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DP 09/2017-032

The Liquidity and Welfare Implications of the Securities Lending Market for European Treasuries

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Current Draft: September 27, 2017

First Draft: March 15, 2017

Abstract

The growing demand for high quality liquid assets in the securities lending market gave rise to a new form of convenience yield for German treasuries as shown by the significantly higher auction prices and lower yields for bonds with higher expected lending income in the primary and secondary market. Pension funds and insurance firms could capitalize on this demand to generate additional revenues on their large low yield treasury portfolios. At year-end, with the banks' withdrawal from the market, additional opportunities arise for nonbank lenders to become primary lenders and earn higher fees while providing the much needed funding liquidity.

***JEL classification*:** G12, G18, G21, G23

Keywords: Bond yields, Convenience yield, Collateral, Central counterparty, Pension funds, Wealth preservation, Securities lending.

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[1] The authors thank Edina Berlinger (discussant), Ekkehart Boehmer, Huang Dashan, Bálint L. Horváth, Markus Huggenberger, Yue Ling, Roger K. Loh, Pippa Lowe, Ernst Maug, David M. Reeb, Johan Sulaeman, Weina Zhang, and all seminar and conference participants at the German Finanzagentur, the University of Mannheim, National University of Singapore, Singapore Management University, 2017 Summer Workshop of the Hungarian Academy of Sciences (MTA-KTI), IRMC 2017 Florence, and the IFABS 2017 Oxford Conferences.

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1. Introduction

By 2016 the securities lending market had grown to a $15 trillion global business (IHS Markit, 2016). Reflecting its importance, the equity side of the market has attracted ample academic attention, where studies (e.g., Saffi and Sigurdsson, 2011) find that a well-functioning over-the-counter securities lending market is essential for pricing efficiency to support arbitrage activities.[2] In contrast, the fixed income segment of the lending market is largely understudied, perhaps overshadowed by the repo market – although more than a third of all securities on loan were government bonds, accounting for more than $5 trillion in 2016 (ISLA, 2016). The fixed income segment of the securities lending market is similar to the equity segment in supporting various trading activities and market efficiency, but it also has important welfare implications because the lenders are typically pension funds, insurance firms, and mutual funds who are critical for the long-term wealth preservations of citizens.

In recent years, the borrowing demand for treasuries has grown significantly on the two ends of the sovereign risk spectrum. On one end, the increasingly active credit default swap (CDS) market generates demand for risky European treasuries, where the 2012 European naked sovereign CDS ban requires traders to own the underlying securities prior to the trade.[3] On the other end of the spectrum, the demand increased due to flight-to-safety, need for high quality collateral as the derivative trading moved from OTC to central counterparty (CCP) settlement, and with tightened

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[2] For example, Duffie et al. (2002; 2005) and Kolasinski, Reed, and Ringgenberg (2013) examine how search costs and oligopolistic market structure in the OTC securities lending market generate inefficiencies in the securities lending market. Saffi and Sigurdsson (2011) show that the internationally developed stock lending market is necessary to support short selling, while Bris, Goetzman, and Zhu (2007) and Boehmer and Wu (2013) show that these short sell trades are important for pricing efficiency.

[3] See Augustin, Subrahmanyam, Tang and Wang (2016) and Tang and Yan (2017) for detailed reviews of the CDS market and transaction details.

banking and financial market regulations after the global financial crisis. As the demand for high quality collateral increases, the securities lending market for fixed income assets becomes increasingly important for collateral swaps or collateral transformation, where market participants can transform lower quality fixed income assets to higher credit quality bonds to secure financing in the repo market (ECB, 2014).

The demand for high quality collateral is expected to further rise to about $1.9 trillion by 2020 due to shift towards centralized derivative settlements and the implementation of initial margin requirements (Oliver Wyman, BCBS / IOSCO QIS, 2013). On the other hand, the supply is shrinking due to new banking regulations, which force banks to hoard cash and high quality liquid assets to meet new liquidity and collateral requirements, especially around reporting dates.[4] The high quality collateral shortage in Europe has become more acute with the large scale asset purchase program of the ECB, which included the purchase of €1.3 trillion worth of government bonds by the end of 2016 (Aggarwal, et al. 2016; ECB, 2017a; ECB 2017b; FT, 2017), with over €300 billion in German government bonds. In an attempt to alleviate the high quality liquid collateral shortfall, the ECB and a number of other national central banks have introduced active securities lending programs to make assets from their portfolios available for market participants promoting funding liquidity (ECB, 2017a, 2017b).

In this study, instead of focusing on the role of securities lending market in the context of monetary policy, we take the end users' perspective to examine welfare implications for pension

[4] This potential shortfall of high quality collateral has been noted not only by industry participants and regulators (Singh, 2013) but also by academics (Aggarwal, Bai, and Laeven, 2016).

funds, insurance firms, and mutual funds. European insurance firms and pension funds invest about one third of their total holdings, €2.25 trillion, in low yield fixed income assets such as high quality EU treasuries to meet current regulatory requirements, such as Solvency II rules which mandates large long-term fixed income holdings, typically government bonds, to minimize asset-liability mismatches and reduce capital requirements (ECB, 2016). Thus, if the low interest rate environment persists, conservative investments may struggle to keep up with inflation (Anderson and Liu, 2013; Hooke, 2014; Mnyanda and Duarte De Aragao, 2016).

We specifically focus on the highest quality and most liquid European benchmark treasury assets: German sovereign debt securities. For these bonds, shorting and CDS trading are less likely to be driven by negative information, allowing us to focus on the income-generating potential of securities lending for mutual funds, pension funds, and insurance firms serving as wealth preservation agents. During our sample period of July 2006 to June 2015, we observe the availability and lending activity of these high quality assets in the securities lending market. Contrary to the low utilization rates (the fraction of total lendable supply value, which is lent out) of 5% to 10% in the equity segment, we find significantly higher utilization rates, at 50% and above, for German treasuries. The lending fees show a rising trend, despite the relatively stable supply with a dip only during the global financial crisis, providing more income-generating opportunities for potential lenders.

We find that besides the on-the-run premium, German sovereign bond yields contain a new form of convenience yield arising from expected future lending income. We also consider the demand and supply implication of the recent banking regulation for German treasuries. With the implementation of Basel III, banks are incentivized to engage in balance sheet window-dressing around reporting dates, resulting in a significant decline in their liquidity provision in funding

markets at year-end. This shortage of high quality collateral is aggravated by the implementation of Solvency II, which encourages insurers to hold long maturity safe securities, such as AAA-rated government bonds. This decrease in supply from banks and insurers provides not only opportunities for pension funds to charge higher fees on their safe and liquid sovereign bonds but also highlights the need for pension funds active participation in securities lending around regulatory reporting dates. In addition to the secondary market evidence, we also show that investors are willing to pay higher prices for bonds that have substantial expected income from securities lending at the primary auction.

Overall, we document the liquidity implications of the securities lending market for German treasuries. We find that expected income from securities lending has important pricing implications in the primary and the secondary market as well. We suggest that using securities lending benchmark proxies to estimate demand and expected income potential, pension funds and insurance firms can better optimize their treasury allocation to realize additional income from their passive holdings. However, we also call for regulatory attention to the vulnerability of pension funds in treasury purchases. We suggest that pension funds should be allowed to participate directly in the auctions to reduce costs of securing mandated treasury holdings through auction group participants and other dealers.

2. Literature Review: Convenience Yield on Treasuries and Welfare Implications

2.1 Pricing Implication of the Repo and Securities Lending Markets for Treasuries

The literature is relatively limited on empirical analysis of sovereign bond returns because the expectations hypothesis explains a significant portion of the yield curve for the benchmark risk free securities (e.g., U.S. and German treasury bonds in Europe): longer maturity instruments carry

greater duration risk in addition to the risk free component of yields.[5] However, convenience yield or variation in exposures to risk factors along the yield curve can cause cross-sectional differences. For example, the on-the-run versus off-the-run phenomenon is well documented by showing that seasoned U.S. treasuries are less liquid and investors demand a liquidity premium for holding these assets (Buehler and Vonhoff, 2011; Fontaine and Garcia, 2012; Gurkaynak et al., 2007; Jordan and Jordan, 1997; Kempf et al., 2012; Krishnamurthy, 2002; Schuster and Uhrig-Homburg, 2013). Special repo rates and the convenience yield of on-the-run treasuries are jointly cyclical over the auction cycle (Cherian, Jacquier, and Jarrow, 2004). Off-the-run premiums can be explained along the yield curve by three major maturity buckets: T-bills, 2- to 5-year notes, and 10-year bonds (Goyenko et al., 2011).

Investors tend to assign additional value to the liquidity and safety of treasuries, seen as safe haven assets, and are willing to accept lower yields relative to similar securities (Krishnamurthy and Vissing-Jorgensen, 2011; Longstaff, 2004; Schuster and Uhrig-Homburg, 2013; Schwarz, 2015). Recent work examining the German nominal yield curve presents evidence of economically negligible market segmentation and shows that liquidity differs significantly across short and long maturities (Driessen et al., 2016). The difference is most likely a by-product of regulation and delegated asset management. The liquidity of shorter maturities is linked to both the cost and ease of trading. Moreover, investment banks and mutual funds regularly rebalance their portfolios and systematically look for easily traded assets. On the other hand, liquidity of long maturities is

[5] We exclude international (cross-country) studies that explain different yields in sovereign debt instruments in relation to country risk and political uncertainty and focus on domestic studies explaining yield variation within one country as our empirical analysis is also focus on only one country.

neither cost-driven nor systematic: typically, these bonds are locked up in buy and hold investor portfolios, such as pension or insurance funds, and traded less frequently.

Although the costs make active trading of treasuries and other fixed income assets relatively scarce, these assets are frequently traded in repo contracts, especially the safer securities such as U.S. and German treasuries. The repo market plays a crucial role in providing funding liquidity. In these transactions, the investment banks, mutual, pension and insurance funds who own the sovereign bonds initiate a contract to give the asset at a discount to the "lender," with the promise to buy the asset back at a higher price. Traditionally, banks participated in the repo market willingly at any time because they could generate income from contractually safe, fully collateralized transactions. However, in recent years, they have been increasingly reluctant to lend cash in exchange for collateral, especially around quarter and year-end dates when they lock in liquid assets for window-dressing purposes (e.g., Allen and Saunders, 1992; Griffiths and Winters, 1997), eventually decreasing their regulatory capital needs, in alignment with Basel III. This practice led to a critical systemic meltdown of repo markets by the end of 2016 (ICMA, 2017).

Although repo liquidity is increasingly prone to drying up, the securities lending market for government bonds is far more active than the market for equities or corporate bonds (Aggarwal et al., 2016). Short selling mostly drives demand for equities, but government bonds can be used for collateral transformation, settlement of futures and CDS contracts, and hedging positions.[6] Besides banks, the potential lenders for treasuries are so called passive market participant, such as pension funds or mutual funds who hold long term Treasuries for duration matching and income generating

[6] See Appendix A for an overview of the repo and securities lending transactions in the context of fixed income securities from the International Securities Lending Association (ISLA, 2016).

purposes and willing to lend out. However, with the implementation of Solvency II, insurance firms also become more reluctant to lend out high quality Treasuries in the funding market because the new regulatory environment makes it more attractive for insurers to hold AAA-rated bonds, rather than holding cash in a bank account (ECB, 2017b).

In our setting of the German sovereign bond market, the most likely triggers for borrowing demands are asset managers making collateral swaps (collateral transformation) or money managers requiring the asset for delivery on futures contracts. In collateral swaps, asset managers holding low credit quality treasuries (especially non-collateralizable assets) may temporarily offload and "switch" the assets for high credit quality treasuries such as German sovereign bonds. For example, the fund manager can borrow German bonds for value X and deliver collateral of a lesser credit quality (e.g., Greek treasury) in the value of X + haircut. Although the haircut could be significant, the manager still benefits in terms of liquidity because of holding a German rather than a Greek sovereign bond, which can be used as general collateral at clearing houses and for trading. Thus, the manager could use securities lending to increase the fund's leverage. The securities lending market for government bonds has a unique role in transforming collateral from low-quality assets to high-quality liquid assets (HQLA) and likely contributed to the market growth in lendable assets valued at almost $1 trillion and $362 billion borrowed (Agarwal et al., 2016).

The repo and securities lending market effects on liquidity transformation and their pricing implications warrant attention, specifically after the 2008 global financial crisis and the subsequent European sovereign debt crisis. Since 2010, the European Central Bank and other national central banks have actively intervened in the capital market with various large-scale asset repurchase programs to stimulate the economy. Theoretically, as long as funding markets have access to

treasuries, asset purchase programs should not disrupt supply in the funding market. Nevertheless, in practice, collateral shortages and extreme special rates occur, partly because market participants have limited access to central bank credit lines, and/or because central banks participating in securities lending do not use the standard GMRA and GMSLA contract formats (ICMA, 2017).

2.2 Welfare Implications: The Importance of Income from Treasuries

Financial institutions, insurance firms, pension funds, and trusts are the primary investors in treasuries. Pension funds and insurance firms play a key role in Europe, where the majority of retirees rely on social security (government or public pensions), and/or occupational pension income. Because the European pension and insurance sectors are so economically essential, they are heavily regulated. Most European pension funds are required to hold a minimum amount in low-risk fixed-income assets, such as European treasuries. Although the requirement is based on good intentions, it caused the aggregate European pension sector to have a negative net worth for the first time in 2016 (ECB, 2016).[7]

The Solvency II Directive of the EU, the regulatory framework for insurance firms and pension funds, was established in a normal interest rate environment without considering that ultra-low interest rates might occur for a prolonged period. In Germany, the corporate pension schemes or BAVs face tight investment restrictions, while defined benefit (Directzusage) schemes using

[7] In extreme cases, for example, ERAFP (*Retraite additionelle de la Fonction publique*), which manages the French public service additional pension scheme, had to invest 75% of assets into bonds until 2015, when the limit was lowered. In 2016, more than 50% of the fund's assets were still in sovereign bonds (Global Pension Assets Study, 2016). Philippe Desfosses, CEO of ERAFP, France's second largest pension fund, expressed concerns about the suboptimal portfolio allocation of the €26 billion portfolio of the fund, asking the government to alleviate the restrictions on portfolio allocation, and to cut the minimum allocation to bonds in the trust's investment mandate (Bloomberg, 2016).

contractual trust arrangement (CTA) are theoretically freer to make investment choices.[8] Nevertheless both funds generally comply with the Insurance Supervision Act (VAG) governing insurers and pension funds.[9] VAG requires that funds cannot invest more than 35% of their portfolios in risky assets; the remaining 65% must be invested in fixed income and real estate assets.[10] Mercer 2015 survey data indicate that non-corporate German pension funds allocate 66% of bond allocations in domestic government bonds, while corporate pension funds allocate 38%.[11] Although pension funds have voiced concerns about the low yields of these conservative assets, no major asset re-allocations have occurred. In addition, the European regulation, Solvency II is expected to further constrain pension funds (IPE, 2016).

The regulation of pension and insurance funds actively promotes safe assets, such as low-risk treasuries, in asset portfolios. Bond investments have benefits in addition to the general lower risk in offering coupon reinvestment and liquidity generation through repo transactions. More recently, the active securities lending market has provided an alternative for generating income from government bond holdings. Markit data show that about 25% to 30% of the lenders are retirement and pension funds; 20% are insurance firms, and 20% are mutual funds. Thus, most institutions important to wealth preservation rely on the securities lending market to generate additional income. This nonconventional income generation, through structured financing, is likely to

[8] *Betriebliche Altersvorsorge*, which can be structured as *Pensionkassens* or *Pensionfunds*.

[9] *Versicherungsaufsichtsgesetz* (VAG).

[10] For example, most German pension funds place a 30% limit on stocks, a 25% limit on property, and a 5% limit on non-EU bonds, among others. (In Germany, there are five five major pension fund types. The so-called pension funds are actually the least regulated but these type of institutions established only after 2011 contribute to only a negligible fraction of the market).

[11] Corporate pension funds had 46% of their total assets in bonds, while other pension funds not using CTAs (non-CTA funds) had 52% of their assets in bonds.

become critical in the persistently low interest rate environment (State Street, 2016). The situation is acute in Germany and the European Union, where most pension funds hold a large portfolio of sovereign debt, while nominal yields approach zero, and real yields have been negative since 2011.

3. Data, Summary Statistics and Hypothesis Development

3.1 Data

Our dataset contains daily bond yields of Germany treasuries from July 3, 2006 to June 1, 2015. Daily closing mid-prices of German treasury securities, obtained from Bloomberg, are used to calculate yield-to-maturity, following market conventions. The Germany Federal bonds (Bunds), five-year Federal notes (Bobls), and Federal treasury notes (Schätze) are listed on the German stock exchanges, which provide transparency about daily prices and yields (Deutsche Bundesbank, Eurosystem 2016). We complement the daily yield data with bond characteristics such as issue and maturity dates and information on coupon and issuance amounts from Bloomberg. We also collect data from the German Finance Agency on all primary auctions during our sample period, including information on issuance amounts, initial average price, lowest price, average yields and bid-to-cover ratios. To adjust for market liquidity and demand for a security, we also create an on-the-run dummy, capturing the liquidity premium in secondary market bond yields, as in Krishnamurthy (2002) and Jordan and Jordan (1997).

Using International Securities Identification Numbers (ISIN), we match all bond yields and characteristics with securities lending market data from Markit. The dataset contains information on the total amount available for borrowing of a specific issue, the total amount borrowed in USD, and the active utilization rate, which is the percentage of total lent out value of the total lendable

value.[12] Our key securities lending market variables are: relative supply (*RelSupply*), which is the percentage of the total issuance value available for borrowing in the securities lending market; relative borrowing demand (*Utilization*), which is the percentage of the issuance value borrowed; and value-weighted lending fee (*Allfees*), which is the value-weighted annualized lending fee on all outstanding contracts realizable by the lender.

We also have information about the cross-section spread in fees (*Feespread*), which is the difference between the highest and lowest fee at any time point on all outstanding contracts. This information is relatively important in the equity segment of the securities lending market capturing the dispersion in opinion across investors because it is associated with misevaluation in the presence of binding short-sale constraints (Miller, 1977). However, in our case, the spread is negligible, as investors have similar opinions about the risk and performance of one of the most liquid and safe sovereign debt asset available in Eurozone (Finanzagentur, 2017).[13]

3.2 Summary Statistics

Table 1 presents the summary statistics of the key variables based on the sample period of German treasuries from July 2006 to June 2015. Panel A presents the full sample statistics and Panel B presents time-to-maturity buckets. Table 1 Panel A shows that in our sample the average bond issue size is EUR 17.5 billion, issued about 5.5 years ago (*Age*) and has 7.8 year remaining until

[12] Securities lending market studies exploring equity data use the shares lent out and the shares available for lending, but in the bond universe the unit of transaction is unclear. Instead, we use the total value lendable and lent, both directly available from Markit. In reality, a typical transaction is documented in €1000 unit, while the prices are quoted in €100 units. This market convention could conceivably cause misreporting regarding the number of units available for borrowing and lent out in Markit. Thus, we use the lent-out value and lendable value in USD. In addition, we must also apply a currency adjustment, as the issuance size is recorded in EUR, while the securities lending data are in USD. We convert the securities lending information into EUR using the daily exchange rate information from the Statistical Data Warehouse of the European Central Bank.

[13] *Finanzagentur*: (Website: http://www.deutsche-finanzagentur.de/en/institutional-investors/)

maturity (*TTM*). The average coupon rate is 3.56% and the average yield-to-maturity is 1.99%. On average, 5.1% of the outstanding bonds are on-the-run. Considering the securities lending market activity measures, we find that on average, 11.6% of the total issuance value is available for borrowing in the securities lending market (*RelSupply*). The average lending fee (*Allfees*) is 10.8%. The average spread on the highest and lowest fees (*Feespread*) is 3.83 bps, and the average utilization rate (*Utilization*) is 52%.

[Table 1 about here]

Table 1 Panel B provides summary statistics for the variables by the following maturity buckets: 0-1 year, 1-2 years, 2-5 years, 5-10 years, and above 10 years. Issue sizes are relatively stable across the maturities, with the most liquid 5- to 10-year bucket containing the largest issues. Although we do not directly use the age variable, we show that the different types of bonds are well represented across the different maturity buckets in our sample. Indeed, we find that ages of the issues are comparable, around four years, across the four maturity buckets with time-to-maturity less than 10 years. The coupon rates are slightly increasing with time-to-maturity to cater to the clientele of long-term assets: insurance firms and pension funds, which use the regular coupon payment cash flows to meet specific obligations. Long maturity bonds are also more often on-the-run, in 9.2% of the cases. Although these features mechanically decrease with shorter time-to-maturity, these tenors are typically issued more often. Yields also increase with time-to-maturity, which likely captures investors' liquidity preferences.

The differences in securities lending market activity along the yield curve are also of interest in understanding the differences in liquidity implications. Our key measure, the lending fee, is relatively stable across the various maturity buckets: *AllFees*, the annualized lending fee, is around

11 basis points across the different maturities. In contrast with equity securities lending studies (e.g., Geczy et al., 2002) we find no extreme variations. The maximum lending fee is 2.65% for bonds with maturity greater than 10 years and around 4.7% for the shorter maturities. The *Feespread* measure, the difference between the lowest and highest fee on any day for a specific security, is also relatively small, about 4 bps, which suggests that market participants agree regarding equilibrium fees. The average relative supply is from 7.2% to 16.5%, with the longest maturity bonds being more readily available in the securities lending market. Interestingly, the maximum relative supply peaks in the 5- to 10-year maturity bucket, where 92% of the total issue size is available for a specific issue. The greater supply is likely in response to the greater demand. That is, the *Utilization* rate is highest for the 2- to 5-year and 5- to 10-year buckets, which contain issues serving as the basis for the most frequently traded CDS and Bund futures contracts.

In addition to Table 1, we provide more dynamic time series insights about the securities lending market for German treasuries in our sample. Figure 1 depicts the time-series of the moving monthly average of the key securities lending variables. The upper figure shows the average of the value-weighted fees and the utilization rate over time. Fees show significant variation over time, with a notable increase after the Lehman bankruptcy, and a peak at around 40 bps at the height of the European debt crisis. Specifically, the average fee rose significantly in the fall of 2011 and spiked at 25 basis points in November of 2011, just before the ECB implemented the historically largest infusion of credit into the European banking system in the euro's 13-year history, loaning €489 billion to 523 banks (Reuters, 2011).

[Figure 1 about here]

The lower panel in Figure 1 shows the time-series of the monthly average aggregate demand and supply in billion euros. The two series seem to move in lockstep, preserving the 2.5% to 3% difference: they have two larger dips around the financial crisis and the onset of the euro crises, while both supply and demand seem to stay persistently higher in later years of the sample period. Interestingly, the supply of German treasuries in the securities lending market significantly increases after 2012, and the demand also picks up, as needs for collateral transformation and swap activities increase with the downgrade of periphery EU treasuries, reducing the availability of high quality assets in the market.

In Figures 2 and 3, we examine the time trend for securities lending by maturity buckets. During the first years in our sample, before the global financial crisis, all maturity buckets have negative lending fees, implying that the securities lending market is used as repo financing and lenders lend assets at a negative fee to receive cash collateral. (Cash collateral was traditionally the norm in the European securities lending market.) With the shorter maturities, maturities of 1 and 2 years in the time series trend is somewhat unclear with lending fees, but the utilization rates are still overall above 50%, suggesting that the assets are in high relative demand (see Figure 2).

[Figures 2 and 3 about here]

In Figure 3, we see a clear increasing trend in fees for longer maturity bonds. As bonds with 5-10 year maturities are the most commonly used underlying assets for interest rate futures and sovereign CDS, they are expected to be the most highly demanded. We capture this in utilization rates well beyond 60% after 2012. Market participants may dislike betting on Germany's default, and proponents of the naked CDS ban urge against such speculation, but holding uncovered CDS positions could be part of hedging or arbitrage strategies (Portes, 2010; Basel Committee, 2011).

Moreover, trading on German CDS has regulatory implications, as holding CDS on high quality assets reduces banks' regulatory capital requirements (Klinger and Lando, 2016). Similarly, these German bond issues are also important for settling futures contracts. When they become cheapest to deliver, their demand and lending income potential are temporarily increased.

3.3 Hypothesis Development

Ample evidence indicates that the equities lending market activity benefits the market: it facilitates price discovery and market efficiency (Boehmer and Wu, 2013; Engelberg et al., 2012) by supporting short selling to convey new negative information to the market (Boehmer et al., 2008; Desai et al., 2002; Diether et al., 2009), and preventing price bubbles (Hong, Scheinkman, and Xiong, 2006). Indeed, a study of the pricing behavior of stock lenders and the return implications contributes to the price discovery process by showing that stock lending fees predict future stock returns (Duong et al., 2016).

Despite the extensive literature on the equity segment of the securities lending market, studies on fixed income securities lending are scarce. We aim to fill this gap by examining the liquidity implications of the securities lending market activity of German treasuries from July 2006 to June 2015. Our work is motivated by the on-the-run premium phenomenon, where newly issued bonds of a given tenor become "special" or referent, and thus attract higher demand (Jordan and Jordan, 1997; Krishnamurthy, 2002). Specialness in repo and lending markets means that the security is subject to high demand. Generally, the demand rises through the cash market, where market-makers or dealers must use repo or lending markets to borrow bonds of limited supply to fulfill delivery obligations (ICMA, 2013).

For example, when futures sellers must deliver specific issues that are not readily available in the cash market, they would try to borrow the security in the securities lending market. In some cases, market movements or specific information may also result in clustered demand, where the demand for a given issue can be extremely high, resulting in high borrowing costs and negative rebate rates. Thus, we conjecture that relatively informed investors can price in the additional liquidity and the expected income from the securities lending market. Specific bond issues, with more lending activity and higher earnable lending fees, can provide a non-negligible alternative source of income beyond the regular coupon payment for investors. In other words, the increased realizable income for investors creates demand that lowers yields on these securities, similarly to Duffie (1996):

> *H1A: Securities lending activity plays a role in the cross-sectional and time-series variation in treasury yields: bond issues with higher expected future lending income have lower market yields (higher prices).*

We empirically analyze the liquidity implications of the securities lending market in a panel setting, using secondary market daily bond yields on all outstanding plain vanilla nominal German sovereign bonds from July 2006 to June 2015. Specifically, we consider three aspects of the securities lending market: supply, demand, and lending fees at the intersection of demand and supply. Each measure captures some aspects of the intensity of securities lending market activity, and is expected to signal positive income earnings potential from securities lending market activity.

We extend the first hypothesis by considering seasonality in the dynamics of the securities lending and repo markets. More important, we focus on banks engaging in balance sheet window-

dressing to comply with and reduce the more stringent capital reporting requirements that came after the global financial crisis and with the implementation of Basel III. Specifically, we expect that shrinking supplies of high quality assets will cause banks to withhold these assets, but the demand remains largely unchanged. As a result, we observe significantly lower supply around the regulatory reporting dates, which leads to tightening funding conditions. Thus institutions willing to engage in lending step up to provide liquidity and realize higher fee income:

H1B: Around reporting dates when banks temporarily withdraw from the lending market, nonbank lenders can capitalize on the limited supply and charge higher fees for providing liquidity in the funding markets. Supply should shrink and lending fees should increase around year's end.

Last, we consider investment decisions according to whether expected income influences the initial price in bond auctions. A selected set of investors, called primary dealers, compete in bidding at treasury auctions, determining the initial yields of the new issues. We expect that pricing information comes from lending fees and securities lending market utilization of outstanding bonds that are similar to the newly auctioned issues.

H2: Securities lending market activity signals liquidity that predicts higher auction prices, as investors incorporate the realizable future income and utilization in the securities lending market convenience yield.

Specifically, in the auction context, we expect that investors price in the expected income from future securities lending, as Duffie et al (2002) and Porras-Prado (2016) suggested in the equity market context. Moreover, our analysis of auction prices also relates to the "auction cycle" effect

in treasury bond yields. The limited risk-bearing capacity of primary dealers and potential capital immobility of end-investors causes an inverted V-shape pattern in yields around auctions (Fleming and Rosenberg, 2007; Lou, Yan, and Zhang, 2013). The pattern is consistent with primary dealers requiring compensation for inventory risk, especially when demand is low relative to the supply of new issues, and has been confirmed in the Italian treasury market but not for German treasuries (Beetsma et al., 2016). In Germany, where treasuries are regarded as a safe haven and are in demand, the inventory risk is effectively zero.

4. Empirical Results

To test our hypotheses, the empirical analysis is structured in two parts. First, we examine the liquidity implications of the securities lending market in a panel setting, using daily yield data on all outstanding plain vanilla nominal German sovereign bonds from July 2006 to June 2015. Specifically, we test whether the securities lending market activity explains the cross-section of bond yields over time. We also observe differences along the yield curve and the effect of bank window-dressing on lending variables. Second, we consider the pricing and liquidity implications of securities lending market activity in the context of primary auctions.

4.1 Panel Regression Analysis of Daily German Treasury Yields in the Secondary Market

In the first part of our empirical analysis (Table 2), we examine whether lending fees explain returns in the panel setting using daily secondary market bond yield information from Bloomberg. Our sample covers all plain vanilla German nominal sovereign bonds that we matched with securities lending market data. Lending fees effectively proxy for liquidity of a specific bond in the securities lending market, where the fees are established as the intersection of demand and supply. As Figure 1 shows, average supply and demand are relatively stable over time. Higher fees

imply that the owner of the security can earn significant additional income, which is why owners (buyers) are more likely to accept holding assets with lower yields (Duffie, 1996).

[Table 2 about here]

The results in Table 2 Panel A align with this expectation: they reveal a significant negative relation between lending fees and bond yields. We estimate the economic magnitude of the lending fee's effect by comparing two bonds that have similar bond characteristics but different lending fees. The results are non-negligible: in Model 1, comparing a bond with 0.05% average lending fee with another with 0.1% lending fees reveals that the bond with the 100% higher fee has 16.7 bps lower yield in the secondary market. For the other lending market activity measures, such as utilization rate, supply, and feespread, the results point to the same direction, suggesting lower yields for an issue that is more active in the securities lending market. This finding is similar to that of Krishnamurthy and Vissing-Jorgensen (2011), who show that investors are willing to accept lower yields on U.S. Treasuries because of high liquidity and credit quality. In our sample, lower yields also indicate a convenience yield because of (future) realizable lending fee income.

In the last two models (columns 5 and 6), we examine the lending fee in conjunction with utilization. A high bond fee may occur accidently, but if only 2% of its total supply is utilized on average, a lender may fail to realize economically important income from lending the bond. We find that fees and the extent to which the available bond volume is utilized both decrease yields. Moreover, the convenience yield gets larger as the utilized portion of supply and fees jointly increase.

Next, in Table 2 Panel B, we test the robustness of our results from Table 2 Panel A, by including additional bond level fixed effects in the regression analysis. The economic magnitude

of the lending fee declines, but the coefficient estimates on the measure are still highly statistically significant. Overall, the results in Table 2 support Hypothesis 1A: securities lending activity gives rise to observable yield differences in the cross-section and time-series of treasury yields. More specifically, bond issues with higher earnable lending fees and greater lending activity have lower yields (higher prices).

Next, in Table 3, we test the robustness of our results by examining the relation between yields and securities lending market activities by maturity buckets. In Table 3 Panel A, we show that specific maturity buckets do not drive the effect of lending fees on yield. In Table 3 Panel B, we find that the pricing implications of the utilization rate are more sensitive to maturity buckets. The finding is unsurprising because the supply varies significantly across the different maturities: the much larger supply for longer maturities means that high utilization rates are necessary for potential lenders to consider realizable lending income. More important, considering utilization rate in conjunction with lending fees, in Table 3 Panel D, we show that for maturities longer than 2 years, either fees, utilization rates, or the interaction of the two variables significantly explain the yield curve.

[Table 3 about here]

Based on Tables 2 and 3 findings, we conclude that securities lending market activity has important asset pricing implications in the German treasury market. As such, when market participants trade these assets, they actively price in the expected lending income. These results are consistent with the findings of Porras Prado (2016) based on the U.S. equity market and support our first hypothesis. We document significant explanatory power of securities lending activity in the cross-

section of sovereign yields in Table 2. In Table 3, we show that the relation holds over the entire yield curve and is not driven by a subset of maturities.

4.2 Regulatory Reporting Requirements Impact on the Securities Lending Market

Banks with large trading desks have traditionally been active participants of repo and securities lending markets. However, with the increasingly stringent regulation and reporting requirements, they are incentivized to lock in good credit quality and liquid assets in their portfolios at quarter and year-end reporting dates to minimize their required capital buffers. Consequently, around these dates, banks are less willing to participate as lenders and thus provide funding liquidity, which in turn reduces supply of high quality liquid assets such as German treasuries. Supply shrinks, but demand is unaffected, which might simultaneously drive up lending fees. Various market participants have objected to this unintended negative impact of regulation (ICMA 2017), but it provides opportunities for nonbank lenders to capitalize on their "unique" lender position at reporting dates, especially around year-end. To test this conjecture, and thus Hypothesis 1B, in Table 4 we examine whether supply and fees present a cyclical pattern around year-end.

In the empirical analysis, we use five calendar days to proxy for year-end (*Yrend*).[14] In Table 4, Models 1A and 2A, results show that at year-end, the fees in the cross-section of bonds average 1.7 basis points higher. Although the results in Models 1B and 2B are statistically weaker with the relative supply measure, they show nontrivial economic magnitude. The negative coefficient of -0.24 on the Yrend dummy implies that the supply shrinks by about 24% at the year-end: from

[14] In auxiliary analysis, we use 3 and 4 calendar days, as well as 3, 4, and 5 trading days. The results are economical and statistically similar.

11.6% to 8.8%. These findings are consistent with Aggarwal et al. (2016) and ICMA (2017) who express concerns that more stringent banking regulations may have potential systemic effects such as a market meltdown. Overall, Table 4 provides significant support for Hypothesis 1B that year-end regularity reporting requirements adversely affect the securities lending market liquidity for German treasuries.

[Table 4 about here]

4.3 Event Study Method: Auction Outcome for German Treasuries

Next, we consider the information content of our securities lending market measures for the primary market of German treasuries. We conjecture that securities lending market information can provide insights useful for pricing bonds issued at the auctions. If securities lending activity of similar securities can "predict" auction outcomes, primary dealers and end investors are better able to choose from various treasuries to maximize future income revenue or leverage potential from securities lending. For the auction process, we collect auction data from the German Finance Agency. The dataset contains coupon rate, tenor, issue size, average price, lowest price, expected size, and bid-to-cover ratio. The relevant summary statistics based on the 296 unique new issuances and reopenings throughout our sample period are presented in Table 5.

[Table 5 about here]

Table 5 Panel A presents statistics of the overall auction sample. We include both new issues and reopenings, where multiple reissuances allow a specific ISIN target volume to be reached. This Finance Agency practice helps maintain market liquidity and allows auction participants to purchase bonds at prices reflecting current market conditions. The table shows the value-weighted

average and lowest prices for all auctions involving plain vanilla German nominal bonds during our sample period of July 2006 to June 2015 when securities lending market was available. The value-weighted average and lowest prices are slightly above the face value. However, investors are sometimes willing to pay almost 40% more. The average auction has a bid-to-cover (BTC) ratio of 1.66, while oversubscription (BTC>2) for issues is quite common, suggesting the string supply for the Eurozone benchmark asset. Coupons range from 0% to 4%.

We construct securities lending benchmarks for all issuances, specifically for fees (*BenchFees10d*), utilization (*BenchUti10d*), relative supply (*BenchSupply10d*) and feespread (*BenchmFeespread*). These variables are defined as the moving average of a securities lending measure based on the preceding 10 days, where the average is taken over securities that are similar to the new issuance in their respective maturities and coupons. The benchmark fee (*BenchFees10d*) is 9.5; the benchmark utilization (*BenchUti10d)* is around 50%; the *BenchSupply10d* is around 11%.

Table 6 presents the regression results regarding liquidity and pricing implications of the securities lending market for the German treasury auctions. The dependent variables are the average and the lowest bid prices at the auctions in Panels A and B, respectively. The results in Table 6 Panel A suggest that the expected future income from securities lending, proxied by the average lending fee, is priced in as suggested by Duffie et al. (2002) and Porras Prado (2016). In Table 6 Panel A, with the pooled auction sample, we find that higher securities lending market activity captured by higher lending fee and higher relative active supply is associated with a higher auction price. For instance, interpreting the coefficient on lending fee in Model 2 means that evaluated at the average fee (11 bps), the price effect of securities lending fees is € 2.6, while the one standard deviation higher lending fee (at 15 bps) is associated with € 3.5 price effect, assuming

a € 100 notional issuance. The results hold for both the average price (Panel A) and the lowest bid price (Panel B).

In Table 6, the utilization rate has negative results, suggesting that higher utilization rate is associated with lower price. But when utilization rate and fees are considered together, in Models 5 and 6, average utilization rate and fees both predict higher price but their interaction is negatively associated with auction price. Thus, higher utilization beyond lending fee is associated with negative returns, implying that demand could be inelastic thus fails to affect pricing: investors are not paying a higher price for the issue because they do not expect greater income.

[Table 6 about here]

Overall, the results from Table 6 provide further evidence that securities lending market activity has important pricing implication for treasury yields, and that market participants can use securities lending market data to obtain additional information on future auction outcomes. The results confirm Hypothesis 2 by showing that securities lending market activity of similar bonds is an important liquidity signal incorporated in the primary market pricing of German treasuries.

5. Conclusion

We document the pricing implications of the securities lending market for German treasuries from July 2006 to June 2015. We show that the securities lending market activity is priced into the treasury yields in the secondary market and also provides material information about the auction outcome of new issuances. The results have important welfare implications for insurance firms and pension funds responsible for preserving wealth and managing retirement savings for the majority of European citizens.

Previous stock market crashes and the 2008 global financial crisis greatly influenced the current regulatory environment for pension funds and insurance firms, requiring them to have safe and liquid assets, such as treasuries, overrepresented in their portfolios. The focus on the safest and most liquid assets is an understandably prudent strategy, but the core EU sovereign bonds tend to deliver only minimal real returns, which poses as major obstacles for meeting investment targets and promises.

We suggest that pension and insurance funds should actively participate in the securities lending market not only to generate additional income but also to acquire securities lending market information to strategically invest in new and outstanding issues with the highest expected demand. Moreover, as the bank window-dressing results suggest, pension funds and insurance firms can further capitalize on the collateral shortage situation around regulatory reporting dates when banks are locking in high-quality liquid assets and are unwilling to participate in repo and securities lending. Thus, nonbank lenders can assume systemic importance by stepping in and providing funding liquidity. In turn, they can increase lending fees while building relationship capital with other market participants.

References

Aggarwal, R., Bai, R., and Laeven, L. 2016. The Role of the Government Bond Lending Market in Collateral Transformation, Working Paper. Georgetown University.

Allen, L. and Saunders, A. 1992. Bank Window Dressing: Theory and Evidence, *Journal of Banking & Finance* 16 (3), 585-623,

Anderson, R. and Li, Y., 2013. How Low Can You Go? Negative Interest Rates and Investors' Flight to Safety, *Regional Economist*. Federal Reserve Bank of St Luis. Pages 1-13.

Augustin, P., Subrahmanyam, M., Tang, D. Y. and Wang, S. Q. 2016. Credit Default Swaps: Past, Present, and Future", *Annual Review of Financial Economics* 8, 175-196.

Beetsma, R., Giuliodori, M., de Jong, F., and Widijanto, D., 2016. Price Effects of Sovereign Debt Auctions in the Euro-Zone: The role of the crisis. *Journal of Financial Intermediation* 25, 30-53.

Bloomberg, 2016, Bond Squeeze 'Bleeding to Death' $28 Billion Pension Fund, by Mayes Joe, https://www.bloomberg.com/news/articles/2016-11-17/bond-squeeze-bleeding-to-death-28-billion-french-pension-fund

Boehmer, E. and Wu, J. Short Selling and the Price Discovery Process, *The Review of Financial Studies* 26 (2), 287–232.

Bris, A. Goetzman, W. N, and Zhu, N. 2007. Efficiency and the Bear: Short Sales and Markets around the World, Journal of Finance 62 (3), 1029-1079.

Cherian, Joseph A.; Jacquier, Eric; Jarrow, Robert A, 2004. A Model of the Convenience Yields in On-the-Run Treasuries. *Review of Derivatives Research.* 79-97.

Deutsche Bundesbank, 2016. Prices and yields of listed Federal securities, Deutsche Bundesbank, Eurosystem, https://www.bundesbank.de/Navigation/EN/Service/ Federal_securities/ Prices_and_yields/prices_and_yields.html (accessed on October 28, 2016).

Driessen, J., Nijman, T. E., and Simon, Z., 2016. Much Ado about Nothing: A Study of Differential Pricing and Liquidity of Short and Long Term Bonds. Working paper.

Duffie, D., 1996. Special Repo Rates. *The Journal of Finance* 51, 493–526.

Duffie, D., Gârleanu, N., and Pedersen, L. H. 2002. Securities Lending, Shorting, and Pricing. *Journal of Financial Economics* 66 (2-3), 307-339.

Duffie, D., Gârleanu, N., and Pedersen, L. H. 2005. Overt-The-Counter Markets, *Econometrica* 73 (6). 1815-1847.

ECB, 2014. Collateral Eligibility and Availability, Follow-up Report on "Collateral Eligibility Requirements – A Comparative Study across Specific Frameworks", https://www.ecb.europa.eu/pub/pdf/other/cea201407en.pdf?c5856909bbcb7b0ed884be5b281ddc24

ECB, 2016. European Central Bank. Statistics on Euro Area Insurance Corporations and Pension Funds: Second Quarter 2016, Press Release, 30 September 2016, https://www.ecb.europa.eu/press/pdf/icpf/icpf16q2.pdf

ECB, 2017a. Asset Purchase Programs, https://www.ecb.europa.eu/ mopo/implement/omt/html/index.en.html

ECB, 2017b. Bond scarcity and the ECB's Asset Purchase Programme, Speech by Benoît Cœuré, Member of the Executive Board of the ECB, at the Club de Gestion Financière d'Associés en Finance, Paris, 3 April 2017, https://www.ecb.europa.eu/press/key/ date/2017/html/sp170403_1.en.html

Financial Times, 2017. How the ECB's Purchases Have Changed European Bond Markets, February 8, 2017 by Thomas Hale, https://www.ft.com/content/c5568324-ec8f-11e6-930f-061b01e23655

Finanzagentur, 2015. Bund Issues Auction Group, Bundesrepublic Deutschland Finanzagentur, GmbH, http://www.deutsche-finanzagentur.de/en/institutional-investors/primary-market/bund-issues-auction-group/ (accessed September 25, 2015).

Fleming, M. J. and Rosenberg, J. V., 2007. How Do Treasury Dealers Manage Their Positions? Federal Reserve Bank of New York Staff Reports, No. 299.

Fontaine, J.-S. and Garcia, R., 2012. Bond Liquidity Premia. *Review of Financial Studies* 25, 1207–1254.

Griffiths, M. D. and Winters, D. B,. 1997. On a Preferred Habitat for Liquidity at the Turn-of-the-Year: Evidence from the Term-Repo Market, *Journal of Financial Services Research* 12 (1), 21–38

Geczy, C.C., Musto, D.K and Reed, A., 2002. Stocks are Special Too: An Analysis of the Equity Lending Market. *Journal of Financial Economics* 66, 241–269.

Global Pension Assets Study 2016, Willis Tower Watson, February 2, 2016. https://www.willistowerswatson.com/en-CH/insights/2016/02/global-pensions-asset-study-2016

Goyenko, R., Subrahmanyam, A., and Uhkov, A., 2011. The Term Structure of Bond Market Liquidity and Its Implications for Expected Bond Returns. *Journal of Financial and Quantitative Analysis* 46, 111–139.

Gurkaynak, R. S., Sack, B., and Wright, J. H., 2007. The U.S. Treasury Yield Curve: 1961 to the Present. *Journal of Monetary Economics* 54, 2291–2304.

Hong, H, Scheinkman, J., Xiong, W., 2006. Asset Float and Speculative Bubbles, *The Journal of Finance* 61 (3), 1073-1117.

Hooke, J., 2014. In the Nation's Interest: Negative Nominal Interest Rates: Uncharted Waters, Committee for Economic Development (https://www.ced.org/blog/entry/negative-nominal-interest-rates-uncharted-waters: Accessed January 13, 2017).

ICMA, 2013. Frequently Asked Questions on Repo, International Capital Market Association, http://www.treasurers.org/ACTmedia/Repo_faqs.pdf: Accessed January 13, 2017.

ICMA, 2014. Collateral is the New Cash: The Systematic Risk of Inhibiting the Collateral Fluidity: An Initiative of the European Repo Council, by Andy Hill, April 2014.

ICMA, 2017. Closed For Business: A Post-Mortem of the European Repo Market Break-Down over the 2016 Year-End, by Andy Hill, February 2017, https://www.icmagroup.org/resources/icma-publications-and-services/icma-reports/

IHS Markit, 2016. Securities Lending: A Year in Review. 21 December, 2016. http://www.markit.com/Commentary/Get/21122016-Equities-Securities-lending-year-in-review

IPE, 2016. Pensions in Germany: The Joys Of Negative Rates. Investment and Pensions Europe (IPE), April 2016. https://www.ipe.com/pensions/pensions-in/germany/pensions-in-germany-the-joys-of-negative-rates/10012506.fullarticle (Accessed March 9, 2017).

ISLA, 2016. Reports at the European Post Trade Forum, Brussels, May 2016, http://ec.europa.eu/finance/financial-markets/docs/clearing/eptf/160519-isla_en.pdf.

Jordan, B. D. and Jordan, S. D., 1997. Special Repo Rates: An Empirical Analysis. *The Journal of Finance* 52, 2051–2072.

Kempf, A., Korn, O., and Uhrig-Homburg, M., 2012. The Term Structure of Illiquidity Premiums. *Journal of Banking & Finance* 36, 1381–1391.

Klinger, S. and Lando, D., 2015. Safe-Haven CDS Premia. Working paper.

Kolasinski, A., Reed, A., and Ringgenberg, M.C., 2013. A Multiple Lender Approach to Understanding Supply and Search in the Equity Lending Market. *Journal of Finance* 68, 559–595.

Krishnamurthy, A. and Vissing-Jorgensen, A., 2011. The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy. Brookings Papers on Economic Activity. Fall 2011.

Krishnamurthy, A., 2002. The Bond/Old Bond Spread. *Journal of Financial Economics* 66, 463–506.

Krishnamurthy, A., Nagel, S., and Vissing-Jorgensen, A., 2014. ECB Policies Involving Government Bond Purchases: Impact and Channels. Working Paper.

Longstaff, F. A., 2004. The Flight to Liquidity Premium in U.S. Treasury Bond Prices. *Journal of Business* 77, 511–526.

Lou, D., H. Yan, and J. Zhang, 2013. Anticipated and Repeated Shocks in Liquid Markets, *Review of Financial Studies* 26 (8) 1891-1912.

Miller, E. M., 1977. Risk, Uncertainty, and Divergence of Opinion, *Journal of Finance*, 1151-1168.

Oliver Wyman, BCBS / IOSCO QIS, 2013, Wholesale & Investment Banking Outlook,

Global Banking Fractures: The Implications, Blue paper, Morgan Stanley and Oliver Wyman Research, April 11, 2013. http://www.oliverwyman.com/content/dam/oliver-

wyman/global/en/files/archive/2013/Outlook_for_Wholesale_and_Investment_Banking_2013.pdf

Porras Prado, M., 2015. Future Lending Income and Security Value. *Journal of Financial and Quantitative Analysis* 50, 869-902.

Porras Prado, M., Saffi, P. A. C., and Sturgess, J., 2016. Ownership Structure, Limits to Arbitrage, and Stock Returns: Evidence from Equity Lending Markets, *Review of Financial Studies,* 29 (12): 3211-3244.

Portes R., 2010. Ban naked CDS. Eurointelligence, March 18

Reuters, 2011. Exclusive: Italian banks tap 116 billion euros of ECB loans, December 22, 2011. http://www.reuters.com/article/us-italy-banks-ecb/exclusive-italian-banks-tap-116-billion-euros-of-ecb-loans-idUSTRE7BK1NL20111221

Saffi, P.A.C. and Sigurdsson, K., 2011. Price Efficiency and Short Selling, *Review of Financial Studies* 24 (3): 821-852.

Schuster, P. and Uhrig-Homburg, M., 2013. The Term Structure of Bond Market Liquidity Conditional on the Economic Environment: An Analysis of Government Guaranteed Bonds. Working Paper.

Schwarz, K., 2015. Mind the Gap: Disentangling Credit and Liquidity Risks in Spreads. Working Paper.

Singh, M., 2013. The Changing Collateral Space, IMF Research Paper.

State Street 2016. The Savers Save Europe and Themselves. State Street Global Advisors. Official Institutional Group. August 2016.

Tang, D. Y and Yan, H. 2017 Understanding Transactions Prices in Credit Default Swaps Market, *Journal of Financial Markets* 32, 1-27.

Table 1. Summary Statistics from July 3, 2006 to June 1, 2015

The table reports summary statistics of the main variables used in the empirical analysis. *Age* is the fraction of years since the first issue date. *TTM* is the time-to-maturity of a specific Germany treasury bond, measured in years with 2-decimal accuracy. *Coupon* is the annual coupon rate in percentage format. *Ontherun* dummy takes on the value of one for a specific security for a given trading day, when the security is on-the-run for its tenor. *Sizeineuro* is the issue size in million euros. *Yield* is the daily yield-to-maturity and is calculated based on the daily closing mid prices from Bloomberg, following market conventions. *AllFees* is the annualized value-weighted average fee in percentage. *Feespread* is the difference between the highest and lowest fees in basis points on all outstanding borrowing contracts for a specific security. *Suppleurval* is the total supply of a specific issue in millions of euro, while the *RelSupply* is the percentage of the total issuance volume available for borrowing. *Utilization* is the percentage of the total supply of the issue utilized, currently out on loan. For these measures, the numerator is the total available value and lent out value reported from Markit in USD, which is converted into EUR using the daily exchange rate from the Statistical Data Warehouse of the European Central Bank. Our maturity buckets are 0-1 year, 1-2 years, 2-5 years, 5-10 years, and above 10 years.

Label	N	Mean	Std. Dev	Minimum	Maximum
Age	115611	5.475	5.628	0.000	28.970
TTM	115611	7.779	8.025	0.500	32.480
Coupon	115611	3.566	1.620	0.000	6.500
Ontherun	115611	0.051	0.219	0.000	1.000
Sizeineuro	115611	17472.900	5107.939	750.000	27000.000
Yield	115574	1.986	1.547	-0.300	4.900
AllFees	115611	0.108	0.122	-0.663	4.172
Feespread	104505	3.834	1.047	-6.908	8.161
Suppleurval	115611	3697.902	2695.570	0.000	35164.830
RelSupply	115611	0.116	0.077	0.000	0.924
Utilization	115611	0.516	0.243	0.000	1.000

Table 1 continued.

Panel B. Summary Statistics by Maturity buckets

Label	N	Mean	Std. Dev	Minimum	Maximum
Bonds with TTM < 1 year					
Age	9902	4.210	3.307	0.97	9.78
TTM	9902	0.750	0.147	0.500	1.000
Coupon	9902	2.906	1.622	0.000	6.000
Ontherun	9902	0.000	0.000	0.000	0.000
Sizeineuro	9902	17002.630	3461.685	8750.000	27000.000
Yield	9898	1.396	1.651	-0.300	4.600
AllFees	9902	0.092	0.092	-0.598	1.066
Feespread	9502	3.445	1.026	0.000	6.796
Suppleurval	9902	2209.928	1454.292	0.000	14100.140
RelSupply	9902	0.072	0.045	0.000	0.384
Utilization	9902	0.547	0.224	0.000	1.000
Bonds with TTM >1 year and less than 2 year					
Age	19328	4.098	4.873	0.000	28.970
TTM	19328	1.505	0.288	1.010	2.000
Coupon	19328	2.755	1.706	0.000	6.000
Ontherun	19328	0.000	0.010	0.000	1.000
Sizeineuro	19328	16833.310	4129.734	750.000	27000.000
Yield	19324	1.398	1.619	-0.300	4.700
AllFees	19328	0.111	0.120	-0.428	3.250
Feespread	17737	3.591	0.920	-2.303	8.161
Suppleurval	19328	2736.636	1879.378	0.000	11199.430
RelSupply	19328	0.088	0.057	0.000	0.420
Utilization	19328	0.529	0.228	0.000	1.000
Bonds with TTM 2 year and less than 5 year					
Age	32546	4.912345	5.476715	0.000	28.02
TTM	32546	3.479	0.867	2.010	5.000
Coupon	32546	3.270	1.519	0.000	6.000
Ontherun	32546	0.052	0.221	0.000	1.000
Sizeineuro	32546	18587.180	4909.578	750.000	27000.000
Yield	32542	1.522	1.478	-0.300	4.800
AllFees	32546	0.101	0.089	-0.647	2.600
Feespread	29628	3.830	1.026	-2.303	7.863
Suppleurval	32546	3958.043	2717.930	0.000	21414.490
RelSupply	32546	0.113	0.069	0.000	0.768
Utilization	32546	0.588	0.227	0.000	1.000

Table 1 continued.
Panel C. Summary Statistics by Maturity buckets with TTM greater than 5 years

Label	N	Mean	Std. Dev	Minimum	Maximum
Bonds with TTM >5 years but less than 10 years					
Age	29263	4.475	6.101	0.000	25.020
TTM	29263	7.554	1.449	5.010	10.000
Coupon	29263	3.444	1.229	0.000	6.250
Ontherun	29263	0.066	0.248	0.000	1.000
Sizeineuro	29263	19117.730	5918.748	750.000	27000.000
Yield	29256	2.217	1.328	-0.200	4.700
AllFees	29263	0.114	0.149	-0.663	4.172
Feespread	25626	4.045	1.094	-6.908	7.495
Suppleurval	29263	3945.377	2763.650	0.000	35164.830
RelSupply	29263	0.111	0.074	0.000	0.924
Utilization	29263	0.529	0.250	0.000	1.000
Bonds with TTM >10 years					
Age	24572	9.003	5.068	0.000	20.020
TTM	24572	21.507	5.965	10.010	32.480
Coupon	24572	5.005	1.114	0.500	6.500
Ontherun	24572	0.092	0.289	0.000	1.000
Sizeineuro	24572	14730.760	4251.487	750.000	24000.000
Yield	24554	3.029	1.121	0.100	4.900
AllFees	24572	0.116	0.135	-0.613	2.650
Feespread	22012	3.957	1.039	-2.3026	8.160
Suppleurval	24572	4414.363	3063.018	0.000	21506.620
RelSupply	24572	0.165	0.088	0.000	0.4403228
Utilization	24572	0.380	0.217	0.000	1.000

Table 2. Daily Panel Regressions of German Treasury Yields based on Secondary Market Trade Prices

The dependent variable, *Yield,* is the daily yield-to-maturity in percentage, calculated based on the daily closing mid prices from Bloomberg, following market conventions. *AllFees* is the annualized value-weighted average fee in percentage. *Utilization* is the ratio of the total supply which is lent out for a specific security. *RelSupply* is the fraction of the total issuance value available for borrowing, where the numerator is the total available value to borrow from Markit converted into EUR using daily exchange rates from the Statistical Warehouse of the European Central Bank. *Feespread* is the difference between the highest and lowest fees on all outstanding borrowing contracts for a specific security. *AllFees*Uti* is an interaction variable of the AllFees and Utilization variables. *LogTTM* is the natural logarithm of time-to-maturity of specific Germany treasury measured in years with 2-decimal accuracy. Issue size (*LogSize*) is the issue size in € million, as reported by the German Bundesbank at the time of the issuance. *Ontherun* dummy takes the value of one for a specific security for the trading days when the specific security is on-the-run for its tenor. *Coupon* is the annual coupon rate in percentage. Coefficient estimates are reported with t-stats (in parenthesis) allowing for clustering of the standard errors at the bond level, and asterisks denote the conventional significance levels

Panel A. Panel Regression Results of Bond Yields with Securities Lending Variables

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Yield	**Yield**	**Yield**	**Yield**	**Yield**	**Yield**
AllFees	-0.167**				-0.208***	-0.077
	(-2.39)				(-3.14)	(-1.59)
Utilization		-0.303***			-0.312***	-0.237***
		(-4.56)			(-4.66)	(-3.10)
RelSupply			-0.369*			
			(-1.79)			
Feespread				-0.039***		
				(-4.37)		
Allfees*Uti						-0.693***
						(-4.02)
Logttm	0.739***	0.722***	0.751***	0.749***	0.722***	0.718***
	(32.17)	(31.52)	(29.96)	(32.99)	(31.50)	(30.66)
LogSize	-0.010	0.042	-0.000	-0.104	0.046	-0.065
	(-0.19)	(0.82)	(-0.01)	(-0.92)	(0.87)	(-0.73)
Ontherun	0.048	0.023	0.023	0.015	0.025	0.029
	(0.59)	(0.30)	(0.28)	(0.17)	(0.32)	(0.36)
Coupon	0.045***	0.045***	0.047***	0.043***	0.045***	0.042***
	(3.24)	(3.42)	(3.32)	(3.31)	(3.44)	(3.21)
Constant	2.272***	1.945***	2.196***	3.330***	1.921***	3.005***
	(4.27)	(3.75)	(4.14)	(2.99)	(3.59)	(3.41)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	No	No	No	No	No
Observations	115,574	115,574	115,574	104,481	115,574	112,851
R-squared	0.902	0.904	0.902	0.903	0.904	0.904

Table 2. Continued

Panel B. Panel Regression Results of Bond Yields with Securities Lending Variables with Bond Fixed Effects

	(1) Yield	(2) Yield	(3) Yield	(4) Yield	(5) Yield	(6) Yield
AllFees	-0.210***				-0.246***	-0.140***
	(-3.64)				(-4.34)	(-3.22)
Utilization		-0.280***			-0.291***	-0.250***
		(-4.65)			(-4.89)	(-3.85)
RelSupply			-0.895***			
			(-5.39)			
Feespread				-0.014**		
				(-2.07)		
Allfees*Uti						-0.463***
						(-3.38)
Logttm	1.205***	1.148***	1.206***	1.176***	1.147***	1.148***
	(12.04)	(12.08)	(12.42)	(11.70)	(12.04)	(11.92)
Ontherun	0.130*	0.098	0.072	0.113	0.102	0.110
	(1.92)	(1.50)	(1.03)	(1.54)	(1.55)	(1.64)
Constant	0.843***	1.109***	0.955***	0.959***	1.131***	1.115***
	(3.30)	(4.54)	(3.76)	(3.65)	(4.63)	(4.51)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115,574	115,574	115,574	104,481	115,574	112,851
R-squared	0.929	0.930	0.930	0.928	0.930	0.930

Table 3. Explaining Yields across Various Maturity Buckets

The dependent variable, *Yield*, is the daily yield-to-maturity, calculated based on the daily closing mid prices from Bloomberg, following market conventions. The explanatory variables based on securities lending market activity (*AllFees*, *Utilization*, *RelSupply*, and *Feespread*) and the time variant bond characteristics (*LogTTM*, and *Ontherun*) are defined in Table 2. The coefficient estimates with the corresponding t-stats (in parentheses) are reported from panel regression with year fixed effect and bond fixed effects, allowing for the clustering of the standard errors at the bond level.

Panel A. Explaining the Yields across Various Maturity Buckets with Securities Lending Fees

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
	TTM<1	**1<TTM<2**	**2<TTM<5**	**5<TTM<10**	**TTM>10**
	Yield	**Yield**	**Yield**	**Yield**	**Yield**
AllFees	-0.826**	-0.265**	-0.435***	-0.142**	-0.217***
	(-2.40)	(-2.39)	(-3.44)	(-2.41)	(-3.82)
LogTTM	1.004**	0.974***	2.373***	4.776***	5.371***
	(2.57)	(3.78)	(9.88)	(12.45)	(12.09)
Ontherun		-0.120	0.134**	0.104	0.172***
		(-0.78)	(2.52)	(1.54)	(3.16)
Constant	1.236***	1.237***	-1.618***	-8.561***	-13.690***
	(2.70)	(2.83)	(-2.84)	(-8.49)	(-9.29)
Observations	9,898	19,324	32,542	29,256	24,554
R-squared	0.973	0.970	0.956	0.949	0.938

Panel B. Explaining the Yields across Various Maturity Buckets with Utilization rate

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
	TTM<1	**1<TTM<2**	**2<TTM<5**	**5<TTM<10**	**TTM>10**
	Yield	**Yield**	**Yield**	**Yield**	**Yield**
Utilization	0.208*	0.084	-0.117*	-0.087	0.151**
	(1.67)	(1.00)	(-1.67)	(-1.57)	(2.54)
LogTTM	1.043**	0.953***	2.401***	4.734***	5.477***
	(2.54)	(3.75)	(9.86)	(12.64)	(12.53)
Ontherun		-0.050	0.117**	0.101	0.175***
		(-0.31)	(2.19)	(1.47)	(3.27)
Constant	0.972*	1.178**	-1.647***	-8.435***	-14.117***
	(1.85)	(2.58)	(-2.88)	(-8.58)	(-9.73)
Observations	9,898	19,324	32,542	29,256	24,554
R-squared	0.972	0.970	0.955	0.949	0.938

Table 3. Continued

Panel C. Explaining the Yields across Various Maturity Buckets with Relative Supply

	(1) TTM<1 Yield	(2) 1<TTM<2 Yield	(3) 2<TTM<5 Yield	(4) 5<TTM<10 Yield	(5) TTM>10 Yield
RelSupply	0.155	0.071	-0.241	-0.624***	-0.252***
	(0.32)	(0.18)	(-1.32)	(-3.86)	(-3.61)
LogTTM	1.026**	0.965***	2.406***	4.701***	5.460***
	(2.52)	(3.69)	(9.86)	(12.88)	(11.61)
Ontherun		-0.095	0.118**	0.073	0.156***
		(-0.61)	(2.18)	(1.07)	(2.86)
Constant	1.075**	1.195***	-1.690***	-8.312***	-13.939***
	(2.17)	(2.66)	(-2.94)	(-8.71)	(-9.00)
Observations	9,898	19,324	32,542	29,256	24,554
R-squared	0.972	0.969	0.955	0.949	0.938

Panel D. Explaining the Yields across Various Maturity Buckets with Fees and Utilization Interaction

	(1) TTM<1 yield	(2) 1<TTM<2 yield	(3) 2<TTM<5 yield	(4) 5<TTM<10 yield	(5) TTM>10 yield
AllFees	0.046	-0.208	-0.212*	-0.054	-0.144***
	(0.06)	(-1.33)	(-1.75)	(-1.42)	(-5.15)
Utilization	0.335*	0.104	-0.069	-0.027	0.177**
	(1.70)	(1.15)	(-0.87)	(-0.55)	(2.69)
Allfees*Uti	-1.650*	-0.126	-0.534	-0.464***	-0.441**
	(-1.73)	(-0.56)	(-1.59)	(-3.13)	(-2.23)
LogTTM	0.994**	0.964***	2.371***	4.723***	5.426***
	(2.61)	(3.81)	(9.98)	(12.60)	(12.37)
Ontherun		-0.063	0.120**	0.107	0.181***
		(-0.39)	(2.32)	(1.56)	(3.47)
Constant	1.058**	1.206***	-1.579***	-8.406***	-13.946***
	(2.06)	(2.70)	(-2.83)	(-8.56)	(-9.56)
Observations	9,898	19,324	32,542	29,256	24,554
R-squared	0.974	0.970	0.956	0.949	0.938

Table 4. The Impact of Regulatory Reporting on the Securities Lending Market

The dependent variables are the value-weighted average fee in percentage in the treasury securities lending market (*Allfees*) in Models 1A and 2A and the relative available supply as the ratio of the total supply and total outstanding issue amount (*RelSupply*) in Models 1B and 2B. The key explanatory variable is the year end dummy variable, *Yrend*, which takes on the value of 1 for the last 5 calendar days of the year. The other bond characteristics control variables are defined in Table 1 and Table 2, the standard controls. Models 1A and 1B report the coefficient estimates with the corresponding t-statistics in parenthesis from a panel regression with year fixed effects and clustered standard errors at the bond level. Models 2A and 2B report the coefficient estimates with the corresponding t-statistics in parenthesis from a panel regression with year fixed effects and bond fixed effects and clustered standard errors at the bond level.

	(1A)	**(2A)**	**(1B)**	**(2B)**
	Allfees	**Allfees**	**RelSupply**	**RelSupply**
Yrend	0.017***	0.017***	-0.243*	-0.329*
	(3.79)	(3.51)	(-1.67)	(-1.94)
LogTTM	0.004	0.006	3.231***	0.254
	(1.38)	(0.49)	(8.89)	(0.21)
LogSize	0.011		3.016***	
	(0.64)		(4.97)	
Ontherun	0.012*	0.017*	-6.336***	-6.078***
	(1.67)	(1.96)	(-10.55)	(-8.64)
Coupon	0.001		0.594***	
	(0.27)		(2.82)	
Constant	-0.066	0.040	-23.472***	13.425***
	(-0.39)	(1.24)	(-3.89)	(3.97)
Time FE	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes
Observations	115,611	115,611	115,611	115,611
R-squared	0.098	0.150	0.230	0.388

Table 5. Summary Statistics of German Treasury Bond Auctions from July 3, 2006 to June 1, 2015.

VWaveprice (*Lowestprice*) is the value weighted-average price (the lowest accepted bid price) at the initial auction, as reported by the German Finanzagentur based on €100 notional amount. *Bid-to-cover ratio* is the ratio of total bid value to the overall issued amount. Coupon rate is (*Coupon*). Ages is measured as the natural logarithm of the number until the maturity date (*LogAge*). *BenchmFee10d* is the average fee based on the last 10 trading-day data of similar securities, which are bonds within the same maturity bucket as the new issuance, and with the same coupon rate. *BenchmUti10d* is the average utilization rate based on the last 10 trading-day data of similar securities. *BenchmFeespread* is the average fee spread based on the last 10 trading-day data of similar securities. Similar securities are defined as other German treasury bonds within the same maturity bucket as the new issuance, and with the same coupon rate. Our maturity buckets are 0-1 year, 1-2 years, 2-5years, 5-10 years, and above 10 years. Appendix B provides definitions of the variables.

Variables	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
VWaveprice	296	100.761	4.053	87.920	138.250
Lowestprice	296	100.736	4.033	87.860	138.120
Bid-to-cover ratio	296	1.663	0.387	1.000	4.000
Coupon	296	1.965	1.437	0.000	4.750
LogAge	296	1.682	0.850	0.693	3.401
BenchmFee10d	296	0.095	0.042	0.007	0.249
BenchUti10d	296	0.534	0.113	0.203	0.756
BenchSupply10d	296	0.109	0.035	0.045	0.247
BenchmFeespread	296	0.038	0.004	0.025	0.054

Table 6. Predicting Average Price Outcome at Auctions

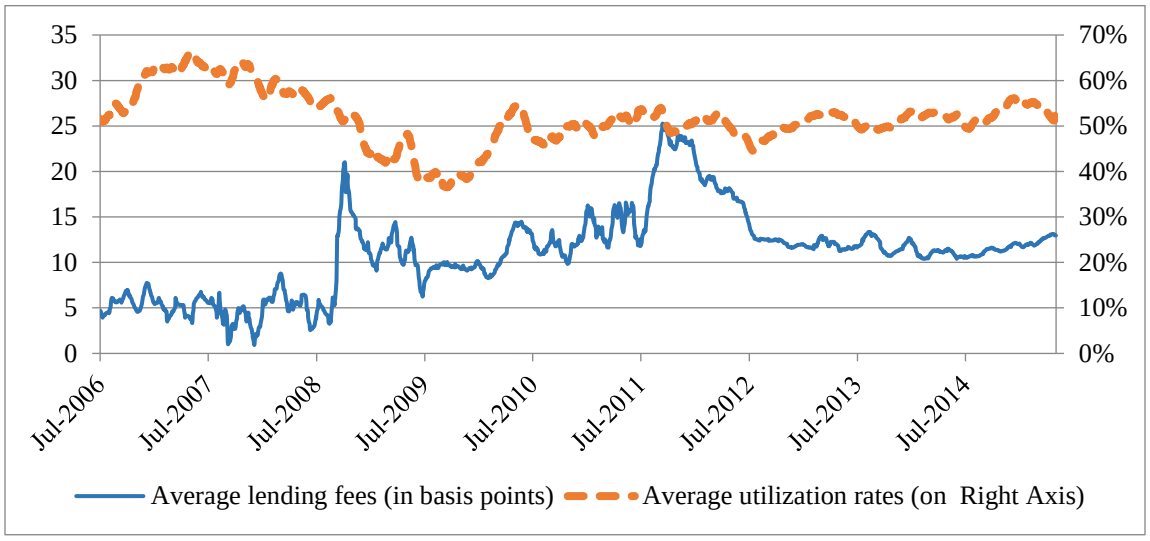
The table reports the results of the event study analysis of auction outcomes, controlling for benchmark securities lending market variables and bond characteristics. Variables are provided in Table 5 and Appendix B. The reported t-statistics are based on clustering of the standard errors throughout all models, and asterisks denote the conventional significance levels.

Panel A. Predicting Average Price at Primary Auction

	(1) VWaveprice	(2) VWaveprice	(3) VWaveprice	(4) VWaveprice	(5) VWaveprice	(6) VWaveprice
BenchmFee10d		27.386***			26.765***	86.774***
		(2.97)			(2.83)	(3.38)
BenchUti10d			-5.013*		-4.714*	7.703***
			(-1.97)		(-1.71)	(4.15)
BenchSupply10d				17.206***		
				(6.66)		
BenchFee*BenchUti						-118.697***
						(-3.34)
LogAge	-0.948	-1.186*	-1.011	-1.412*	-1.240	-1.094
	(-1.33)	(-1.74)	(-1.21)	(-1.73)	(-1.53)	(-1.38)
Coupon	2.840**	3.107**	2.678**	2.892**	2.950***	2.832***
	(2.22)	(2.74)	(2.30)	(2.17)	(2.87)	(2.84)
Constant	91.235***	89.358***	94.692***	89.638***	92.652***	86.225***
	(28.19)	(29.23)	(67.01)	(27.81)	(77.53)	(30.18)
Observations	296	296	296	296	296	296
R-squared	0.289	0.324	0.303	0.300	0.337	0.348

Panel B. Predicting Lowest Auction Price at the Primary Auction

	(1) Lowestprice	(2) Lowestprice	(3) Lowestprice	(4) Lowestprice	(5) Lowestprice	(6) Lowestprice
BenchmFee10d		27.156***			26.542***	85.899***
		(2.98)			(2.84)	(3.40)
BenchUti10d			-4.963*		-4.666	7.616***
			(-1.94)		(-1.69)	(4.20)
BenchSupply10d				16.940***		
				(6.84)		
BenchFee*BenchUti						-117.409***
						(-3.35)
LogAge	-0.978	-1.214*	-1.040	-1.434*	-1.267	-1.122
	(-1.36)	(-1.76)	(-1.23)	(-1.75)	(-1.55)	(-1.40)
Coupon	2.837**	3.103**	2.678**	2.889**	2.947***	2.831***
	(2.22)	(2.73)	(2.30)	(2.17)	(2.86)	(2.84)
Constant	91.265***	89.404***	94.687***	89.693***	92.664***	86.308***
	(28.32)	(29.37)	(67.75)	(28.04)	(78.45)	(30.67)
Observations	296	296	296	296	296	296
R-squared	0.288	0.323	0.302	0.299	0.335	0.346



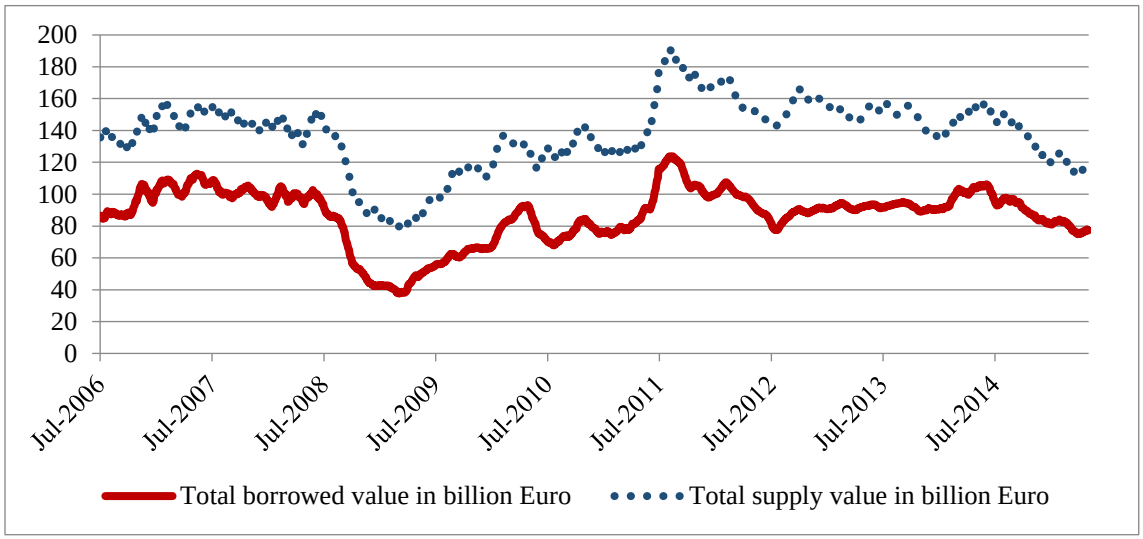
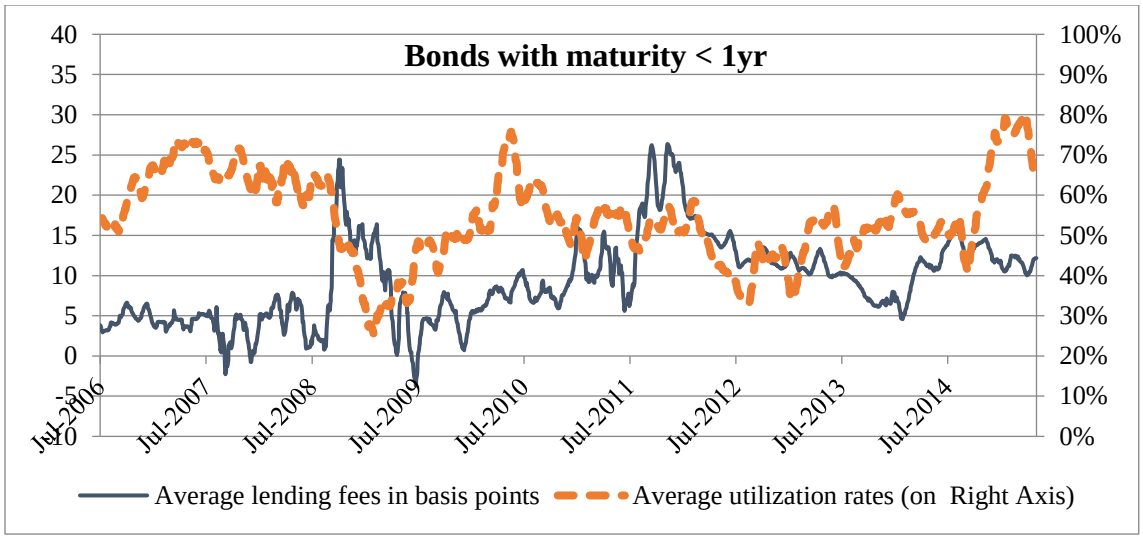
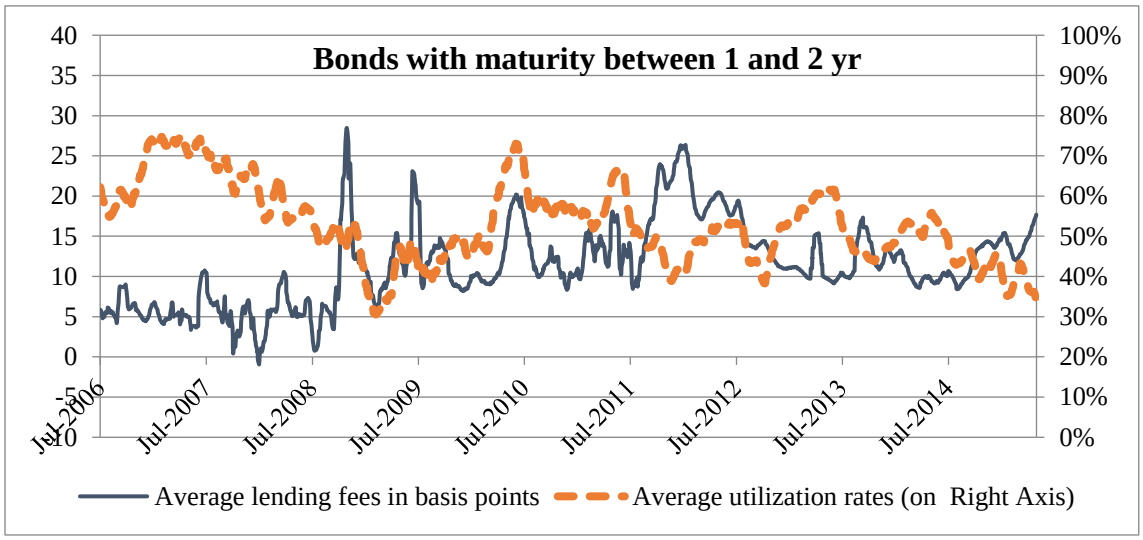


Figure 1. Time-series of Average Lending Market Variables for German Sovereign Bonds

The figures depict the time-series of average lending market variables for German sovereign bonds from July 2006 to June 2015. The top panel shows the time-series of the monthly moving average lending fee and utilization rates across all available German bonds, while the bottom panel depicts the aggregate shorted value and supply value in the market in billions of euros.


Bonds with maturity < 1yr
40
35
30
25
20
15
10
5
0
-5
-10
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jul-2006
Jul-2007
Jul-2008
Jul-2009
Jul-2010
Jul-2011
Jul-2012
Jul-2013
Jul-2014
Average lending fees in basis points
Average utilization rates (on Right Axis)


Bonds with maturity between 1 and 2 yr
40
35
30
25
20
15
10
5
0
-5
-10
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jul-2006
Jul-2007
Jul-2008
Jul-2009
Jul-2010
Jul-2011
Jul-2012
Jul-2013
Jul-2014
Average lending fees in basis points
Average utilization rates (on Right Axis)

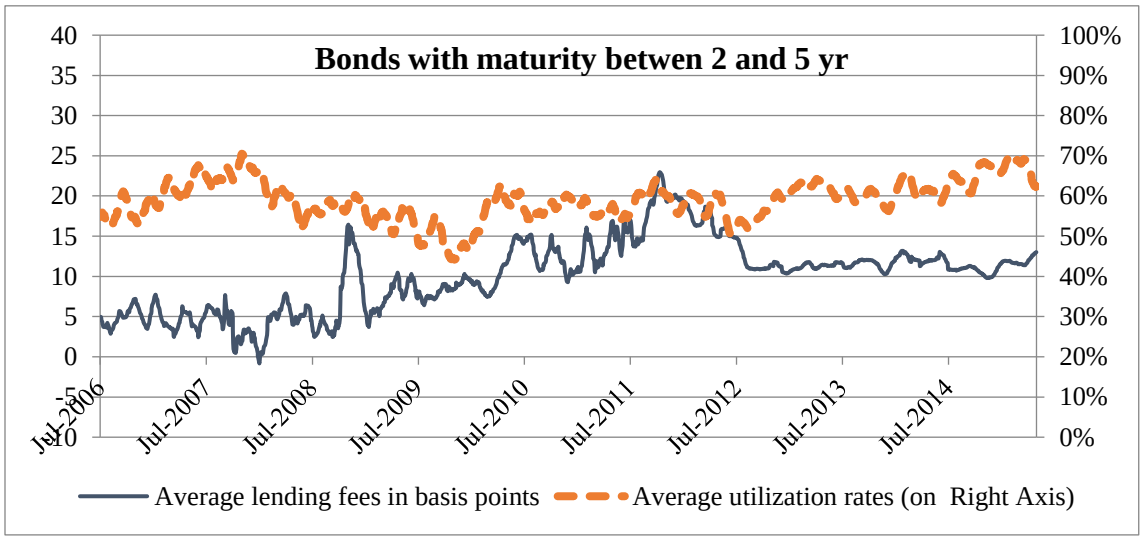
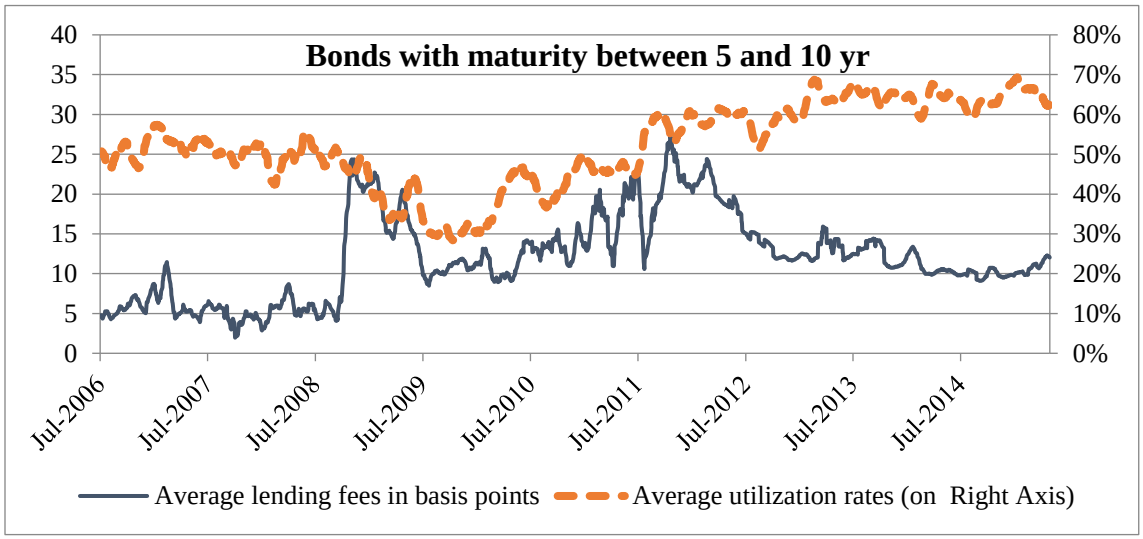

Bonds with maturity betwen 2 and 5 yr
40
35
30
25
20
15
10
5
0
-5
-10
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jul-2006
Jul-2007
Jul-2008
Jul-2009
Jul-2010
Jul-2011
Jul-2012
Jul-2013
Jul-2014
Average lending fees in basis points
Average utilization rates (on Right Axis)

Figure 2. Time-series of Average Lending Fees and Utilization Rates for German Sovereign Bonds with Maturity Less Than 5 Years



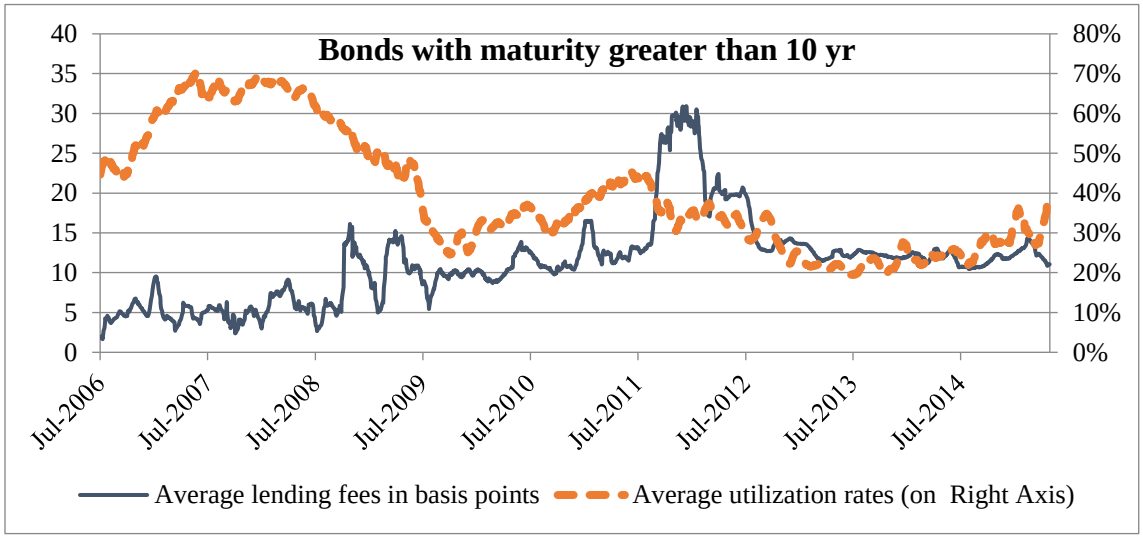
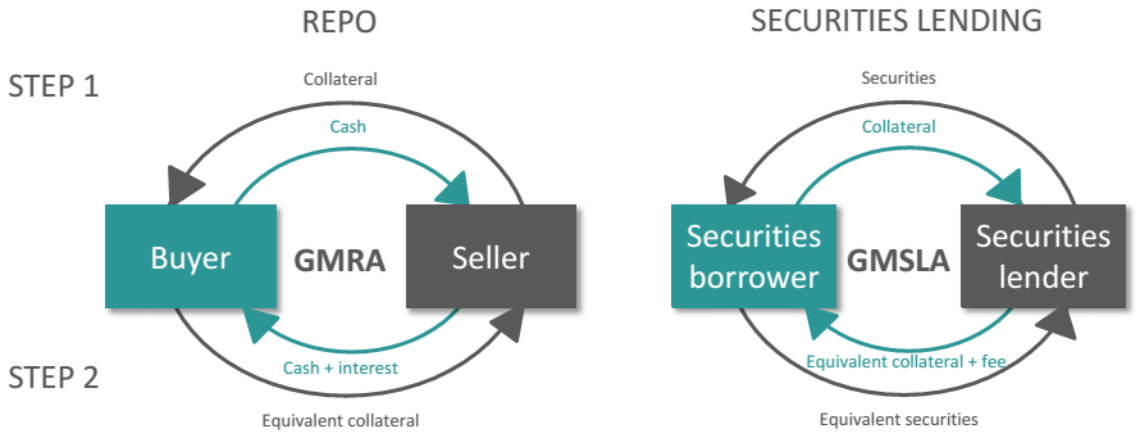


Figure 3. Time-series of Average Lending Fees and Utilization Rates for German Sovereign Bonds with Maturity Longer Than 5 Years

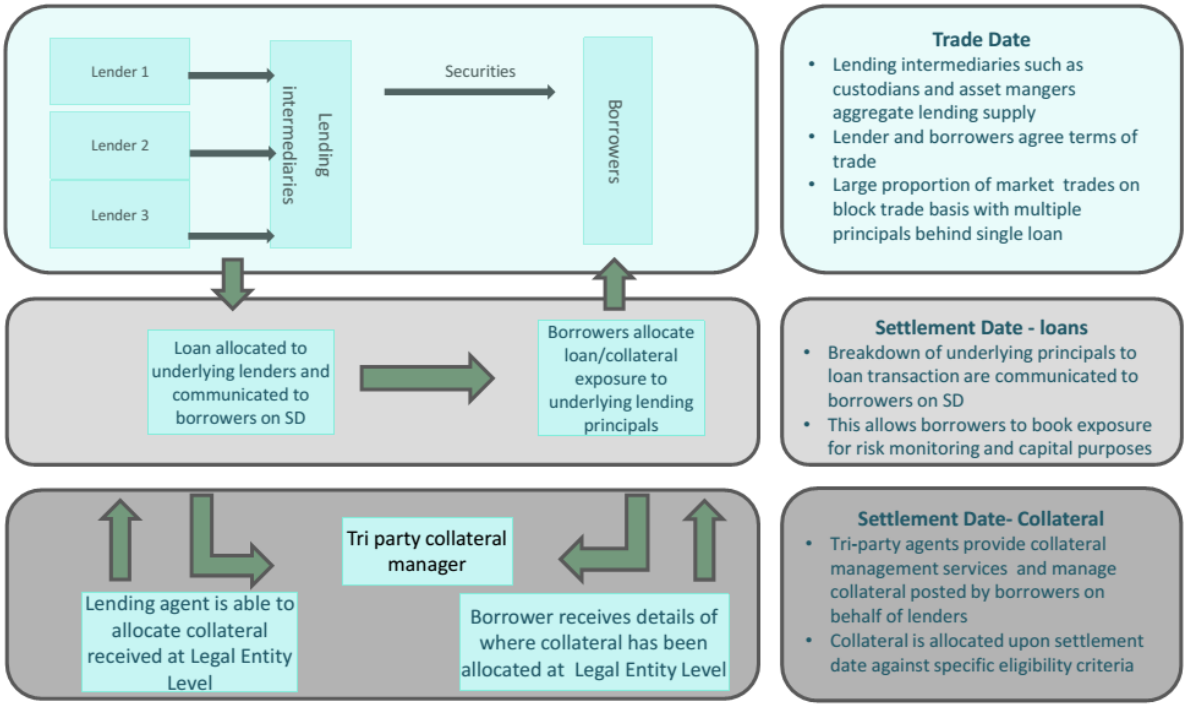
Appendix A. Overview of Fixed Income Securities Lending Transactions

Panel A: Legal Framework for Repo and Securities Lending: Global Master Repurchase Agreement versus Global Master Securities Lending Agreement



- Repo is predominantly used by banks. Institutional investors use repo to invest cash on a secured basis.
- Securities lending is predominantly used by institutional investors with banks acting as intermediaries.
- In each step asset transfers occur under legal agreements using EU Title Transfer Collateral Arrangements (TTCA).

Panel B: Securities Lending Loan and Collateral Flows from Trade to Settlement



Source: International Securities Lending Association (ISLA, 2016).

Appendix B. Description of Variables

Panel A. Key Variables for the Panel Data Analysis

Variables	Definition and explanation
Issue size (LogSize)	The *Issue size* is the total issue size in million euros as reported by the German Bundesbank at the time of issuance.
Coupon	The coupon rate is the annual percentage amount, as reported by the Bundesbank.
Ontherun	Ontherun is an indicator variable. It takes the value of one for the days when the specific security is on-the-run for its tenor, and is zero for all seasoned securities.
Yield or market yield	The *yield-to-maturity* is at the daily frequency and is calculated based on the daily closing secondary market mid prices from Bloomberg, following market conventions.
Time-to-maturity (TTM) and (Age)	*TTM* is the time-to-maturity of specific Germany treasury, measured in years and with 2-decimal accuracy. Age is the number of years since issuance, at the 2-digit accuracy.
Allfees	Allfees is the value-weighted average annualized lending fee, based on all outstanding contracts, as provided by the Markit database. The variable is reported in basis points.
RelSupply	RelSupply is the percentage of the total issuance volume available for borrowing. It is calculated as the total available supply reported by Markit Securities relative to the total issuance value. Since Markit reports the daily lent out value in USD, we convert the daily value into EUR, using the daily relevant exchange rates from the Statistical Warehouse of the ECB.
Utilization	Utilization is the percentage value of assets on loan from lenders, divided by the total lendable value.
Feespread	*Feespread* is the difference between the highest and the lowest fees on all outstanding borrowing contracts for a specific security.

Panel B. Key Variables for the Event Study Analysis

Variables	Definition and explanation
VWaveprice	*VWaveprice* is the value weighted-average price at the initial auction, as reported by the German Finanzagentur. The price, following international conventions, is based on a €100 notional amount, or the percentage of the bond face value.
Lowestprice	*Lowestprice* is the lowest bid price placed at the initial auction, as reported by the German Finanzagentur. The price, following international conventions, is based on a €100 notional amount, or the percentage of the bond face value.
BenchmFee10d	*BenchmFee10d* is the average fee, based on the last 10 trading-day data of similar securities, which are bonds within the same maturity bucket as the new issuance, and with the same coupon rate. Our maturity buckets are 0-1 year, 1-2 years, 2-5years, 5-10 years and above 10 years.
BenchmSupply10d	*BenchmSupply10d* is the average relative supply based on the last 10 trading-day data of similar securities, where the relative supply is the percentage of issuance value available for borrowing in the securities lending market. Similar securities are bonds within the same maturity bucket as the new issuance, and with the same coupon rate. Our maturity buckets are 0-1 year, 1-2 years, 2-5years, 5-10 years and above 10 years.
BenchmUti10d	*BenchmUti10d* is the average utilization rate across bonds with the same maturity bucket as the new issuance, based on the last 10 trading-day data, where the maturity buckets are 0-1 year, 1-2 years, 2-5years, 5-10 years and above 10 years.

Appendix C. Overview of the German Treasury Market

Primary Market of German Sovereign Bonds

The German Finance Agency has been responsible for issuing German Federal securities on behalf of the German government, since June 2001. German sovereign bonds are not only highly liquid; they also carry small issuer risk and managed to preserve their AAA rating throughout the Euro crisis. The German Government issues various maturity instrument, such as 6 and 12-month maturity treasury discount papers, 2-year maturity Federal treasury notes (Schaetze); five-year maturity Federal notes (Bobls) and 10 and 30-year maturity Federal bonds (Bunds). The two-year notes account (Schaetze) for 9% of the outstanding German public debt and about 11% of the total trading volume while the five-year notes (Bobls), account for one fifth of the outstanding tradable German sovereign debt value and constitute to about 17% of the overall trading volume. The 2-year, 5-year, 10-year, and 30-year treasuries account for about 90% of all German tradable government debt and 70% of the total issuance (German Finance Agency, 2015). Thus, any study that includes these assets provides a representative picture of the German government debt market and the benchmark interest rate in Europe.

The German Finance Agency (Treasury) reports that 90% of the funding needs of the Federal Government are covered by placing issues to primary dealers in the form of single issues via auctions. Primary dealers are financial institutions approved by the Finance Agency and admitted to the Bund Issues Auction Group. In principle, any credit or securities trading institution or investment firm domiciled in the EU can become a member of the Auction Group. The membership comes with rights and obligations. Specifically, members must bid a specific amount of each issue. The auctions take place according to the issuance calendar announced at the end of each year for the following calendar year. These annual previews include detailed information on the forthcoming issuances: including the type of the security to be issued, the day of the issuance, maturity date, and targeted nominal issuance amount. Such high level of transparency and detailed schedule makes the German Government a globally recognized and reliable issuer.

All regularly issued capital market securities are issued in a tender process, where members of the Bund Issues Auction Group participate in a multiprice auction process. As such, the bids are allotted at the price specified in the bid, not at a single price. Bids that are above the lowest accepted bid are allotted in full. At the end of the auction, the allotted amounts are published in the Bund Bidding System, and shortly after the information becomes publicly available. For each auction, the government retains a certain amount of the nominal volume issued, which is gradually

introduced into the secondary market following the tender. Moreover, for some issues, auctions are also followed by multiple reopenings, which aim to facilitate liquidity in the market and the delivery of futures contracts on these bonds.

Secondary Market of German Sovereign Bonds

All German capital market securities are traded on stock exchanges, international electronic trading platforms, and OTC. They are quoted by market makers throughout the trading day, and at the tightest bid-ask spreads of all euro-denominated sovereign debt securities. Quotes are at a voluntary basis; thus, no artificial liquidity or market depth are created. According to the statistics of the Finance Agency, the average yearly trading volume of capital market securities was EUR 5.7 trillion between 2006 and 2015. This, for 2015, an average nominal volume of EUR 1.1 trillion was in circulation, which implies that this amount has turned over 4-6 times every year for the same period. The corresponding daily trading volumes were in the magnitude of EUR 19 billion. The liquidity of German bonds is supported by futures contracts traded on the Eurex. While future contracts are available on most Bundesbonds, with 2-, 5-, 10- and 30-year maturities, the most liquid products are those linked to 10-year Federal Bunds with a turnover of 177 million contracts traded yearly, in the volume of EUR 27 trillion in 2015.

The securities that are retained at the auctions are mostly sold in the secondary market, to collateralize repos or interest swaps or to be used in securities lending. Next to providing additional liquidity and facilitating delivery of specific securities, the Finance Agency and the Deutsche Bundesbank (German National Bank) also act as market makers on the different platforms, where German public debt is traded. Nevertheless, the Agency and the Bundesbank aim to minimize the price impact of their secondary market transactions.

According to the information supplied by a representative sample of primary dealers, most trading activity of German debt securities takes place between European and Euro area counterparties. Looking at the institutional shares of trades, the Finance Agency reports that the most important parties are brokers, asset managers, and banks, with a slight increase in hedge fund and decrease in central bank transactions.