: *ONLOAN* is the value on loan as a percentage of amount outstanding, *NONCASH* is the ratio of the value on loan using non-cash as collateral to the total value on loan, *FEE* is the lending fee in basis points, *LOAN TENURE* is the duration of a loan contract, and *LOAN SPREAD* is the spread of the highest and lowest borrowing fee. Bond characteristics include: *BOND SIZE* is the logarithm of the value of bond outstanding in million euros, *TIME TO MATURITY* is the time to maturity in years, *FLOATING DUMMY* equals one if the bond has floating coupon rate, and zero otherwise, and *BOND YIELD* is the yield in percentages. Country-level variables include the 3-month Euribor-OIS spread, the OIS rate, and the local stock market return of each country. The sample period is from July 2006 to March 2017.

	Mean	Median	SD
ONLOAN (%)	3.30	1.20	6.67
NONCASH (%)	67.58	84.40	36.76
FEE (bps)	19.52	12.59	42.40
LOAN TENURE (days)	126.83	82.80	148.34
LOAN SPREAD (bps)	35.45	19.60	51.91
BOND SIZE (log(€mil))	0.17	0.00	1.84
TIME TO MATURITY (years)	5.31	3.16	6.50
FLOATING DUMMY	0.15	0.00	0.36
BOND YIELD (%)	2.31	1.48	18.98
EURIBOR-OIS (%)	0.32	0.16	0.33
OIS (%)	0.76	0.19	1.38
STOCK MKT RETURN (%)			
Austria	-0.08	0.22	3.84
Belgium	0.13	0.19	2.62
Finland	0.09	0.00	2.83
France	0.11	0.27	2.64
Germany	0.10	0.24	2.63
Greece	-0.27	0.00	5.32
Ireland	0.03	0.12	3.62
Italy	0.01	0.10	3.04
Netherlands	0.13	0.22	2.65
Portugal	-0.05	0.04	2.81
Spain	0.06	0.10	3.22

Table 3
Supply and Demand Shifts: Safe vs Non-Safe

This table reports summary statistics for shifts in supply and demand for European government bonds before and during the European crisis. Following Cohen, Diether, and Malloy (2007), we place bonds into four categories: demand outward (*DOUT*), supply inward (*SIN*), supply outward (*SOUT*), and demand inward (*DIN*), based on the change of price-quantity pairs during the peak of the European crisis as compared to before the European crisis. Bonds in *DOUT* experience both borrowing cost and borrowing amount rise over the designated horizon; bonds in *SIN* experience borrowing cost rise and borrowing amount fall; bonds in *SOUT* experience borrowing cost fall and borrowing amount rise; and bonds in DIN experience both borrowing cost and borrowing amount fall. An increase in both borrowing cost and borrowing amount, irrespective of all other shifts, implies that at least a demand shift out (increase) has occurred. Panel A calculates the change based on the subsample mean, and Panel B on medians. For each shift category, we report the number of bonds in the category and the proportion of the particular type of shift for *SAFE* and *NONSAFE* respectively. *SAFE* refer to bonds issued by a government with sovereign rating of AAA or AA+, and *NONSAFE* are bonds whose issuing country has a rating lower than AA+. The sample period is from July 2009 to June 2012.

Panel A: Difference in Mean Values

	DOUT		***SIN***		***SOUT***		***DIN***	
	N	%	N	%	N	%	N	%
SAFE	209	43.18%	148	30.58%	72	14.88%	52	10.74%
NONSAFE	24	12.57%	128	67.02%	11	5.76%	28	14.66%

Panel B: Difference in Median Values

	DOUT		***SIN***		***SOUT***		***DIN***	
	N	%	N	%	N	%	N	%
SAFE	202	41.74%	146	30.17%	81	16.74%	46	9.50%
NONSAFE	26	13.61%	129	67.54%	12	6.28%	23	12.04%

Table 4
European Government Bond Lending in Market Stress: Borrowing Demand

This table reports regression results examining borrowing demand for European government bonds during periods of market stress. The dependent variable is *ONLOAN*, the value on loan as a percentage of bond outstanding amount. The proxy for market stress is the spread of the three-month Euribor and OIS rates, *EURIBOR-OIS*. *SAFE* is a dummy variable that equals to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables include the three-month OIS rate, local stock market return of each country, duration of a loan contract, spread of the highest and lowest borrowing fee for the bond, log of bond outstanding value, bond time-to-maturity, a floating rate dummy that equals one if the bond is floating rate, and zero otherwise, and bond yield. The sample period is from July 2009 to June 2012, before and during the European sovereign debt crisis. Regressions use weekly values averaged from daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable = *ONLOAN*				
	(1)	(2)	(3)	(4)	(5)
EURIBOR-OIS*SAFE	1.467***	1.466***	1.291**	1.285**	1.279***
	(3.19)	(3.19)	(3.08)	(2.38)	(3.52)
EURIBOR-OIS	-0.715**	-0.711**	-1.024**	-1.361**	-0.881***
	(-2.94)	(-2.92)	(-2.79)	(-2.82)	(-3.70)
SAFE	-0.341	-0.338	-0.151	0.024	-0.212
	(-1.44)	(-1.44)	(-0.44)	(0.05)	(-1.05)
OIS	0.123	0.121	0.003	0.043	0.184
	(0.45)	(0.45)	(0.01)	(0.11)	(1.18)
STOCK MKT RETURN		-0.005	-0.005	-0.007	-0.006*
		(-0.82)	(-1.48)	(-1.21)	(-2.19)
LOAN TENURE			0.005***	0.005***	0.001
			(4.22)	(4.77)	(1.60)
LOAN SPREAD			0.013**	0.013**	0.006**
			(2.65)	(2.76)	(2.88)
BOND SIZE			-0.326**	-0.045	
			(-2.63)	(-0.35)	
TIME TO MATURITY			0.012	0.009	-0.106
			(0.51)	(0.37)	(-0.83)
FLOATING DUMMY			3.128	1.789	
			(1.73)	(1.35)	
BOND YIELD				-0.001	-0.000
				(-0.69)	(-1.26)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	N	Y
Cluster(Country)	Y	Y	Y	Y	Y
N	159731	159731	138166	113726	113726
R-squared	0.0349	0.0349	0.0863	0.0871	0.6735

Table 5
Borrowing Demand in Market Stress: IV Regressions

This table reports IV regression results for Table 4 by instrumenting borrowing cost, *FEE*, with the country-level outstanding government debt scaled by local gross domestic products, *DEBT/GDP*. The dependent variable is *FEE* in the first stage and is *ONLOAN* in the second stage. The proxy for market stress is the spread of the three-month Euribor and OIS rates, *EURIBOR-OIS*. *SAFE* is a dummy variable that equals to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables include the three-month OIS rate, local stock market return of each country, duration of a loan contract, spread of the highest and lowest fee for the bond, log of bond outstanding value, bond time-to-maturity, a floating rate dummy that equals one if the bond is floating rate, and zero otherwise, and bond yield. The sample period is from July 2009 to June 2012, before and during the European sovereign debt crisis. Regressions use weekly values averaged based on daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

First-stage: Dependent Variable = *FEE*					
	(1)	(2)	(3)	(4)	(5)
DEBT/GDP	-23.416***	-29.555***	-19.752***	-28.585***	-40.656*
	(-12.35)	(-15.03)	(-11.69)	(-13.62)	(-1.83)
Control Variables in Second-stage	Y	Y	Y	Y	Y
Observations	138638	138638	138166	113726	113726
Adjusted R^2	0.1039	0.1048	0.1873	0.1855	0.5724
F-test of excluded inst			136.69***		
(*P*-value)			(0.000)		

Second-stage: Dependent Variable = *ONLOAN*					
	(1)	(2)	(3)	(4)	(5)
EURIBOR-OIS*SAFE	1.643***	1.631***	2.445***	3.694***	1.279***
	(4.49)	(4.45)	(6.69)	(4.73)	(3.10)
EURIBOR-OIS	-0.922*	-0.901*	-2.685***	-5.078***	-0.881**
	(-1.89)	(-1.85)	(-5.51)	(-4.34)	(-3.09)
SAFE	-0.334**	-0.329**	-0.325***	-0.343*	-0.212
	(-2.49)	(-2.45)	(-2.64)	(-1.88)	(-0.95)
OIS	0.091	0.089	0.044	0.090	0.184
	(1.52)	(1.50)	(0.77)	(1.27)	(1.15)
STOCK MKT RETURN		-0.006	-0.002	0.001	-0.006*
		(-1.21)	(-0.42)	(0.09)	(-2.16)
LOAN TENURE			0.006***	0.009***	0.001
			(14.49)	(8.01)	(1.66)
LOAN SPREAD			0.001	-0.015*	0.006***
			(0.28)	(-1.71)	(3.69)
BOND SIZE			0.077	0.921***	
			(0.68)	(3.07)	

TIME TO MATURITY			0.020***	0.024***	-0.106
			(5.92)	(4.18)	(-0.93)
FLOATING DUMMY			3.592***	2.751***	
			(25.00)	(8.94)	
BOND YIELD				-0.014***	-0.000
				(-3.36)	(-1.53)
FEE (INSTRU)	0.005	0.005	0.070***	0.161***	0.011***
	(0.43)	(0.39)	(3.58)	(3.22)	(3.56)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	N	Y
Cluster(Country)	Y	Y	Y	Y	Y
N	138638	138638	138166	113726	113726
R-squared	0.0349	0.0349	0.0863	0.0871	0.6753
Kleibergen-Paap LM Statistic			136.57***		
(*P*-value)			(0.000)		
Cragg-Donald Wald F-statistic			136.69		

Table 6
Borrowing Demand in Market Stress: Alternative Demand Proxy

This table reports regression results of borrowing demand for European government bonds in market stress with alternative proxies of demand variable: *LOG(ONLOAN)*, the logarithm of value on loan in million euros in Panel A, and *UTILIZATION*, the value on loan as a percentage of bond lendable inventory amount, in Panel B. Market stress is measured by the spread of three-month Euribor and OIS rates, EURIBOR-OIS. SAFE is a dummy variable that is equal to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables are the same as in Table 4. The sample period is from July 2009 to June 2012. Regressions use weekly values averaged from daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Dependent Variable = LOG(*ONLOAN)*					
	(1)	(2)	(3)	(4)	(5)
EURIBOR-OIS*SAFE	1.095**	1.094**	1.337***	1.692***	1.597***
	(2.83)	(2.83)	(4.06)	(4.27)	(3.61)
EURIBOR-OIS	-1.119***	-1.117***	-1.500***	-1.861***	-1.377***
	(-3.23)	(-3.22)	(-5.15)	(-5.15)	(-3.55)
SAFE	-0.256	-0.255	-0.241	-0.385**	-0.642**
	(-1.29)	(-1.29)	(-1.64)	(-2.36)	(-2.27)
OIS	-0.099*	-0.100*	-0.202	-0.245*	-0.084
	(-2.04)	(-2.07)	(-1.54)	(-1.86)	(-1.77)
STOCK MKT RETURN		-0.002	-0.003*	-0.004*	-0.003***
		(-1.65)	(-2.03)	(-2.10)	(-3.44)
LOAN TENURE			0.002***	0.002***	0.000*
			(6.70)	(6.16)	(1.94)
LOAN SPREAD			0.010***	0.010***	0.006***
			(7.02)	(6.26)	(5.41)
BOND SIZE			1.079***	1.134***	
			(13.40)	(14.50)	
TIME TO MATURITY			-0.005	-0.004	0.114
			(-0.78)	(-0.55)	(1.19)
FLOATING DUMMY			0.651	0.654	
			(1.29)	(1.32)	
BOND YIELD				-0.001***	0.009
				(-5.51)	(0.79)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	N	Y
Cluster(Country)	Y	Y	Y	Y	Y
Observations	159731	159731	138166	113726	113726
Adjusted R^2	0.0321	0.0321	0.5498	0.5713	0.8098

Panel B: Dependent Variable = *UTILIZATION*					
	(1)	(2)	(3)	(4)	(5)
EURIBOR-OIS*SAFE	3.667**	3.661**	4.346***	7.253***	7.260***
	(2.53)	(2.53)	(3.73)	(6.02)	(3.18)
EURIBOR-OIS	-1.761	-1.717	-5.407***	-7.851***	-6.737***
	(-1.12)	(-1.09)	(-4.18)	(-5.72)	(-3.23)
SAFE	0.508	0.532	1.147	0.119	-0.698
	(0.60)	(0.63)	(1.24)	(0.17)	(-0.41)
OIS	0.800	0.777	-0.640	-1.382	-0.523
	(0.49)	(0.47)	(-0.32)	(-0.77)	(-0.59)
STOCK MKT RETURN		-0.060***	-0.060***	-0.068***	-0.048***
		(-3.73)	(-4.60)	(-3.83)	(-3.99)
LOAN TENURE			0.004	0.006*	-0.000
			(1.10)	(1.95)	(-0.30)
LOAN SPREAD			0.091***	0.097***	0.080***
			(11.32)	(12.10)	(7.89)
BOND SIZE			3.079***	3.531***	
			(3.96)	(5.11)	
TIME TO MATURITY			-0.653***	-0.650***	-0.285
			(-6.80)	(-7.61)	(-0.66)
FLOATING DUMMY			9.135	6.404	
			(1.63)	(1.03)	
BOND YIELD				-0.001	0.001
				(-0.90)	(1.14)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	N	Y
Cluster(Country)	Y	Y	Y	Y	Y
Observations	138584	138584	138112	113673	113673
Adjusted R^2	0.0355	0.0356	0.1242	0.1484	0.6314

Table 7
European Government Bond Lending in Market Stress: Borrowing Collateral

The table presents results of collateral analysis for European government bonds. The dependent variable is NONCASH, the ratio of non-cash collateral to the sum of cash and non-cash collateral. The proxy for market stress is the spread of the three-month Euribor and OIS rates, EURIBOR-OIS. SAFE is a dummy variable that is equal to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables include the three-month OIS rate, local stock market return of each country, duration of a loan contract, spread of the highest and lowest fee for the bond, log of bond outstanding value, bond time-to-maturity, a floating rate dummy that equals one if the bond is floating rate, and zero otherwise, and bond yield. The sample period is from July 2009 to June 2012, before and during the European sovereign debt crisis. Regressions use weekly values averaged from daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Dependent Variable = *NONCASH*					
	(1)	(2)	(3)	(4)	(5)
EURIBOR-OIS*SAFE	20.111***	20.088***	8.913**	7.539*	12.928**
	(3.78)	(3.78)	(2.32)	(1.69)	(2.47)
EURIBOR-OIS	-10.183*	-10.024*	3.080	5.422	-7.885
	(-2.17)	(-2.15)	(0.72)	(0.95)	(-1.58)
SAFE	-13.345**	-13.287**	-9.885*	-9.742	-7.211
	(-2.48)	(-2.48)	(-2.02)	(-1.81)	(-1.11)
OIS	-8.600*	-8.795*	-6.640	-7.246	-2.675
	(-1.86)	(-1.94)	(-1.30)	(-1.49)	(-0.63)
STOCK MKT RETURN		-0.056	-0.069*	-0.109*	0.013
		(-0.93)	(-1.82)	(-2.10)	(0.70)
LOAN TENURE			0.036***	0.037***	0.020*
			(7.28)	(5.88)	(2.18)
LOAN SPREAD			-0.051***	-0.056***	-0.053***
			(-5.39)	(-4.56)	(-4.75)
BOND SIZE			-3.569***	-2.866***	
			(-4.38)	(-3.47)	
TIME TO MATURITY			0.068	-0.004	-4.498***
			(0.50)	(-0.04)	(-5.31)
FLOATING DUMMY			9.084***	8.614***	
			(5.27)	(4.35)	
BOND YIELD				-0.005**	-0.014***
				(-2.70)	(-9.39)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	N	Y
Cluster(Country)	Y	Y	Y	Y	Y
Observations	82778	82778	79761	66431	66431
Adjusted R^2	0.0358	0.0358	0.0905	0.0804	0.5939

Table 8
Government Bond Lending and ECB Bond Purchases

This table examines the influence of ECB bond purchases on the value on loan in the government bond lending market. The dependent variable is *ONLOAN*, the value on loan as a percentage of bond outstanding amount. *SMP* is the ECB's weekly total purchase amount (in billions of euros) of sovereign bonds issued by the country. *SMP* (%) is the ECB's weekly total purchase amount of sovereign bonds issued by the country as a percentage of the country's total bonds outstanding. *SMP* and *SMP* (%) are set to zero for countries not targeted by the SMP. EURIBOR-OIS is the spread between the three-month Euribor and OIS rates. SAFE is a dummy variable that is equal to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables include three-month OIS rate, stock market return of the country, duration of the loan contract, spread of the highest and lowest fee for the bond, log of bond outstanding value, bond time-to-maturity, a floating rate dummy that equals one if the bond is floating rate, and zero otherwise, and bond yield. Regressions use weekly values averaged from daily observations, with the exception of the SMP and SMP (%) variables which are aggregated over the week. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable = *ONLOAN*					
	(1)	(2)	(3)	(4)	(5)	(6)
EURIBOR-OIS*SMP	-0.048	0.062	-0.018			
	(-0.41)	(0.53)	(-0.15)			
SMP	0.023	-0.036	-0.011			
	(0.33)	(-0.53)	(-0.18)			
EURIBOR-OIS*SMP (%)				-0.399	0.110	-1.138
				(-0.45)	(0.11)	(-1.01)
SMP (%)				0.124	-0.045	0.328
				(0.39)	(-0.12)	(0.82)
EURIBOR-OIS*SAFE	1.431***	1.325***	1.229**	1.432***	1.300***	1.184**
	(3.15)	(2.92)	(2.14)	(3.17)	(2.88)	(2.09)
SAFE	-0.322	-0.166	0.049	-0.323	-0.155	0.068
	(-1.36)	(-0.47)	(0.11)	(-1.37)	(-0.44)	(0.15)
EURIBOR-OIS	-0.674*	-1.059**	-1.303**	-0.675*	-1.033**	-1.258**
	(-2.21)	(-2.46)	(-2.43)	(-2.18)	(-2.36)	(-2.36)
OIS	0.124	-0.000	0.048	0.124	0.002	0.052
	(0.45)	(-0.00)	(0.13)	(0.45)	(0.00)	(0.13)
STOCK MKT RETURN	-0.005	-0.005	-0.007	-0.005	-0.005	-0.007
	(-0.83)	(-1.39)	(-1.22)	(-0.83)	(-1.40)	(-1.23)
LOAN TENURE		0.005***	0.005***		0.005***	0.005***
		(4.22)	(4.77)		(4.22)	(4.76)
LOAN SPREAD		0.013**	0.013**		0.013**	0.013**
		(2.65)	(2.76)		(2.65)	(2.76)
BOND SIZE		-0.326**	-0.045		-0.326**	-0.045
		(-2.63)	(-0.35)		(-2.63)	(-0.34)
TIME TO MATURITY		0.012	0.009		0.012	0.009
		(0.51)	(0.37)		(0.51)	(0.37)

FLOATING DUMMY		3.128	1.789		3.128	1.789
		(1.73)	(1.35)		(1.73)	(1.35)
BOND YIELD			-0.001			-0.001
			(-0.71)			(-0.71)
Country dummy	Y	Y	Y	Y	Y	Y
Cluster(Country)	Y	Y	Y	Y	Y	Y
Observations	159731	138166	113726	159731	138166	113726
Adjusted R^2	0.0349	0.0863	0.0871	0.0349	0.0863	0.0872

Table 9
Impact of Bundesbank Public Lending on German Government Bond Private Lending

This table examines the influence of Deutsche Bundesbank's security lending program on the demand in the private lending market. We adopt a two-step approach. In Step 1, we use various sets of variables to predict future demand, *ONLOAN* at time t+1, based on the estimation window six months before the implementation of public lending program, i.e. October 2014 to March 2015. In Step 2, for the period April 2015 to March 2017 when the Bundesbank public lending program is in place, we use the realized value of predictors and the corresponding estimated coefficients from Step 1 to calculate the predicted demand. The spread between realized demand and predicted demand is defined as *EXCESS DEMAND*. We then regress excess demand on the eligibility of bonds in the public lending program. The dummy variable *ELIGIBLE* is equal to one if a bond is eligible in the public lending program. Control variables are the same as in Table 4. In Step 1, the predictive regression also include issuer fixed effect and cluster standard errors at issuer level. In Step 2, we include the year-week time dummy to control for the trend of excess demand. Regressions use weekly values averaged from daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Step 1: Predictive Regression in Estimation Window October 2014 – March 2015			
	Dependent Variable = *ONLOAN at t+1*		
	(1a)	(2a)	(3a)
EURIBOR-OIS	0.066	0.179	0.202
	(0.70)	(1.32)	(1.35)
OIS	-0.010	-0.026	-0.002
	(-0.24)	(-0.56)	(-0.03)
STOCK RET	0.032	-0.094***	-0.095***
	(1.02)	(-3.48)	(-3.77)
LOAN TENURE		0.004	0.004
		(1.37)	(1.40)
LOAN SPREAD		0.006**	0.005**
		(2.45)	(2.03)
BOND SIZE		-0.035***	-0.034***
		(-3.27)	(-3.14)
TIME TO MATURITY		-0.000	0.000
		(-0.98)	(0.95)
FLOATING DUMMY		0.013	0.006
		(0.83)	(0.36)
BOND YIELD			-0.007***
			(-4.19)
Issuer Dummy	Y	Y	Y
Cluster (Issuer)	Y	Y	Y
Observations	9215	9014	8898
Adjusted R^2	0.1873	0.4185	0.4324

Step 2: Calculate Excess Demand in Event Window April 2015 – March 2017			
	Dependent Variable = EXCESS DEMAND		
	(1b)	(2b)	(3b)
ELIGIBLE	-2.006***	-2.145***	-1.842***
	(-14.05)	(-14.94)	(-13.99)
CONSTANT	4.719***	4.121***	3.742***
	(83.37)	(72.24)	(71.03)
Year-week Dummy	Y	Y	Y
Observations	33245	32444	32004
Adjusted R^2	0.0108	0.0124	0.0115

Appendix

Table A1
European Government Bond Lending in Market Stress: Borrowing Demand with Time Effects

This table reports regression results examining borrowing demand for European government bonds during periods of market stress. The dependent variable is *ONLOAN*, the value on loan as a percentage of bond outstanding amount. The proxy for market stress is the spread of the three-month Euribor and OIS rates, *EURIBOR-OIS*. *SAFE* is a dummy variable that equals to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables are the same as in Table 4. The sample period is from July 2009 to June 2012, before and during the European sovereign debt crisis. Regressions use weekly values averaged from daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent Variable = *ONLOAN*				
	(1)	(2)	(3)	(4)
EURIBOR-OIS*SAFE	1.477***	1.478***	1.316***	1.304**
	(3.65)	(3.65)	(3.34)	(2.48)
SAFE	-0.199	-0.201	-0.201	-0.006
	(-0.94)	(-0.95)	(-0.60)	(-0.02)
STOCK MKT RETURN		-0.017*	-0.018*	-0.022**
		(-1.99)	(-2.12)	(-2.26)
LOAN TENURE			0.005***	0.005***
			(4.17)	(4.78)
LOAN SPREAD			0.013**	0.013**
			(2.64)	(2.75)
BOND SIZE			-0.331**	-0.050
			(-2.63)	(-0.38)
TIME TO MATURITY			0.012	0.009
			(0.51)	(0.37)
FLOATING DUMMY			3.136	1.788
			(1.74)	(1.38)
BOND YIELD				-0.001
				(-0.65)
Country Dummy	Y	Y	Y	Y
Year-Week Dummy	Y	Y	Y	Y
Cluster(Country)	Y	Y	Y	Y
N	159731	159731	138166	113726
R-squared	0.0360	0.0360	0.0872	0.0890

Table A2
Borrowing Demand in Market Stress: Alternative Instrument Variable – DEBT GROWTH

This table reports IV regression results for Table 4 by instrumenting borrowing cost, *FEE*, with the growth rate of country-level outstanding government debt, *DEBT-GROWTH*. The dependent variable is *FEE* in the first stage and is *ONLOAN* in the second stage. The proxy for market stress is the spread of the three-month Euribor and OIS rates, *EURIBOR-OIS*. *SAFE* is a dummy variable that equals to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables include the three-month OIS rate, local stock market return of each country, duration of a loan contract, spread of the highest and lowest fee for the bond, log of bond outstanding value, bond time-to-maturity, a floating rate dummy that equals one if the bond is floating rate, and zero otherwise, and bond yield. The sample period is from July 2009 to June 2012, before and during the European sovereign debt crisis. Regressions use weekly values averaged from daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

First-stage: Dependent Variable = *FEE*					
DEBT GROWTH	-0.369***	-0.388***	-0.315***	-0.273***	-0.174*
	(-28.83)	(-29.92)	(-28.40)	(-22.36)	(-1.72)
Control Variables in Second-stage	Y	Y	Y	Y	Y
Observations	138638	138638	138166	113726	113726
Adjusted R^2	0.1083	0.1091	0.1912	0.1889	0.5714
F-test of excluded instrument			806.38		
(P-value)			(0.000)		

Second-stage: Dependent Variable = *ONLOAN*					
EURIBOR-OIS*SAFE	1.370***	1.345***	1.067***	1.066***	1.279**
	(5.95)	(5.85)	(5.40)	(5.45)	(3.09)
EURIBOR-OIS	-0.534*	-0.495*	-0.701***	-1.023***	-0.881**
	(-1.96)	(-1.82)	(-3.18)	(-4.47)	(-3.05)
SAFE	-0.265**	-0.257**	-0.118	0.058	-0.212
	(-2.35)	(-2.28)	(-1.13)	(0.58)	(-0.97)
OIS	0.114**	0.114**	-0.005	0.039	0.184
	(2.12)	(2.11)	(-0.10)	(0.81)	(1.15)
STOCK MKT RETURN		-0.006	-0.006	-0.008*	-0.006*
		(-1.27)	(-1.25)	(-1.72)	(-2.17)
LOAN TENURE			0.004***	0.005***	0.001
			(23.49)	(25.08)	(1.66)
LOAN SPREAD			0.015***	0.015***	0.006***
			(11.69)	(11.03)	(3.67)
BOND SIZE			-0.405***	-0.133***	
			(-9.26)	(-2.74)	
TIME TO MATURITY			0.011***	0.007***	-0.106
			(4.34)	(3.11)	(-0.91)
FLOATING DUMMY			3.037***	1.702***	
			(40.91)	(24.09)	
BOND YIELD				0.000	-0.000
				(0.58)	(-1.51)

FEE (INSTRU)	-0.005	-0.006	-0.014*	-0.015*	-0.011***
	(-0.80)	(-0.95)	(-1.86)	(-1.86)	(-3.55)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	N	Y
Cluster(Country)	Y	Y	Y	Y	Y
N	138638	138638	138166	113726	113726
R-squared	0.0449	0.0455	0.0980	0.1008	0.6753
Kleibergen-Paap LM Statistic			801.83***		
(*P*-value)			(0.000)		
Cragg-Donald Wald F-statistic			806.38		

Table A3
European Government Bond Lending under Alternative Proxies of Market Stress

This table reports regression results examining borrowing demand for European government bonds during periods of market stress. The dependent variable is *ONLOAN*, the value on loan as a percentage of bond outstanding amount. The proxy for market stress is the European market VIX index, *EURO VIX* in Panel A and the spread of the 10-year government bond yields between Germany and Italy, *GYIELD* in Panel B. *SAFE* is a dummy variable that equals to one if a bond is issued by a government with sovereign rating of AAA or AA+, and zero otherwise. Control variables are the same as in Table 4. The sample period is from July 2009 to June 2012. Regressions use weekly values averaged from daily observations. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: EURO-VIX as Market Stress Proxy					
Dependent Variable = *ONLOAN*					
	(1)	(2)	(3)	(4)	(5)
EURO VIX * SAFE	0.032**	0.032**	0.031***	0.039***	0.033***
	(3.01)	(3.02)	(3.89)	(4.23)	(5.02)
EURO VIX	-0.012**	-0.011**	-0.017***	-0.025***	-0.014***
	(-2.50)	(-2.51)	(-3.61)	(-3.52)	(-5.26)
SAFE	-0.576	-0.585	-0.409	-0.433	-0.573***
	(-1.59)	(-1.61)	(-1.02)	(-0.84)	(-3.26)
OIS		0.101	0.038	0.117	0.207
		(0.46)	(0.11)	(0.32)	(1.62)
STOCK MKT RETURN		0.373	-0.469	-2.068	-0.004**
		(0.40)	(-0.60)	(-1.30)	(-2.94)
LOAN TENURE			0.005***	0.005***	0.001
			(4.25)	(4.82)	(1.67)
LOAN SPREAD			0.013**	0.013**	0.006**
			(2.56)	(2.67)	(2.82)
BOND SIZE			-0.325**	-0.042	
			(-2.63)	(-0.32)	
TIME TO MATURITY			0.012	0.009	-0.098
			(0.52)	(0.38)	(-0.75)
FLOATING DUMMY			3.135	1.777	
			(1.73)	(1.34)	
BOND YIELD				-0.001	-0.000
				(-0.92)	(-1.68)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	N	Y
Cluster(Country)	Y	Y	Y	Y	Y
Observation	159731	159731	138166	113726	113726
Adj R-squared	0.0346	0.0347	0.0862	0.0869	0.6736

Panel B: The Yield Spread of German and Italian Sovereign Bond as Proxy					
Dependent Variable = *ONLOAN*					
	(1)	(2)	(3)	(4)	(5)
GYIELD * SAFE	0.357**	0.356***	0.319**	0.361***	0.397***
	(3.14)	(3.36)	(2.91)	(3.44)	(5.25)
GYIELD	-0.189***	-0.188***	-0.259**	-0.331***	-0.270***
	(-3.48)	(-3.44)	(-2.59)	(-3.72)	(-3.80)
SAFE	-0.581**	-0.579**	-0.474	-0.458	-0.718***
	(-2.59)	(-2.71)	(-1.25)	(-1.24)	(-3.66)
OIS		0.041	-0.024	0.055	0.165
		(0.16)	(-0.06)	(0.14)	(0.78)
STOCK MKT RETURN		0.157	-1.254**	-3.083*	-0.004*
		(0.24)	(-2.68)	(-1.92)	(-2.05)
LOAN TENURE			0.005***	0.005***	0.001
			(4.20)	(4.76)	(1.48)
LOAN SPREAD			0.013**	0.013**	0.006**
			(2.75)	(2.90)	(3.14)
BOND SIZE			-0.329**	-0.048	
			(-2.67)	(-0.37)	
TIME TO MATURITY			0.012	0.008	-0.074
			(0.51)	(0.36)	(-0.57)
FLOATING DUMMY			3.105	1.771	
			(1.72)	(1.35)	
BOND YIELD				-0.001	-0.000
				(-0.51)	(-0.35)
Country Dummy	Y	Y	Y	Y	Y
Bond Dummy	N	N	N	Y	Y
Cluster(Country)	Y	Y	Y	Y	Y
Observation	159731	159731	138166	113726	113726
Adj R-squared	0.0357	0.0357	0.0869	0.0881	0.6747