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(When) Does transparency hurt liquidity?

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(When) Does Mandatory Disclosure Hurt Liquidity?*

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Abstract

Conventional wisdom suggests that increases in public information improve market liquidity. However, if greater public information incentivizes only sophisticated investors to produce private information, it could exacerbate information asymmetry among investors and thus reduce liquidity. We explore this argument on a sample of mortgage-backed securities (MBSs) by using a recent European regulation that mandates complex disclosures about the individual loans underlying MBSs. We find that the liquidity of the debt tranches of disclosed MBSs *declines* by 23% post-regulation. Our inferences are stronger when the securities are harder to value and when the disparity in investor sophistication is higher. In contrast to these findings, we also find that the disclosures *increase* the liquidity of the equity tranches of the same MBSs. Overall, our evidence implies that the liquidity impact of enhanced public information varies with the nature of the asset in question; this effect is likely a function of the investors' incentives for information production and price discovery.

JEL classification: G10, G21, G23, G28.

Keywords: liquidity, disclosure, regulation, securitization, information sensitivity, MBS, ABS

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1. Introduction

This study examines the impact of public information on the secondary-market liquidity of information-insensitive securities. A financial asset is said to be information-insensitive if investors' incentives to produce private information about the asset are low and if it is common knowledge that producing such private information is unprofitable. Information-insensitivity is critical for debt markets that aim at funding—such as repos, treasuries, asset-backed commercial papers, and asset-backed securities (ABSs)—rather than markets that aim at price discovery—such as stock markets. This is because information-insensitivity allows financial institutions and corporations to execute large trades quickly without undertaking costly information-gathering efforts. In turn, preserving liquidity in these markets is of paramount importance for the stability of debt funding, and thus, the well-functioning of financial systems (e.g., Gorton, 2012; Gorton and Metrick, 2012).

Meanwhile, following the global financial crisis, many observers called for regulations that increase the quantity and quality of public information in funding markets, especially in the securitization domain (Jackson, 2010; Gilson and Kraakman, 2014).[1] These developments have sparked a significant debate on the effects of disclosures in the financial sector (e.g., Goldstein and Sapra, 2014; Acharya and Ryan, 2016; Dang et al., 2019). Our study attempts to contribute to this debate by answering the following high-level questions: How does greater public information about the fundamentals of the underlying assets affect the liquidity of information-insensitive securities in debt funding markets? Given that mandatory disclosures increase public information, can disclosure regulation be used as a tool to facilitate trading in these markets?

[1] These regulations include all-encompassing rules like the Dodd−Frank Act and the Pillar 3 of the Basel Accord. More specifically, the following regulations aim to enhance public information in securitization markets:

Reg. AB II: https://www.sec.gov/oit/announcement/regabii-asset-level-requirements-compliance.html.

ECB LLD Initiative: https://www.ecb.europa.eu/paym/coll/loanlevel/html/index.en.html.

E.U. Reg.: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2402&from=en.

Prior analytical work articulates how enhanced public information improves liquidity by reducing information asymmetry among investors for equity securities (e.g., Verrecchia, 1983; Diamond, 1985; Diamond and Verrecchia, 1991). Supporting this view, the empirical literature documents a positive association between public information and liquidity in stock markets (e.g., Balakrishnan et al., 2014).

However, it is unclear whether what we know based on equity markets can be carried over to debt funding markets. We make this argument because, in contrast to equity markets, in which active price discovery is essential, debt funding markets obviate the need for active information collection by relying on over-collateralization. In other words, as collateralized debt is in-the-money in most cases, investors do not generate private information to assess the specific value of the collateral, to estimate default risk, and to discover prices. Due to this feature, debt funding markets operate smoothly without extensive public information about the fundamentals (Holmstrom, 2015). However, disclosing detailed and complex information about the collateral could hurt the trading of these securities. This thesis is in the spirit of the recent theoretical work, in particular, Dang et al. (2015), who argue that public disclosure of (complex) information about the underlying collateral reduces the liquidity of information-insensitive securities. This is because complex public information incentivizes sophisticated investors, who can process such information with relatively low costs, to generate private information about the likelihood of default of debt in order to make profitable trades. In turn, unsophisticated investors, for whom such private information production remains too costly, face a typical adverse selection problem and decide to pull out of the market, which leads to a dry up in liquidity.[2, 3]

[2] Even if greater public information does not actually trigger sophisticated investors to generate private information, it could still alter the beliefs of unsophisticated investors. The fear of adverse selection itself could induce unsophisticated traders to pull out of the market.

[3] Kim and Verrecchia (1994) make a similar argument in the context of equity markets. However, their theory does not directly apply to our study because as it deals with information-sensitive securities. Furthermore, the evidence we report for equity tranches in our paper is inconsistent with the Kim and Verrecchia (1994) narrative.

To empirically investigate our research question, we explore the debt tranches of residential mortgage-backed securities (MBSs).[4] Our focus is on the European MBSs, which are economically important and provide a suitable setting to study our research question—we need securities that are information-insensitive and used in funding markets.[5] Importantly, the European MBSs have gone through a significant disclosure regulation, which we utilize to explore our research question. In particular, we focus on the European Central Bank's (ECB) Loan-level Disclosure (LLD) Initiative of 2013, which mandated that banks provide periodic and detailed disclosures on individual loans underlying the MBSs that the banks pledge as collateral to the ECB in their repo borrowings. The ECB LLD Initiative has substantially expanded investors' information set about the fundamentals of the loans underlying MBSs. Entailing more than a hundred data fields for tens of millions of loans, these periodic disclosures are complex to process. It is possible that they allow certain players in the market to gain advantages over others.[6]

From an identification standpoint, the disclosure requirements are enacted in the form of an ECB regulation, and they are independent of individual banks' decisions to seek ECB funding as banks were in the ECB repo-financing program prior to the disclosure initiative.[7] Moreover,

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[4] We focus on MBSs because MBSs are by far the largest asset class among all types of ABSs (in our data, MBSs constitute over 95% of ABSs with secondary-market liquidity information).

[5] One feature that makes MBSs suitable for our study is the trading structure. Specifically, trading in these markets takes place over the counter, where traders call each other to buy and sell securities. To execute these bilateral transactions, investors make strategic trading decisions that directly affect liquidity. Further, this over-the-counter, highly opaque, and bilateral trading structure precludes unsophisticated investors from observing and mimicking the trades of sophisticated investors

Another interesting advantage that the European MBS market offers is the nature of risk. Specifically, since the underlying assets of MBSs in Europe are largely adjustable-rate mortgages, the key risk for these products is default risk as against prepayment risk—the latter being more relevant for U.S. MBSs. We note that investors' use of disclosures to ascertain default risk, rather than prepayment risk, more closely captures existing theories, which critically depend on the notion of default risk (e.g., Dang et al., 2015).

[6] For instance, most banks and insurance companies employ ABSs mainly for short-term funding and for safe investments. Consequently, these entities do not prioritize or invest in processing detailed information on the underlying assets. Professional money managers, such as hedge funds, however, are incentivized to actively process the detailed information to produce private information that allows them to make profitable trades. Consistently, our conversations with the data provider suggest that the data is used only by some institutional investors.

[7] The regulation applies to all Eurozone banks; however, banks are affected only if they borrow from the Eurosystem and pledge their ABSs as collateral. While banks' decisions to obtain central-bank financing and to pledge ABSs as collateral are not made in a vacuum, the disclosure requirements apply to banks that were already

the rules apply to individual securities, rather than banks, which allows us to perform our tests within bank-time and thereby remove the effect of confounding factors at the bank level even if they are time-varying (e.g., banks' lending practices, risk profiles, managerial talent). We should also highlight that this initiative focuses purely on disclosure, which provides a cleaner setting than alternative, broad and multifaceted regulatory shocks to banks, such as the adoption of Basel rules and the Dodd–Frank Act.

We conduct our analysis on a sample of 40,033 security-months pertaining to 1,713 distinct debt tranches from 2011 to 2014.[8] We perform a series of difference-in-differences analyses that examine changes in the liquidity of MBSs over the four-year window surrounding the implementation date of the ECB LLD Initiative (January 2013), i.e., two years before and after the passage of the regulation. Measuring liquidity is a challenging task, especially in the MBS market, due to limited data and over-the-counter trading structure of these markets. To capture the different attributes of liquidity comprehensively, we construct a composite proxy of liquidity (Schestag et al. 2016). Specifically, we use the first principal component analysis of the following three measures: (*i*) the implicit bid-ask spread based on Fong et al. (2017), (*ii*) the negative auto-covariance of prices based on Roll (1984), and (*iii*) the number of trading days without a trade divided by the total number of trading days in a month, as used in prior literature (Lesmond et al., 1999; Chen et al., 2007; Adrian et al., 2017).[9]

We find that the mandatory disclosure reduces liquidity in the secondary MBS markets: Treatment MBSs (i.e., the securities whose collateral is disclosed under the regulation) exhibit a

in the ECB repo financing program. Further, we find no evidence suggesting that banks drop out of the repo scheme or cherry-pick ABSs to pledge to avoid the disclosure requirements. In other words, in a difference-in-differences sense, endogenous selection at the time of the disclosure regulation is muted. See Section 2.

[8] In an ABS deal, the cash flows from the underlying collateral (e.g., mortgage loans in an MBS) are used to pay the tranches. Tranches have distinct ISINs, and they are the securities traded. Accordingly, the unit of observation in our tests is an ISIN-month, and we use tranche, ISIN, and security interchangeably.

[9] We note that the individual metrics comprising our composite measure has advantages and shortcomings and that our PCA-based proxy is likely to provide comprehensive evidence. However, for completeness and robustness, we examine the individual components and find similar results.

decrease in liquidity by 0.321, relative to control MBSs, over the two years after the ECB LLD Initiative. For context, our main measure of liquidity has a sample standard deviation of 1.397, which suggests a marginal effect of about 23%. Further, our estimation results are consistent across models that include various controls and fixed effects, including two-dimensional lender-time and tranche-class-time fixed effects.[10] We observe similar pre-regulation trends in the liquidity of disclosed and non-disclosed securities, which adds credibility to our difference-in-differences approach.[11]

To shed light on the mechanisms at work and to elaborate on our baseline findings, we explore two key economic constructs. First, we examine valuation difficulty. Our main effect should be stronger for MBSs that are harder to value because, for such securities, loan-by-loan disclosures would be processed more differently amongst existing investors and, hence, result in greater adverse selection problems. Our empirical proxy for this notion is return volatility, in that securities with above-median return volatility are coded as harder-to-value (Shalen, 1993). In keeping with our prediction, we find that the liquidity-reducing effect of the mandatory disclosure doubles for securities that are harder to value.

Second, we investigate the disparity in investors' information-processing costs. This dimension allows us to ascertain the role of the adverse selection perceived by MBS investors in the illiquidity effect of disclosures. After all, public information should not hurt liquidity if all

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[10] Lender-time fixed effects allows us to hold constant the originator's attributes even if they are time-varying. Tranche-class-time fixed effects control for potential differences in liquidity by tranche classes (e.g., senior tranches are typically traded less often than junior tranches).

[11] In an additional robustness test, we examine ultra-safe, super-senior tranches (tranche class "A1" only). These securities almost never experience losses and thus are hardly susceptible to adverse selection concerns. In keeping with deep-in-the-money securities remaining information-insensitive even after the disclosure regulation, we observe no changes in the liquidity of these securities. We note that, in addition to validating our arguments regarding information sensitivity, the zero-effect finding for ultra-safe tranches also adds credibility to our claim that liquidity decreases because of enhanced public information—not due to another aspect of the disclosure regulation. If different classes of tranches were affected by the disclosure regulation in ways other than an increase in public information (for example, if the LLD Initiative mechanically triggered a disproportionate increase in the pledging of disclosed securities), we would find even stronger illiquidity effects for ultra-safe tranches, as these tend be pledged much more often (they require a smaller collateral haircuts). As noted, however, our inferences suggest otherwise. We discuss this issue further in Section 2.

investors perceive a level playing field for information gathering and processing. That is, when the holders of an MBS have similar levels of sophistication in processing the information, disclosures would not induce investors to leave the market because all of them are equally adept at processing information. Consistent with this prediction, we find that loan-level disclosures do not impair the liquidity of MBSs whose investors have similar skills and expertise in processing the disclosed information. Conversely, our main conclusion that public information reduces liquidity holds for cases with high heterogeneity in investor sophistication.

Our analyses focus on debt tranches, for which we report evidence consistent with the idea that an increase in public information reduces liquidity because it distorts the information-insensitivity of these securities by triggering private information production by a subset of investors. However, as noted above, in equity market settings, the literature consistently finds that greater public information enhances liquidity. Accordingly, in the last part of our study, we take advantage of a unique aspect of MBSs—tranche seniority—to explore this puzzling disparity. We re-estimate our tests for equity tranches and, strikingly, find that the same disclosure regulation *increases* the liquidity of these securities. This inference is in line with the notion that equity tranches—which are already information sensitive and whose investors seek price discovery—experience a reduction in adverse selection post-disclosure-regulation. Aside from reconciling ostensibly contradictory conclusions, this finding also underscores the importance of the existing nature of the assets/markets in question (e.g., information-sensitivity, investor disparity, and valuation complexity) as a crucial factor contributing to the effect of mandatory disclosures and public information on liquidity.

Our paper contributes to several strands of the literature. Broadly speaking, our findings speak to the line of work that studies the link between disclosures and liquidity in capital markets. Prior work documents that voluntary disclosure increases short-term liquidity (e.g., Balakrishnan et al., 2014) and that liquidity dries up in the short window around/before the disclosure of backward-looking aggregate information, such as earnings announcements (e.g., Lee et al., 1993).[12] First, unlike the extant literature, our study focuses on debt securities where liquidity is more important than price discovery, and we also show completely different findings for equity instruments under the same disclosure regulation. Second, our evidence on sustained liquidity effects suggests that public disclosures can have consequences for the use of ABSs as a funding instrument. Public disclosures can cause investors to pull out of the market and transform the nature of an asset class. Lastly, in contrast to the prior work that focuses on disclosures that most investors can interpret with relatively low costs, such as earnings announcements, we examine complex disclosures that involve high processing costs. Our findings from this setting suggest that we may be able to classify public information by its processing costs to understand their liquidity effects. In this sense, these inferences speak to the economic consequences of disclosure regulation (Leuz and Wysocki, 2016).

From a specific disclosure standpoint, our study contributes to the literature that examines the costs and benefits of enhanced public disclosures in the financial sector (Goldstein and Sapra, 2014; Acharya and Ryan, 2016), more specifically, in the securitization domain. Neilson et al. (2019) show that Regulation AB II's disclosure requirements enhance the informativeness of yield spreads, i.e., the predictive ability of ABS spreads for subsequent performance. Schmidt and Zhang (2019) explore the effects of Regulation AB II on the auto-loan-backed securities. The authors find that trades become more concentrated around periodic disclosures as well as a long-term reduction in liquidity and an increase in yields. Overall, we view that Schmidt and Zhang's (2019) evidence from a distinct ABS setting complements our conclusions.

We also provide novel insights into the role of information-acquisition incentives and information sensitivity in the effect of public information on the liquidity of debt instruments.

[12] More recently, Amiram et al. (2016) report evidence that analyst forecasts reduce information asymmetry. Christensen et al. (2016) examine the impact of disclosure regulations on short-term liquidity in equity markets.

Our study thus provides a direct empirical test of the analytical arguments proposed by Dang et al. (2015), Holmstrom (2015), and Gorton (2017). Several recent papers also explore various aspects of this narrative.[13] In contrast to these papers, our study does not infer the effects of information but rather explicitly examines and plausibly exogenously identifies them. Moreover, we examine liquidity as the outcome variable. These key distinctions allow us to speak to the idea that public disclosures can make information-insensitive securities information-sensitive. To this point, we also note that the decline in liquidity persists over the two years post regulation. As Dang et al. (2019) evaluate in their discussion of our paper, this is a key contribution, as it is evidence that a structural change in the nature of an asset class—information-insensitive MBSs becoming information-sensitive and losing their ability to serve as a funding tool.

Finally, our findings should be of interest to regulators. To enhance transparency and thereby promote market discipline, regulators have enacted loan-level disclosure regulations for the ABS markets, including Regulation AB II under the Dodd-Frank Act in the U.S. and the Securitisation Regulation in the EU (i.e., Regulation 2017/2402). However, the influence of these far-reaching reforms on ABS market liquidity is not well explored or understood. Understanding the nature of liquidity provision and the effects of information on this is central to regulating the financial system. We believe that the insights we offer can facilitate regulators' decisions about asset-level disclosure regulations. In particular, we also caution that policies derived from stock markets may not produce the desired effects in funding markets (Dang et al., 2019).

[13] Gallagher et al. (2019) look at money market funds that invest in European bonds during the European debt crisis of 2011–2012. The authors find that sophisticated investors withdraw funding from information-sensitive issuers. Baghai et al. (2018) report evidence that the money market fund reform in the U.S. destroyed the money-ness of these securities. Brancati and Macchiavelli (2019) provide estimates on the amplification effect of information precision on banks' default risk. Benmelech and Bergman (2018) draw inferences about the information sensitivity of debt by showing a positive link between bond liquidity and price. Perignon et al. (2018) report similar conclusions from the rating downgrades in the European wholesale certificate of deposit market.

2. Institutional Background and Empirical Predictions

2.1. Overview of Securitization

Securitization allows lenders to obtain additional funding by packaging their illiquid loans and selling them as liquid notes to a broad set of investors. Moreover, lenders can use ABSs—especially MBSs—as collateral for short-term funding vehicles, such as repo and asset-backed commercial papers. Securitization also provides benefits to investors and borrowers. Investors of different risk appetites (mainly among institutions) can invest in a variety of securities. This is because securitization allows the production of both safer and riskier securities (in the form of senior and junior notes) for a pool of loans with similar risk—often medium creditworthiness. (Figure 1 depicts a typical securitization structure.) Borrowers can get credit at better rates since investors' demand for securitization products reduces the interest rates of the underlying loans. These benefits made securitization a key player in the middle 2000s.[14]

However, when housing prices fell, money market investors worried about the quality of ABSs and started a run on the shadow banking system (Gorton, 2010, 2012, 2017; Geithner and Metrick, 2018). These grave experiences during the recent financial crisis made it clear that securitization is not well understood or effectively regulated. Because of the significant and unexpected damages inflicted by securitization products, regulators and policymakers identified securitization—and its inherent opacity—as one of the main causes of the crisis. According to this view, the lack of transparency reduced originating banks' incentives to screen and monitor borrowers, which deteriorated loan quality. In addition, it has been argued that rating agencies provided inadequate risk assessments and securitization products were priced without accounting for key risk factors, such as correlated defaults.[15] As a response to these developments, a critical

[14] An extensive literature studies the benefits of securitization. Securitization practices unlock a substantial amount of funds for banks and make banks less vulnerable to cost-of-funding shocks (Loutskina, 2011). More generally, securitization can prevent the inefficient continuation of projects (Ayotte and Gaon, 2010).

[15] Prior literature reports evidence of banks' lower screening and monitoring efforts (e.g., Keys et al., 2010; Keys et al., 2012; Kara et al., 2015), although these problems do not necessarily apply to all types of securitization

item in the post-crisis agenda to reform securitization is to enhance transparency (Jackson 2010; Gilson and Kraakman 2014). In particular, asset-level disclosures have been a common theme in the post-crisis regulations around the globe.[16]

2.2. European MBS Market and the ECB's Loan-Level Disclosure Initiative

Institutionally, MBS markets are fundamentally different from equity markets. There is no organized exchange, no centralized reporting of transaction volumes, and no market makers. Rather, trading takes place over the counter, and transactions are often arranged and executed on the phone. Price discrimination is prevalent. While these features restrict data availability (compared to stock market trades), they make this very setting quite suitable to test whether mandatory disclosures could exacerbate information asymmetry among investors and thus reduce liquidity. This is because these markets had been inherently opaque and there have been limited alternative sources of information (including centrally advertised asset prices) that investors can rely on. Further, this over-the-counter, bilateral, and opaque trading structure precludes unsophisticated investors from observing and mimicking the trades of sophisticated investors.

In our paper, we focus on the European MBS market. There are two main reasons for this choice. First, European MBSs have institutional features that are potentially more suitable to test the proposition of whether enhanced public information triggers an increase in private information by a subset of investors. The loans underlying European MBSs are typically adjustable-rate

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(e.g., Benmelech et al., 2012). The problems in ratings and pricing are discussed in the U.S. Congress (https://democrats-oversight.house.gov/sites/democrats.oversight.house.gov/files/documents/20081022102221.pdf). See also "Shareholder Report on UBS's Write-Downs" (http://maths-fi.com/ubs-shareholder-report.pdf) for an insightful first-hand discussion of the practical issues.

[16] In November 2016, the U.S. adopted Regulation AB II, which requires the disclosure of underlying collateral mainly for real estate loan-backed and auto loan-backed securities. In Europe, such asset-level disclosures have been implemented in two phases. The ECB LLD Initiative, which took effect in 2013, applies to ABSs that banks pledge as collateral in ECB repo financing. The EU's Securitisation Regulation 2017/2402—which is yet to be implemented—extends this requirement to all European securitizations. Overall, these disclosure regulations aim to promote transparency, stability, and confidence in the ABS market by providing timely and sufficient information so that investors can monitor the quality of underlying assets better and reduce over-reliance on credit ratings.

(Albertazzi et al., 2018; Badarinza et al., 2018). This detail implies that investors are mainly concerned about default risk. By comparison, in the U.S. market, the predominant use of fixed-rate mortgages makes prepayment risk (i.e., the risk that an abrupt change in interest rates affecting borrowers' refinancing behavior) as a primary consideration.[17] This institutional distinction is desirable because the analytical framework that we rely on characterizes investors' attempts to estimate default risk (not another parameter like prepayment risk) as private information production (see, e.g., Dang et al., 2015).

Second, and potentially more importantly, the European MBS setting gives us the cleanest empirical framework to answer an important economic question. More specifically, to capture a plausibly exogenous increase in public information in the MBS market, we study the ECB LLD Initiative of 2013. This regulation mandated that banks provide periodic and detailed disclosures on individual loans underlying the MBSs (and other ABSs) that the banks pledge as collateral to the ECB in their repo borrowings. We first note that the disclosure requirements constitute a significant increase in public information. The quarterly loan-by-loan reports share a similar format, which includes more than 100 fields comprising mandatory and voluntary inputs about loan terms and performance, borrower characteristics, and the bank's assessments of the borrower's creditworthiness, among other attributes. Prior to the loan-level disclosure regulation, existing investors received sporadic and non-standardized trustee reports based on aggregate figures. Thus, the new loan-level reports not only inform a much larger group of market participants (including potential investors, information intermediaries, competitors, and regulators) but also provide comparable data across securitization entities. Moreover, the loan-

[17] In this instance, investors that expected to have an MBS paying a stream of relatively high coupons going forward are now receiving prepayments that they can only reinvest at lower rates (Hanson 2014). As a result, the most valuable loan level information in the U.S. is information could be related to prepayment risk, as certain households are more prone to prepayment than others (based on income, age, primary/secondary residence, location, etc.). While this detail is not irrelevant in Europe, we believe it is not a first-order consideration. Besides, even if it were, this argument would not invalidate our main narrative that an exogenous rise in public information could trigger private information acquisition, and thus exacerbate adverse selection and hamper liquidity.

level reports reveal a substantial amount of detailed information that investors can use to better ascertain the underlying risks and exposures. Much of these inferences, including assessments of risk-barbelling and risk-layering, would not be discernible in aggregate reports (Ryan 2018).

Moreover, we verify that investors actually use the loan-level data in their decisions. Our discussions with the European DataWarehouse (ED), the regulatory body that collects and administers loan-level disclosures, indicate that about 160 institutional investor subscribers download and process the loan-level data files. Prior literature has also reported evidence on the efficacy of the LLD Initiative, which suggests that an economically meaningful set of investors use this information.[18]

We note two potential concerns regarding our setting. First, if this regulation had been implemented in tandem with other reforms, the LLD Initiative may not be the correct treatment. Indeed, several reforms took place in Europe during 2011–2014 (e.g., the ECB's unconventional monetary policy interventions, developments relating to Basel III and Solvency II, and national banking regulations). However, it is critical to highlight that the LLD Initiative affected a subset of European banks (i.e., those banks that borrow from the Eurosystem with their ABSs pledged as collateral). Thus, to the extent that economic policies and regulatory developments do not affect those banks systematically differently, our setting is not susceptible to these confounding effects. We should also note that our empirical design addresses this concern by adopting a within-bank-time specification, which effectively compares the post-LLD liquidity change of a "disclosed" MBS to that of a "non-disclosed" MBS of the same bank in a given period.

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[18] For instance, Ertan et al. (2017) find that loan-level disclosures increase the quality of loans. The main channel the authors point out is enhanced transparency improved bank managers' monitoring of borrowers as a result of increased market discipline. Balakrishnan and Ertan (2019), on the other hand, focus on the quantity of loans and find that loan-level disclosures increase bank lending to small businesses, conditional on borrowers' demand for credit. The mechanism at work is that enhanced transparency allays banks' financing frictions and reduces the cost of capital, which allows them to raise more funds and ultimately supply more credit to the real sector. This line of work focuses on improvements at the bank level. Our paper focuses on the effects of loan-level disclosures on the market liquidity of MBSs, which might be more directly affected by the disclosure regulation.

The second potential concern is that even if the LLD regulation does constitute the correct treatment effect, it may have affected factors other than the level of public information about MBSs. In particular, the banks' repo borrowing or—conditional on borrowing—pledging decisions could change simultaneously with loan-level disclosures under the regulation. These parameters should relatively stable around the implementation of the disclosure regulation so that we can attribute the main treatment effect to disclosures, rather than changing borrowing/pledging choices. In terms of repo borrowing, we note that when the LLD Initiative started in January 2013, affected banks had already been in the repo program. That is, the banks' loan-level disclosures and repo funding did not start in the same period.[19] With regard to banks' potential cherry-picking of MBSs to pledge, none of our discussions with practitioners suggests that this behavior is commonplace.[20] Importantly, our empirical tests support this view: We find that while the LLD Initiative reduces the liquidity of safe tranches, it has no effect on the liquidity of ultra-safe tranches. If banks' systematically changing their borrowing and/or pledging behavior explained above is commonplace, we should observe a much more significant decline in the liquidity of ultra-safe tranches because banks would prioritize pledging the ultra-safe tranches (for which the required haircut is smallest).

[19] We further examine the average likelihood of an MBS to be pledged as collateral to the ECB around the regulation. We do not observe a significant change around January 2013 (the treatment date) in the ratio of pledged ABS assets to pledgable ABS assets as 41% in 2012 and 43% in 2013. This ratio would dive if the ECB LLD Initiative triggered banks to pledge fewer assets systematically to avoid the costs of disclosures.

See the ECB website for more statistics: https://www.ecb.europa.eu/paym/coll/charts/html/index.en.html.

Moreover, we also note the possibility that banks might have dropped out of the repo program around January 2013 to avoid the cost of disclosures, but our discussions with practitioners indicate that this behavior is not commonplace.

[20] The following example describes a scenario under which the change in banks' pledging behavior could drive our inferences. Suppose that a bank was pledging to the ECB two distinct securities, MBS X and MBS Y, with each of the pledges at €50. Following the LLD Initiative, the bank decides to keep its total repo position with the ECB at €100, but in order to minimize the cost of disclosures, it chooses to pledge MBS X only. (This reshuffling makes the pledged value of MBS X €100 and that of MBS Y €0, allowing the bank to provide loan-level information for MBS X only.) As discussed, however, our anecdotes and empirical evidence are inconsistent with a systematic occurrence of this behavior.

Overall, we believe that the ECB LLD regulation is a suitable setting to study our research questions. The loan-level data paradigm marks an economically significant and plausibly exogenous increase in public information available to MBS investors. In what follows, we hypothesize and test whether this increase in public information triggers private information production by MBS investors, and thus, reduces trading liquidity.

2.3. Empirical Predictions

Trading in financial markets requires liquidity, or the ability to trade securities quickly without the transaction affecting prices and without an uninformed investor losing money to a privately informed party. Given the central role of liquidity in the functioning of financial markets, the relation between disclosures and liquidity has been a long-standing question in the literature. Most studies focus on equity markets and find a positive link between these two constructs. Analytical research, such as Verrecchia (1983), Diamond (1985), and Diamond and Verrecchia (1991), explains why and how disclosures of public information facilitate trade by reducing information asymmetry among investors. The essence of this narrative is that disclosures promote symmetric information. Supporting this view, the extant empirical literature generally documents a positive association between various types of disclosures and market liquidity (e.g., Balakrishnan et al., 2014; Welker 1995). Moreover, following this argument, many researchers use liquidity as an outcome variable to understand the economic consequences of several disclosure regulations (e.g., Bushee and Leuz, 2005; Leuz and Verrecchia, 2000; Bischof and Daske, 2013).

More recently, however, a strand of analytical research contends that the effects of disclosures on liquidity might differ in debt markets. This disparity arises from the structural differences in the goals and functioning of equity and debt markets. As Holmstrom (2015) argues, equity markets primarily aim to share and allocate aggregate risk. To achieve this goal, equity markets pursue active price discovery, in which information is reflected in prices quickly. In equity markets, investors actively gather information to value stocks and realize the highest risk-adjusted return possible.

On the other hand, debt funding markets aim to provide liquidity. The cheapest way to do so is to use over-collateralized debt that obviates the need for active information collection to discover prices. A debt contract simply states that if the borrower pays the face value of the debt at maturity, there are no further obligations and the collateral is returned. This collateralization structure enables investors to avoid a precise assessment of collateral value and a costly price discovery until maturity. That is, collateralized debt, including MBSs, is generally information-insensitive as it is expected to be paid in full in most cases. (Only a high possibility of default will trigger a precise assessment, making debt information-sensitive.)[21] Due to their information insensitivity, debt funding markets operate smoothly without extensive public information about the fundamentals of debt. However, a public release of detailed and complex fundamental information could distort the information insensitivity of debt and hamper investors' willingness to trade by exacerbating adverse selection problems (Dang et al., 2015).

These insights imply that periodic disclosures of loan-level information could reduce the liquidity of the debt tranches of MBSs. Sophisticated investors would be able to understand the pricing implication of the information with lower costs than unsophisticated investors, as it is hard to incorporate such detailed data intro the valuation of MBSs. Accordingly, sophisticated investors would be more incentivized to process the information to make profitable trades against unsophisticated investors. Unsophisticated investors—for whom the option to process the complex information remains prohibitively costly—would be reluctant to trade with sophisticated investors due to fears of adverse selection caused by the heightened information asymmetry as in Akerlof

[21] Building on this idea, theoretical insights from Dang et al. (2010, 2015), Dang et al. (2017), Pagano and Volpin (2012), Gorton (2010, 2014), and Milgrom and Roberts (1990) suggest that debt is the optimal security for funding because it allays the incentive to produce private information about the payoff (Gorton, 2018).

(1970).[22] Accordingly, unsophisticated investors might prevent adverse selection by reducing the trading amount below the expected value of the debt or give in to adverse selection by not trading at all. As a result, market liquidity would decline. The pertinent hypothesis is as follows:

Hypothesis 1. *Mandatory loan-level disclosures reduce the liquidity of the debt tranches of MBSs.*

Given the integral role information acquisition costs play in our narrative, we extend our investigation to ascertain the role of the level of difficulty in valuing MBSs. We expect that unsophisticated investors worry more about adverse selection for harder-to-value deals because information-processing costs for such deals are higher, and, therefore, sophisticated investors would find private information production particularly profitable. Accordingly, the liquidity will drop more significantly when MBSs are more difficult to value. Formally, we pose the following hypothesis:

Hypothesis 2. *The liquidity-reducing effect of the mandatory loan-level disclosures is more pronounced when the valuation of MBSs is harder.*

The level of disparity in investors' incentives to process public information is essential to our narrative. If the net benefits of processing complex loan-level information are uniformly positive (or negative) for all investors, then public information would not result in a dissimilar level of private information production and thus would not impair liquidity. Contrastingly, when only a subset of investors is incentivized to process the complex information, information asymmetry would rise, and liquidity would drop. We posit that the incentive to engage in costly information production would be higher for sophisticated investors (i.e., the more dominant

[22] The MBS market is complex, and individual investors rarely participate in them. Nevertheless, there is a significant variation in the sophistication, skill, and resources of the institutional investors who trade in these markets (Dang et al., 2015).

players in the MBS market who enjoy a more complete infrastructure, such as investment analytics and a team of professionals) than for their unsophisticated counterparts. Accordingly, we examine the variation in investor sophistication to provide insights into the channel through which enhanced public disclosures influence liquidity. Specifically, we expect that the liquidity-reducing impact of disclosures will be greater especially when the investors of a given MBS are particularly different from one another in terms of sophistication. We propose the following hypothesis:

Hypothesis 3. *The liquidity-reducing effect of the mandatory loan-level disclosures is more pronounced when the disparity in investor sophistication is higher.*

3. Data and Research Design

3.1. *Data*

We obtain our data comes from EuroABS, European DataWarehouse, and Bloomberg. Information on the population of European ABSs comes from the EuroABS website. Established in 1999 by ex-market professionals, the EuroABS collects and contains deal and tranche-level data, including issuance date and amount, participants, ratings, and coupon or spread, for all European ABSs that have been issued since 1995. As of December 2017, the EuroABS website stored 7,120 deals comprising 23,448 tranches (ISINs).

Next, we identify ABSs subject to the ECB LLD Initiative using data we obtain from the European DataWarehouse (ED), the data repository that contains loan-level data and provides information on the securities it includes. Since the launch of the LLD regulation in January 2013, loan-level data has been provided in a standardized template and at least on a quarterly basis. The ED administers the processing, verification, and handling of the data. As of 2018, the ED stored about 64 million loans underlying 1,223 active and redeemed deals. Residential MBSs are by far the largest asset class in terms of the number of deals, constituting about 55% of the ABS population.[23]

Lastly, we collect data on the characteristics and transactions of ABSs from Bloomberg. For ABSs contained in the EuroABS and the ED, we collect daily trading prices and bid and ask quotes. For the asset (collateral) side of ABS deals, we gather monthly (amortizing) collateral balances, the number of underlying loans, and collateral quality information such as nonperforming loan portion. For the liability (tranche) side, we collect monthly (amortizing) principal balances, yields, and maturities. We also gather bond quality data, such as credit ratings and loan-to-value ratio, and a variety of other essential information, including investor identities.

Our final sample consists of 40,033 security-months pertaining to 1,713 distinct tranches coming from 10 European countries over the period of 2011–2014. We limit our sample to (residential) MBSs, which constitute over 95% of ABSs with secondary-market data from Bloomberg. The UK, Spain, Ireland, and the Netherlands account for the majority of our sample, consistent with active mortgage securitization and marketable MBSs in these countries.

3.2. Research Design and Measurement

To establish a baseline for our analysis, we compare the illiquidity of MBSs that provide loan-level data as of January 2013 under the ECB LLD Initiative ("Disclosed MBSs") with that of MBSs not subject to the initiative and thus never provide loan-level information. Our security-month-level sample spans the period from 2011–2014, i.e., two years before and two years after the implementation date of the regulation (January 2013).[24] To do so, we estimate the following difference-in-differences model:

[23] Source: European DataWarehouse. For a more detailed explanation of the regulation and the data, see https://www.ecb.europa.eu/paym/coll/loanlevel/html/index.en.html. To perform our empirical analyses, we identify and download individual submissions using the interface provided by the ED. The entire population of loan-level data can be collated via complex query-based analyses of more than 21,000 submissions.

[24] The ECB LLD Initiative was adopted in 2013 but provided banks with a nine-month phase-in period. For this reason and other fundamental factors (e.g., sophisticated investors building the infrastructure for collecting and processing information), we adopt a two-year window, rather than a shorter window.

$$Liquidity_{s,\,t} = \beta_0 + \beta_1\ Disclosed\ MBS_s \times Post_t + \beta_2\ Disclosed\ MBS_s + \Gamma\ \boldsymbol{X}_{s,\,t} + \nu_c + \pi_p + \omega_{r,\,t} + \mu_{l,\,t} + \varepsilon_{s,\,t}. \quad (1)$$

In this model, s denotes a security (i.e., a tranche or ISIN), t denotes a calendar year-month, c denotes a country (i.e., registered country of the security), p denotes a special-purpose entity (i.e., a paper company that issues the security), r denotes a tranche class (i.e., class of the security by its seniority), and l denotes a lender (i.e., originating bank). We work at the tranche level since security liquidity is defined at the tranche (i.e., ISIN) level and because allowing multiple tranches for a given MBS enables us to make seniority comparisons to explore the different information sensitivity by tranche classes. We perform monthly analyses because we observe liquidity at a monthly level.[25] *Disclosed MBS* is a time-invariant indicator variable that switches on for securities whose underlying collateral is disclosed on an asset-by-asset basis under the ECB LLD Initiative. *Post* is also an indicator variable that equals one for months on or after January 2013, and zero otherwise.

Liquidity is a composite measure that relies on a variety of empirical proxied used in credit markets literature (e.g., Adrian et al., 2017; Schestag et al., 2016; Chen et al., 2007; Lesmond et al., 1999). Specifically, *Liquidity* is the first principal component of the following three illiquidity metrics, multiplied by minus one. The first metric is based on Fong et al. (2017) and computed as $2\sigma N^{-1}(1+(z/2))$, where σ is the standard deviation of bond returns, N^{-1} is the inverse function of the cumulative normal distribution of the bond return, and z is the portion of zero-returns days. The second metric is based on Roll (1984) and calculated as $2\sqrt{(\text{-}Cov\ (R_t,\ R_{t\text{-}1})}$ if $Cov < 0$ or 0 otherwise, where R_t is the bond return. The third metric is the number of nontrading days divided by the total number of trading days in a month. (The higher values of these three metrics signify

[25] According to Bloomberg coverage, the European MBS markets do not have a significant level of intra-day trades, and annual-level data would be too coarse to allow us to infer the effects of enhanced public information.

greater illiquidity.) This composite proxy captures the notion of liquidity holistically, but in robustness tests, we examine its components individually.[26]

$\boldsymbol{X}_{s,\ t}$ consists of the following control variables to account for security characteristics that could affect its liquidity and may be correlated with the likelihood of being a disclosed MBS: *Collateral Amount*, *Collateral Balance Factor*, *Tranche Amount*, *Tranche Balance Factor*, *Number of Loans*, *Nonperforming Collateral*, *Yield*, *Rating*, *Loan-to-value*, *Age*, *Remaining Life*, and *Return Volatility*. The amounts and the balance factors include information about the monthly collateral and tranche balances in the special-purpose entity. *Number of Loans* is the natural logarithm of the number of loans outstanding underlying the security at each month-end. *Nonperforming Collateral* is the portion of the nonperforming loan balance to the total balance of the underlying loans. *Yield* is the security's yield, including the coupon. *Rating* is a numerical translation of credit ratings for the security.[27] *Loan-to-value* is the average loan to collateral value ratio, a standard proxy for the extent of over-collateralization. *Age* is the number of years since the security's issuance, while *Remaining life* is the security's time to maturity in years.[28] *Return Volatility* is the monthly standard deviation of the security's daily returns.

Finally, we employ an extensive fixed effects structure, including country (ν_c), special-purpose entity (π_p), tranche-class-time ($\omega_{r,t}$), and lender-time ($\mu_{l,t}$) fixed effects. The country and special-purpose entity (SPE) controls aim to account for the inherent country and ABS attributes that could affect liquidity. For instance, Dutch mortgage and ABS markets are different from

[26] Note that the over-the-counter nature of the European MBS trading renders unavailable trade volume data, which is why we are unable to construct measures of price impact or Amihud's illiquidity—popular proxies for stock market liquidity. However, we also note that researchers examining credit markets commonly use our metrics above. In additional tests, on a restricted sample, we explore the bid-ask spread as a dependent variable.

[27] We assign 1 to the best rating and 22 the worst. If rating agencies provide different ratings, we use the average numerical value of these ratings.

[28] These two variables are particularly helpful to account for life-related factors that impact trading. For instance, the MBS markets could see active trading right after the origination of the MBS, as these securities find their way in the portfolios of real money investors, such as insurance companies and pension funds. Outside of this small window of time, there could be some trading if a security is downgraded and for regulatory reasons pension funds have to sell it.

British markets. Similarly, the type of credit the MBS underlies is fixed in time but likely an important driver of its average liquidity. Among others, these attributes include amortization structure (e.g., interest-only, principal-only, or standard amortization), prepayment risk (adjustable-rate vs. fixed-rate credit), and government guarantees.[29] Tranche-class-time fixed effects dynamically account for concurrent developments and regulations that could affect a whole class of MBSs throughout our sample period. Lender-time fixed effects effectively compare, in the same month, a security with asset disclosures to another without, both of which are originated by the same bank.

To examine our additional hypotheses, we partition our primary estimation sample by MBS valuation difficulty and investor disparity. Our proxy for the former is based on return volatility. With the assumption that securities with higher volatility are harder to value (Shalen, 1993), we split the sample at the median. To capture investor disparity, we first construct a proxy for investor sophistication. Our measure of investor sophistication is the number of deals a given investor invests in. The assumption here is that investors with a greater presence in the MBS market are relatively more sophisticated. Second, for each MBS, we calculate the standard deviation of investor sophistication. This procedure yields our proxy for investor disparity. Namely, disparity gets higher when a deal is invested in by some sophisticated and some unsophisticated investors. As with MBS complexity, in our cross-sectional tests, we split the sample at the median of this variable.

Table 2 presents the sample statistics of our variables. We observe that *Liquidity* has a mean (median) of -0.248 (0.212). About 39% of our observations are coded as *Disclosed MBS*, while about 66% of them come from after January 2013. The median MBS in our sample has a

[29] SPE fixed effects also account for different flavors of MBS structures. The standard plain vanilla tranche is a sequential-pay tranche but there may be other tranches like planned amortization class (PAC) tranches, targeted amortization class (TAC) tranches, support tranches, Z-tranches, etc. Presumably, some tranches are more straightforward to value than others, and we are able to account for these features.

nonperforming loan ratio of 4.1%, a loan-to-value ratio of 71.5%, a yield of 1.3%, an age of about seven years, and a remaining life of over 30 years.

4. Empirical Results

This section presents the results of our empirical analyses. We begin by exploring the findings from baseline tests and proceed to test the robustness of these inferences (Hypothesis 1). We then report evidence on the drivers of the relationship between mandatory disclosure and liquidity (Hypotheses 2 and 3).

4.1. Main Findings and Robustness Tests

To shed light on the average effect of mandatory disclosure on the liquidity in the MBS market, we first estimate equation (1). Table 3 reports the findings; the main coefficient of interest, *Disclosed MBS* × *Post*, is highlighted in grey. Interestingly, in the specification with all fixed effects but without control variables (column (1)), we find that the liquidity of disclosed MBSs increases by 0.544, relative to non-disclosed MBSs, after the implementation of the ECB LLD Initiative. For context, the sample standard deviation of *Liquidity* is 1.397, suggesting a sizeable marginal effect. When we add control variables (column (2)), the coefficient estimate on *Disclosed MBS* × *Post* stabilizes at 0.377.

In columns (3) and (4), we enhance our estimation model with more restrictive fixed effects. We first interact lender and year-month fixed effects and present the results in column (3). These two-dimensional lender-times-year-month fixed effects account for the time-invariant and time-varying characteristics of the originating bank (e.g., banks' lending practices, risk profiles, managerial talent). Therefore, this specification allows us to compare two securities (one disclosed and one non-disclosed) of the same bank in the same month. The estimate of the main effect in this specification slightly goes down to 3.38%. In column (4), we also interact tranche-class and year-month fixed effects to account for potential differences in illiquidity by tranche classes over time (e.g., senior tranches are typically traded less often than junior tranches, and this difference could change over time). This most restrictive specification yields the estimate we mention in the abstract and introduction: a 0.321 decline in liquidity, as a result of the loan-level disclosures, which translates to about 23% of the sample standard deviation of *Liquidity* (which is 1.397).

We also note Figure 2 shows that the effect of disclosures kicks in relatively quickly, while the pre-treatment trend in liquidity appears statistically identical for disclosed and non-disclosed MBSs—which alleviates lingering concerns about potentially confounding differences between these two groups of MBSs. Overall, the inferences from these specifications suggest that our conclusion holds within lender-month and within tranche-class-month. We use this model in our subsequent analyses and suppress the estimates on the control variables for brevity.

To further verify the association between disclosures and illiquidity, we perform several robustness tests. We report these results in Table 4. First, we extend our examination to ultra-safe tranches (i.e., the most senior tranche of the deal with class A1). These securities that (empirically speaking) never experience losses and thus are hardly susceptible to adverse selection concerns. For this group, we do not expect to find a significant result because these securities are so deep in the money that the adverse effects of disclosures on the money-ness of these tranches would be limited. Consistently, as shown in Panel A of Table 4, we find that the liquidity of these securities does not change after the disclosure regulation. By contrast, the main effect is driven by information-insensitive securities that could become information-sensitive. In addition to validating our arguments about information sensitivity, this finding also adds credibility to the main treatment. If the disclosure regulation affected the trading of these securities in ways other than an increase in public information (e.g., if the LLD Initiative mechanically increased the pledging amounts of disclosed securities), we would find even stronger illiquidity effects for ultra-safe tranches. Our inferences, however, suggest otherwise.

Second, we study the robustness of our empirical specifications. We start by re-estimating our tests on a narrower sample that spans 24 months instead of 48 months. Consistent with the takeaways from Figure 2, we observe that the liquidity-reducing effects of mandatory disclosures set in relatively quickly (column (1)). We next perform a treatment intensity test, in which we define *Disclosed MBS* as a continuous variable. This proxy exploits the observation that the disclosure regulation requires the publication of mandatory information fields, as well as voluntary ones. Accordingly, the continuous variant of *Disclosed MBS* ranges from zero to one, with one denoting securities for which all the fields of the LLD reports are disclosed. By definition, control securities have a score of zero. In the sample of treatment securities, *Disclosed MBS* as a continuous variable varies between 0.56 and 1.00. As column (2) of Panel B shows, this quasi-treatment-intensity estimator provides further support for our conclusion, with a statistically significant coefficient estimate of –0.379. Economically, a one standard deviation increase in continuous *Disclosed MBS* (=0.43) reduces *Liquidity* by about 12 of its standard deviation. In column (3) of the same panel, we show results from a specification that relies on a propensity-score-matched (PSM) sample.[30] This test helps us better ensure the similarity between disclosed and non-disclosed securities, especially in terms of observables. We observe that our inferences continue to hold.

Finally, we estimate our primary regression model for alternative measures of liquidity. This analysis aims to ascertain the extent to which our conclusions are driven by a specific component of our composite liquidity measure. As discussed in the preceding section, we use three common proxies for liquidity (or lack thereof). As Panel C of Table 4 shows, our conclusions hold for each of the three individual illiquidity proxies—the illiquidity measure of Fong et al. (2017), the illiquidity measure of Roll (1984), and the portion of nontrading days. We complement this finding by examining bid-ask spreads, which are available for a markedly smaller sample. The results

[30] Note that the PSM sample has significantly fewer observations. This is because our matching procedure ensures that the treatment and control samples are statistically indistinguishable at the time of the regulation (January 2013). The first stage of our matching process includes the entirety of the controls we employ in our tests.

presented in Panel D of Table 4 suggest that our main takeaway holds for alternative specifications in which the dependent variable is bid-ask spread (column (1)) and the first principal component of bid-ask spreads and the three measures mentioned above (column (2)). Collectively, the estimates we discuss thus far provide support for Hypothesis 1: mandatory loan-level disclosures reduce the liquidity of the debt tranches of MBSs.

4.2. Mechanisms: Valuation Complexity and Investor Disparity

We next shift our focus to the cross-section to better understand the mechanism. We first explore valuation difficulty. The underlying rationale here is that for harder to value securities, holding all else constant, the room for differential interpretation and processing of disclosure will be higher. As a result, our main effects should be stronger for harder-to-value instruments. We use past return volatility as a proxy, in that we code securities as harder-to-value if they are associated with above-median return volatility. We present our empirical findings in Table 5. Even though there are economically meaningful effects for securities that are less difficult to value, we report statistically and quantitatively more significant effects for comparatively harder-to-value securities (Hypothesis 2). These estimation results underscore the importance of valuation difficulty in the link between mandatory disclosures and liquidity.

We then explore investor disparity. In our narrative, a critical element that mediates the negative relation between disclosures and liquidity is adverse selection driven by the disparity in investor sophistication. Thus, we expect that loan-level disclosures hurt liquidity more for MBSs that exhibit a relatively large variation in investor sophistication (Hypothesis 3). We posit that loan-level disclosures are complex enough that the degree to which sophisticated investors can process them is different from that of unsophisticated investors, and that more experienced investors have a higher level of sophistication. Accordingly, we measure investor sophistication by the extent of an investor's involvement in the MBS market. Specifically, we use the number of distinct MBS deals each of the MBS investors have invested. (Larger values indicate greater sophistication and expertise in the MBS market.) We then take the standard deviation of this value for each security to capture the variation in sophistication. Table 6 presents the results. When the disparity in investor sophistication is low (i.e., below the sample median), we do not find that mandatory public information reduces liquidity (column (1)). In contrast to this finding, the difference-in-differences estimator almost doubles for a subsample of securities in which there is a high disparity in investor sophistication (column (2)).

Overall, these inferences provide insights consistent with cautionary arguments in prior work (Holmstrom 2015; Dang et al., 2015; Gorton 2018). In the absence of public information, the MBS market operates smoothly without severe information asymmetry among investors. A public release of detailed information could enhance the incentives of sophisticated investors to value MBSs and thereby increase the information asymmetry between sophisticated and unsophisticated investors. Fearing adverse selection, unsophisticated investors would reduce or stop trading. As a result, the liquidity in the MBS market would fall.

4.3. Equity versus Debt

In the final part of our study, we exploit a unique feature of MBSs, in that these instruments have multiple tranches that differ in pay-off structure. Specifically, we contrast our findings from the debt tranches with that from equity tranches. As discussed above, unlike with debt tranches, price discovery is of paramount importance in equity tranches.

As Table 7 shows, the sign of the main effect flips for these securities (the coefficient estimate becomes 0.784). This finding suggests that loan-level disclosures *increase* liquidity when the security is inherently information-sensitive, namely, when investors are seeking information. This insight has two important implications. First, it highlights that public disclosure, for the same underlying structure, could have different liquidity effects, depending on the asset's information sensitivity. Second, this finding from equity tranches is not directly consistent with the prediction of Kim and Verrecchia (1994) that public information reduces liquidity in equity markets; rather, it is in line with the prediction of the traditional equity literature (Diamond and Verrecchia, 1991).

In addition to helping us evaluate the variation in the treatment effect by the degree of information sensitivity, these tests provide reassuring evidence on our main story. For instance, there may be lingering concerns that the availability of more accurate information reduces the amount of trading because the end investors can make a clearer assessment of the risks involved and thus be more resolute about whether they want to hold on to the security or not. That is, price is discovered with fewer trades. Furthermore, there may be concurrent regulations and developments affecting certain securities more. These concerns, however, predict a uniform relationship—or at least a monotonic relationship—across different degrees of seniority. By contrast, our findings lend support to our main argument: Only for information-insensitive assets, an increase in public information exacerbates adverse selection by leading to endogenous private information production.

5. Conclusion

Prior literature generally documents that disclosures improve liquidity by reducing information asymmetry among investors. More recently, analytical researchers have challenged this view and argued that the effect depends on the structure of the financial market in question, as well as the information-acquisition incentives of investors. Specifically, enhanced public information can hurt the liquidity of information-insensitive securities if such information results in a divergence of information-acquisition incentives amongst investors.

To shed light on this issue, we examine the secondary-market liquidity effects of mandatory loan-level disclosures for the debt tranches of mortgage-backed securities (MBSs). We find that the loan-level disclosures reduce the liquidity of the debt tranches of MBSs by 23%. We find that the liquidity decline is stronger among securities that are harder to value, which is consistent with the notion that public information for such securities can result in differential information advantages for investors. Further, we find that the skill asymmetry among investors is an important factor in the liquidity-reducing effect of disclosures. Loan-level disclosures decrease liquidity especially when the disparity in investor sophistication is high.

We acknowledge that our paper is not without limitations. In particular, the welfare implication of our findings is not obvious. As Holmstrom (2015) points out, the accumulation of liquidity in good times could result in bigger crashes later. If this is the case, the reduction of liquidity in ABS markets due to enhanced transparency could be desirable for financial stability. We also recognize that the adverse effects of a reduction in the liquidity in ABS markets could be offset by improvements in securitization practices (Mersch, 2014, 2017; Ertan et al., 2017; Balakrishnan and Ertan, 2019). As a result, even though our evidence is relevant to regulators seeking to implement credit-market reforms, the inferences we provide alone do not prescribe an optimal regulatory system.

We also leave future research several important follow-up questions that are beyond the scope of our study. First, does the cost of reduced liquidity in secondary markets outweigh the benefits from more transparent securitization practices? Second, do the conclusions we draw apply in bad times? Third, does disclosure hurt liquidity in other experimental settings, such as Regulation AB II in the U.S.? These questions deserve attention from a regulatory perspective as well, since securitization markets are in the process of adopting asset-level disclosure rules globally.

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Table 1. Variable Definitions

Variable Name	Definition
Age	Difference between security issuance date and current date in years.
Collateral Amount	Natural logarithm of the original face amount of collateral in Euros.
Collateral Balance Factor	The month-end face balance of collateral divided by the original face amount of collateral.
Liquidity	The first principle component of three illiquidity metrics, multiplied by -1 for ease of interpretation. The first metric is based on Fong et al. (2017) and computed as $2\sigma N^{-1}(1+(z/2))$, where σ is the standard deviation of bond returns, N^{-1} is the inverse function of the cumulative normal distribution of the bond return, and z is the portion of zero-returns days. The second metric is based on Roll (1984) and calculated as $2\sqrt{(-Cov\ (R_t,\ R_{t-1})}$ if $Cov < 0$ or 0 otherwise, where R_t is the bond return. The third metric is the number of nontrading days divided by the total number of trading days in a month; its higher value signifies greater illiquidity.
Loan-to-value	The weighted average loan to value ratio of the collateral group to which the security belongs.
Nonperforming Collateral	The month-end face balance of nonperforming collateral divided by the month-end face balance of total collateral.
Number of Loans	Natural logarithm of the number of loans outstanding underlying the security at month-end.
Post	Indicator variable that switches on for months on or after the implementation date of the ECB's LLD Initiative (January 2013).
Rating	The mean of the initial credit ratings for the security of S&P, Moody's, and Fitch (converted to 1 to 22 with 1 denoting the highest rating and 22 the lowest rating).
Remaining Life	Difference between the current date and the maturity date in years.
Return Volatility	Monthly standard deviation of daily returns. (Values are imputed where missing.)
Tranche Amount	Natural logarithm of the original issue amount of tranche in Euros.
Tranche Balance Factor	The month-end principal balance of tranche divided by the original issue amount of tranche.
Disclosed MBS	Indicator variable that switches on for securities whose underlying loans are disclosed on an asset-by-asset basis under the ECB's LLD Initiative. The data source is the European DataWarehouse.
Yield	Monthly yield including coupon.

Sorted alphabetically. The data source is Bloomberg unless stated otherwise. Test-specific variables are defined in table captions.

Table 2. Descriptive Statistics

This table presents the sample statistics. Each observation is an ISIN-month. For indicator variables, only the sample averages are presented, as the other moments are degenerate. All variables are defined in Table 1.

	Mean	Std. Dev.	p10	p50	p90	N
Liquidity	-0.248	1.397	-2.116	0.212	0.933	40,033
Disclosed MBS $\times$ *Post*	0.283	.	.	.	.	40,033
Disclosed MBS	0.388	.	.	.	.	40,033
Post	0.664	.	.	.	.	40,033
Collateral Amount	21.244	1.636	19.824	20.786	25.159	40,033
Collateral Balance Factor	0.530	2.289	0.177	0.386	0.789	40,033
Tranche Amount	18.461	1.795	16.186	18.307	20.832	40,033
Tranche Balance Factor	0.681	0.328	0.186	0.770	1.000	40,033
Number of Loans	8.731	1.553	6.925	8.394	11.922	40,033
Nonperforming Collateral	0.081	0.105	0.004	0.041	0.244	40,033
Yield	0.019	0.033	0.005	0.013	0.034	40,033
Rating	3.971	3.531	1.000	2.667	9.000	40,033
Loan-to-value	0.661	0.177	0.408	0.715	0.826	40,033
Age	7.045	2.337	4.339	7.181	9.794	40,033
Remaining Life	31.342	8.655	22.706	30.018	41.477	40,033
Return Volatility	0.013	0.023	0.000	0.004	0.033	40,033

Table 3. Mandatory Disclosures and Liquidity—Main Results

This table presents the results of the difference-in-differences analyses that examine the impact of the ECB LLD Initiative on the secondary-market liquidity of mortgage-backed securities. Each observation is an ISIN-month. The dependent variable, *Liquidity*, is the first principle component of three illiquidity metrics, multiplied by -1 for ease of interpretation. The first metric is based on Fong et al. (2017) and computed as $2\sigma N^{-1}(1+(z/2))$, where σ is the standard deviation of bond returns, N^{-1} is the inverse function of the cumulative normal distribution of the bond return, and z is the portion of zero-returns days. The second metric is based on Roll (1984) and calculated as $2\sqrt{(-Cov\ (R_t,\ R_{t-1})}$ if $Cov < 0$ or 0 otherwise, where R_t is the bond return. The third metric is the number of nontrading days divided by the total number of trading days in a month; its higher value signifies greater illiquidity. *Disclosed MBS* and *Post* are indicator variables that switch on for ISINs whose underlying loans are disclosed under the initiative and for months on or after the implementation date of the initiative, respectively. All other variables are defined in Table 1. The not-applicable (n/a) designation for fixed effects indicates that the pertinent vector is subsumed in the presence of a more restrictive fixed-effects specification. For example, year-month fixed effects are not estimated when the model includes lender-year-month fixed effects. The results shown in the subsequent tables are from the estimation of the most saturated specification, model (4). Standard errors (in parentheses) are robust to within-country and year-month correlations as well as heteroscedasticity. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Liquidity	*Liquidity*	*Liquidity*	*Liquidity*
Disclosed MBS × Post	-0.544***	-0.377***	-0.338***	-0.321***
	(0.062)	(0.049)	(0.055)	(0.050)
Disclosed MBS	0.183***	-0.035	-0.066	-0.067
	(0.052)	(0.042)	(0.044)	(0.040)
Collateral Amount		0.042***	0.050***	0.051***
		(0.016)	(0.015)	(0.015)
Collateral Balance Factor		0.003*	0.004*	0.004*
		(0.002)	(0.002)	(0.002)
Tranche Amount		-0.044***	-0.049***	-0.048***
		(0.011)	(0.011)	(0.010)
Tranche Balance Factor		-0.028	-0.029	-0.044
		(0.032)	(0.033)	(0.034)
Number of Loans		0.097***	0.094***	0.091***
		(0.016)	(0.015)	(0.015)
Nonperforming Collateral		-1.136***	-1.346***	-1.370***
		(0.180)	(0.195)	(0.196)
Yield		0.016	0.025	0.241
		(0.528)	(0.548)	(0.529)
Rating		0.013***	0.013***	0.012***
		(0.005)	(0.005)	(0.005)
Loan-to-value		0.102	0.085	0.070
		(0.091)	(0.091)	(0.091)
Age		-0.027***	-0.026***	-0.028***
		(0.005)	(0.005)	(0.005)
Remaining Life		-0.005***	-0.004***	-0.005***
		(0.001)	(0.001)	(0.001)
Return Volatility		-29.328***	-28.966***	-28.562***
		(1.562)	(1.566)	(1.548)
Observations	40,033	40,033	40,033	40,033
Adjusted R-squared	0.294	0.469	0.480	0.489
Country FE	Y	Y	Y	Y
Special-purpose entity FE	Y	Y	Y	Y
Tranche-class FE	Y	Y	Y	n/a
Lender FE	Y	Y	n/a	n/a
Year-month FE	Y	Y	n/a	n/a
Tranche-class × Year-month FE	N	N	N	Y
Lender × Year-month FE	N	N	Y	Y

Table 4. Mandatory Disclosures and Liquidity—Robustness

This table presents the results of the difference-in-differences analyses that examine the impact of the ECB LLD Initiative on the secondary-market liquidity of mortgage-backed securities. Each observation is an ISIN-month. *Disclosed MBS* and *Post* are indicator variables that switch on for ISINs whose underlying loans are disclosed under the initiative and for months on or after the implementation date of the initiative, respectively. The dependent variable, *Liquidity*, is the first principle component of three illiquidity metrics, multiplied by -1 for ease of interpretation. The first metric is based on Fong et al. (2017) and computed as $2\sigma N^{-1}(1+(z/2))$, where σ is the standard deviation of bond returns, N^{-1} is the inverse function of the cumulative normal distribution of the bond return, and z is the portion of zero-returns days. The second metric is based on Roll (1984) and calculated as $2\sqrt{(-Cov\ (R_t,\ R_{t-1})}$ if $Cov < 0$ or 0 otherwise, where R_t is the bond return. The third metric is the number of nontrading days divided by the total number of trading days in a month; its higher value signifies greater illiquidity. In Panel A, the ultra-senior tranche in column (2) denotes a subsample that includes class "A1." The sample in column (1) is the main sample minus those shown in column (2). In Panel B, column (1) re-estimates the main analysis over a 24-month window, instead of the original 48-month window. Column (2) shows the result of a treatment intensity test, in which *Disclosed MBS* is defined as a continuous variable, the number of non-missing fields of the LLD report divided by the number of all the fields. Column (3) presents the result of the estimation of the main model using a propensity-score matched (PSM) sample. This sample is constructed using MBS' observable attributes as at 2012H1: *Collateral Amount*, *Collateral Balance Factor*, *Tranche Amount*, *Tranche Balance Factor*, *Number of Loans*, *Nonperforming Collateral*, *Yield*, *Rating*, *Loan-to-value*, *Age*, *Remaining Life*, and *Return Volatility*, which are defined in Table 1 and are used all previous controls in the models. In Panel C, the dependent variables are the aforementioned three individual components of *Liquidity*, as indicated in column headings, FHT, Roll, and Nontrading days. These are metrics of illiquidity, thus a positive coefficient on *Disclosed MBS* × *Post* indicates a decline in liquidity, i.e., an increase in illiquidity. In Panel D, the dependent variable is the bid-ask spread (a measure of illiquidity) and the first principal component of the three main measures as well as the bid-ask spread. Standard errors (in parentheses) are robust to within-country and year-month correlations, as well as heteroscedasticity. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Breakdown of Senior Tranches: Safe Securities vs. Ultra-safe Securities

	(1)	(2)
	Safe tranche	Ultra-safe tranche
	Liquidity	*Liquidity*
Treatment MBS × Post	-0.342***	-0.107
	(0.048)	(0.209)
Treatment MBS	-0.077*	-0.410*
	(0.040)	(0.240)
Observations	38,483	1,550
Adjusted R-squared	0.489	0.571
All previous controls	Y	Y
Country FE & SPE FE	Y	Y
Tranche-class × Year-month FE	Y	Y
Lender × Year-month FE	Y	Y
p-value for the difference between coefficients in models (1) and (2)	<0.01	

Panel B. Specification Robustness

	(1)	(2)	(3)
	Narrow Window	Continuous Treatment	Matched Sample
	Liquidity	*Liquidity*	*Liquidity*
Treatment MBS × Post	-0.427***	-0.379***	-0.129*
	(0.068)	(0.065)	(0.073)
Treatment MBS	-0.077	0.011	0.042
	(0.060)	(0.060)	(0.065)
Observations	22,917	40,033	11,051
Adjusted R-squared	0.49	0.489	0.525
All previous controls	Y	Y	Y
Country FE & SPE FE	Y	Y	Y
Tranche-class × Year-month FE	Y	Y	Y
Lender × Year-month FE	Y	Y	Y

Panel C. Individual Components of the Liquidity Measure

	(1)	(2)	(3)
	Illiquidity (FHT)	*Illiquidity (Roll)*	*Illiquidity (Nontrading days)*
Disclosed MBS × Post	0.116***	0.128***	0.051***
	(0.021)	(0.041)	(0.012)
Observations	40,033	40,033	40,033
Adjusted R-squared	0.388	0.478	0.246
All previous controls and slopes	Y	Y	Y
Country FE & SPE FE	Y	Y	Y
Tranche-class × Year-month FE	Y	Y	Y
Lender × Year-month FE	Y	Y	Y

Panel D. Alternative Measures of Liquidity

	(1)	(2)
	Illiquidity (Bid-ask spread)	*Liquidity (PCA incl. Bid-ask spread)*
Disclosed MBS × Post	0.196*	-0.465***
	(0.118)	(0.080)
Observations	18,845	19,093
Adjusted R-squared	0.746	0.749
All previous controls and slopes	Y	Y
Country FE & SPE FE	Y	Y
Tranche-class × Year-month FE	Y	Y
Lender × Year-month FE	Y	Y

Table 5. Mandatory Disclosures and Liquidity—Information Complexity

This table presents the results of the difference-in-differences analyses that examine the impact of the ECB LLD Initiative on the secondary-market liquidity of mortgage-backed securities. Each observation is an ISIN-month. The dependent variable, *Liquidity*, is the first principle component of three illiquidity metrics, multiplied by -1 for ease of interpretation. The first metric is based on Fong et al. (2017) and computed as $2\sigma N^{-1}(1+(z/2))$, where σ is the standard deviation of bond returns, N^{-1} is the inverse function of the cumulative normal distribution of the bond return, and z is the portion of zero-returns days. The second metric is based on Roll (1984) and calculated as $2\sqrt{(-Cov\ (R_t,\ R_{t-1})}$ if $Cov < 0$ or 0 otherwise, where R_t is the bond return. The third metric is the number of nontrading days divided by the total number of trading days in a month; its higher value signifies greater illiquidity. *Disclosed MBS* and *Post* are indicator variables that switch on for ISINs whose underlying loans are disclosed under the initiative and for months on or after the implementation date of the initiative, respectively. Less complex subsample in column (1) and More complex in column (2) denote subsamples constructed based on the complexity of information, which is proxied by return volatility, where securities with above-median volatility are coded as more complex and vice versa. All previous controls include *Collateral Amount*, *Collateral Balance Factor*, *Tranche Amount*, *Tranche Balance Factor*, *Number of Loans*, *Nonperforming Collateral*, *Yield*, *Rating*, *Loan-to-value*, *Age*, *Remaining Life*, and *Return Volatility*, which are defined in Table 1. Standard errors (in parentheses) are robust to within-country and year-month correlations, and heteroscedasticity. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
	Liquidity	*Liquidity*
	Less complex	More complex
Disclosed MBS × Post	-0.228***	-0.467***
	(0.036)	(0.075)
Observations	20,019	20,014
Adjusted R-squared	0.220	0.432
All previous controls	Y	Y
Country FE & SPE FE	Y	Y
Tranche-class × Year-month FE	Y	Y
Lender × Year-month FE	Y	Y
p-value for the difference between coefficients in models (1) and (2)	<0.1	

Table 6. Mandatory Disclosures and Liquidity—Investor Disparity

This table presents the results of the difference-in-differences analyses that examine the impact of the ECB LLD Initiative on the secondary-market liquidity of mortgage-backed securities. Each observation is an ISIN-month. The dependent variable, *Liquidity*, is the first principle component of three illiquidity metrics, multiplied by -1 for ease of interpretation. The first metric is based on Fong et al. (2017) and computed as $2\sigma N^{-1}(1+(z/2))$, where σ is the standard deviation of bond returns, N^{-1} is the inverse function of the cumulative normal distribution of the bond return, and z is the portion of zero-returns days. The second metric is based on Roll (1984) and calculated as $2\sqrt{(-Cov\ (R_t,\ R_{t-1})}$ if $Cov < 0$ or 0 otherwise, where R_t is the bond return. The third metric is the number of nontrading days divided by the total number of trading days in a month; its higher value signifies greater illiquidity. *Disclosed MBS* and *Post* are indicator variables that switch on for ISINs whose underlying loans are disclosed under the initiative and for months on or after the implementation date of the initiative, respectively. Low disparity in investor sophistication in column (1) and High disparity in investor sophistication in column (2) denote subsamples constructed based on the standard deviation of investor sophistication, which is measured for each MBS investor as the number of MBSs she invests, and correspond to the below and above median of the standard deviation, respectively. All previous controls include *Collateral Amount*, *Collateral Balance Factor*, *Tranche Amount*, *Tranche Balance Factor*, *Number of Loans*, *Nonperforming Collateral*, *Yield*, *Rating*, *Loan-to-value*, *Age*, *Remaining Life*, and *Return Volatility*, which are defined in Table 1. Standard errors (in parentheses) are robust to within-country and year-month correlations, and heteroscedasticity. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
	Liquidity	*Liquidity*
	Low disparity in investor sophistication	High disparity in investor sophistication
Disclosed MBS × *Post*	0.261	-0.213*
	(0.159)	(0.111)
Observations	5,721	5,744
Adjusted R-squared	0.483	0.554
All previous controls	Y	Y
Country FE & SPE FE	Y	Y
Tranche-class × Year-month FE	Y	Y
Lender × Year-month FE	Y	Y
p-value for the difference between coefficients in models (1) and (2)	<0.01	

Table 7. Mandatory Disclosures and Liquidity—Equity Tranche

This table presents the results of the difference-in-differences analyses that examine the impact of the ECB LLD Initiative on the secondary-market liquidity of mortgage-backed securities. Each observation is an ISIN-month. The dependent variable, *Liquidity*, is the first principle component of three illiquidity metrics, multiplied by -1 for ease of interpretation. The first metric is based on Fong et al. (2017) and computed as $2\sigma N^{-1}(1+(z/2))$, where σ is the standard deviation of bond returns, N^{-1} is the inverse function of the cumulative normal distribution of the bond return, and z is the portion of zero-returns days. The second metric is based on Roll (1984) and calculated as $2\sqrt{(-Cov\ (R_t,\ R_{t-1})}$ if $Cov < 0$ or 0 otherwise, where R_t is the bond return. The third metric is the number of nontrading days divided by the total number of trading days in a month; its higher value signifies greater illiquidity. *Disclosed MBS* and *Post* are indicator variables that switch on for ISINs whose underlying loans are disclosed under the initiative and for months on or after the implementation date of the initiative, respectively. The Equity tranche in column (1) denotes a subsample that includes below class "D". The Debt tranche in column (2) denotes a subsample that includes class "A" to "D" tranches. All previous control variables include *Collateral Amount*, *Collateral Balance Factor*, *Tranche Amount*, *Tranche Balance Factor*, *Number of Loans*, *Nonperforming Collateral*, *Yield*, *Rating*, *Loan-to-value*, *Age*, *Remaining Life*, and *Return Volatility*, which are defined in Table 1. Standard errors (in parentheses) are robust to within-country and year-month correlations, and heteroscedasticity. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
	Equity tranche	Debt tranche (i.e., main sample)
	Liquidity	*Liquidity*
Disclosed MBS × Post	0.784**	-0.321***
	(0.383)	(0.050)
Observations	5,187	40,033
Adjusted R-squared	0.558	0.489
All previous controls	Y	Y
Country FE & SPE FE	Y	Y
Tranche-class × Year-month FE	Y	Y
Lender × Year-month FE	Y	Y
p-value for the difference between coefficients in models (1) and (2)	<0.01	

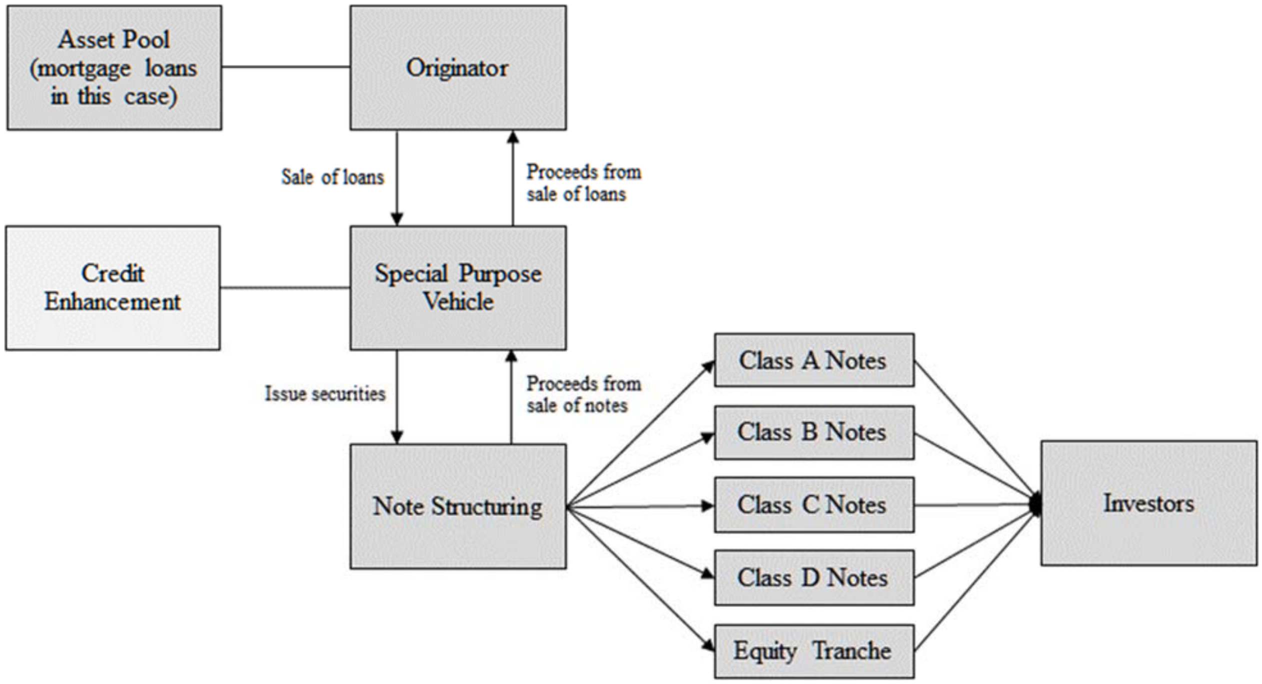

Figure 1. Securitization Process

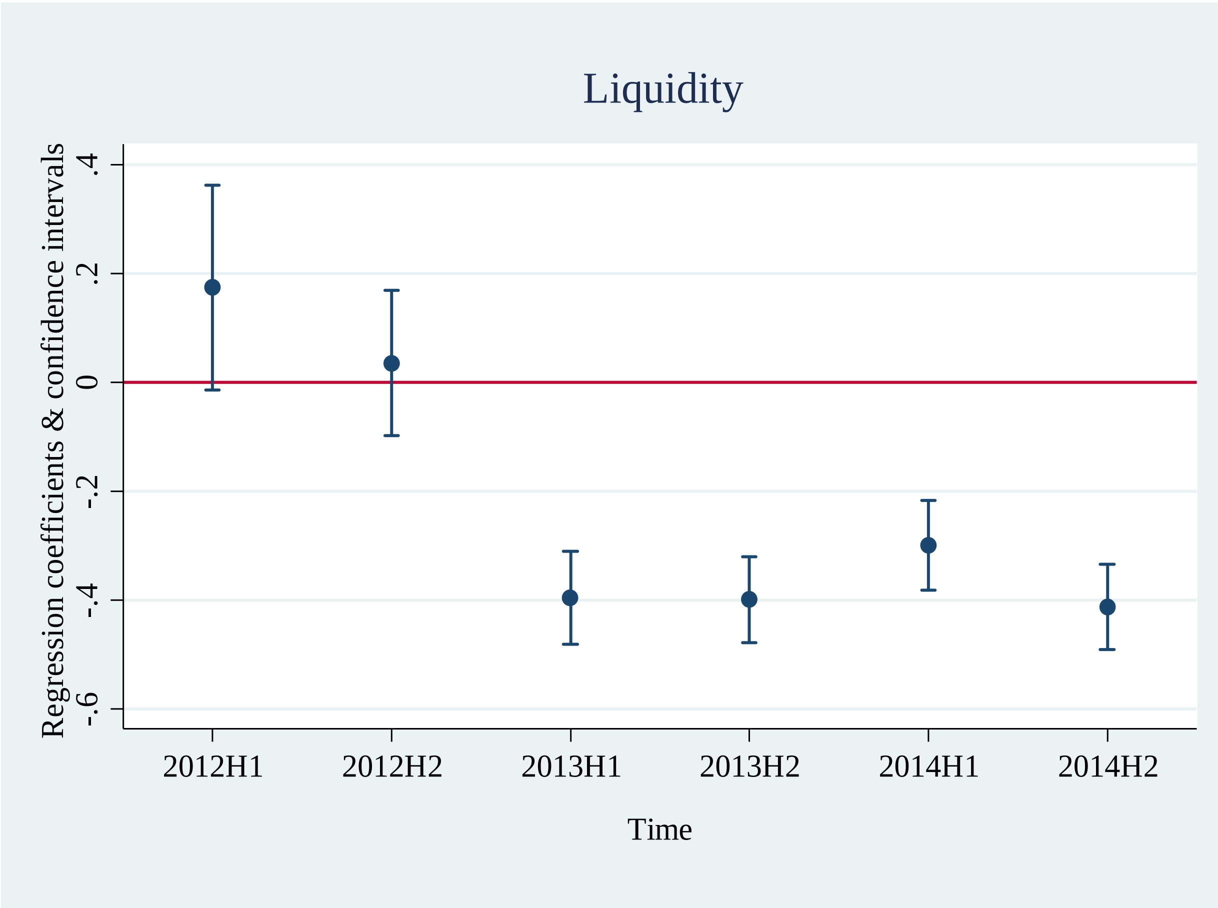

Figure 2. Evolution of the Trading Liquidity of Treatment vs. Control Securities

This figure presents OLS regression individual half-year coefficient estimates and two-tailed 95% confidence intervals, where the dependent variable is *Liquidity* (as in Table 4). The baseline is the year of 2011.