Pledgeability and Asset Prices: Evidence from the Chinese Corporate Bond Markets

Hui Chen Zhuo Chen Zhiguo He
Jinyu Liu Rengming Xie*

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Abstract

We provide causal evidence for the value of asset pledgeability. Our empirical strategy is based on a unique feature of the Chinese corporate bond markets, where bonds with identical fundamentals are simultaneously traded on two segmented markets that feature different rules for repo transactions. We utilize a policy shock on December 8, 2014, which rendered a class of AA+ and AA bonds ineligible for repo on one of the two markets. By comparing how bond prices changed across markets and rating classes around this event, we estimate that an increase in haircut from 0 to 100% would result in an increase in bond yields in the range of 40 to 83 bps. These estimates help us infer the magnitude of the shadow cost of capital in China.

Keywords: Pledgeability, haircut, repo, interbank and exchange market, enterprise bonds, shadow cost of capital

*Hui Chen: MIT Sloan. Zhuo Chen: PBC School of Finance, Tsinghua University. Zhiguo He: Chicago Booth. Jinyu Liu: University of International Business and Economics. Rengming Xie: CITIC Securities. We thank Darrell Duffie, Jennifer Huang, Anil Kashyap, Arvind Krishnamurthy, Francis Longstaff, Dmitry Orlov, Chris Palmer, Jun Pan, Lasse H. Pederson, Jun Qian, Antoinette Schoar, Christopher Sims, Constantine Yannelis, and participants at Chicago lunch seminar, MIT Sloan, the Fudan Fanhai Summer Conference, MFM Summer School, LAEF OTC Markets Workshop, and Shanghai Advanced Institute of Finance for helpful comments. We thank Tianshu Lyu for excellent research assistance.

1 Introduction

It has long been recognized, e.g., by Duffie (2010), that asset prices depend not only on the fundamental cash flows but also "liquidity" factors that are broadly related to the frictions prevalent in modern financial markets. Among these "liquidity" considerations, one that has received arguably the most attention is asset pledgeability, i.e., the ability of an asset to serve as collateral and help reduce financing costs. This is because of its central role in the studies of borrowing constraints in macroeconomics and finance (see e.g., Kiyotaki and Moore, 1997; Gromb and Vayanos, 2002).

Our paper aims to offer an empirical estimate for the value of asset pledgeability. Our study focuses on bonds, which, besides spot transactions, are often involved in repurchase agreements, or repos. Repos are essentially collateralized loans, with the asset in transaction (typically fixed income securities) serving as the collateral.[1] Lenders often set a haircut over the market price of the collateral bond to determine the amount of credit extended; the smaller the haircut, the greater the pledgeability of the bond.

In a world where collateral helps reduce the costs of borrowing for a financially constrained investor (relative to default-adjusted uncollateralized borrowing), pledgeable bonds carry a convenience yield. We refer to this type of convenience yield as the *pledgeability premium*, which is jointly determined by the frequency of the liquidity shocks, the degree of pledgeability (haircut), and the shadow cost of capital (the gap in financing costs between collateralized and default-adjusted uncollateralized borrowing). The pledgeability premium should be reflected in the equilibrium pricing of the bonds. This logic has been used to explain repo specialness (Duffie, 1996), Treasury convenience yields (Longstaff, 2004; Fleckenstein, Longstaff, and Lustig, 2014; Lewis, Longstaff, and Petrasek, 2017), and "basis" across assets with different margins (Garleanu and Pedersen, 2011). Haircut-implied funding costs have also been used by Chen, Cui, He, and Milbradt (2018) to endogenize the holding costs of illiquid assets, which in turn helps account for the liquidity premium in corporate bonds.

Though the theoretical mechanisms via which pledgeability boosts asset values are relatively clear, it is challenging to measure the effect empirically. Asset pledgeability is clearly endogenous, which depends on asset fundamentals, various market frictions, and the interactions between the two. We overcome this endogeneity issue by exploiting a policy shock on asset pledgeability together with a set of unique institutional features in the Chinese bond markets.

The Chinese bond markets have experienced tremendous growth in size during the

[1] A key difference of repo from a collateralized loan is that the repo collateral is exempt from automatic stay in the event of bankruptcy. See, e.g. Adrian, Begalle, Copeland, and Martin (2012).

past decade, and are now ranked third in the world, behind the U.S. and Japan. A distinct feature of the Chinese bond markets is the co-existence of two segmented bond markets, the OTC-based interbank market and the centralized exchange market. The interbank bond market is a wholesale market serving only institutional investors including banks and non-bank financial institutions. The exchange bond market, as a part of the Shanghai and Shenzhen Stock Exchanges, is populated by non-bank financial institutions like mutual funds and insurance companies, as well as retail investors.[2] The restrictions on market access and trading frictions cause the two markets to be largely segmented.

Furthermore, the two markets differ significantly in their rules for repos. Repos on the interbank market essentially follow the standard tri-party repo model in the U.S.. The key transaction terms (collateral, haircuts, repo rates) are negotiated bilaterally; they depend not only on bond characteristics but also the identity (credit quality) of the counter-parties. On the exchange market, the exchange acts as the Central Counter-Party (CCP) to all repo buyers and sellers, and it unilaterally determines the list of eligible collateral and their respective haircuts (which are almost exclusively based on bond ratings). As a result, the pledgeability of the same bonds can differ on the two markets for different investors. For instance, smaller institutional participants with limited government support could find it difficult to borrow on the interbank market even when using AAA bonds as collateral, while borrowing against these bonds will be relatively easy on the exchange. In contrast, a large state-owned commercial bank can borrow against AA- bonds on the interbank market, even though these bonds are not eligible for repo on the exchange. Together, the differences in rating-dependent pledgeability and market segmentation imply that the prices of the same bond can differ on the two markets.

Our main empirical strategy is to exploit these cross-market valuation differences for these dual-listed bonds. Specifically, we define the "exchange premium" as the yield on the interbank market minus that on the exchange market for the same bond with simultaneous transaction prices on the two markets. Under the assumption that any unobservable fundamentals affect the pricing of the same bonds on the two markets similarly, the exchange premium isolates the effects of the non-fundamental factors, including the differences in pledgeability and potentially other liquidity factors on the two markets.

To further isolate the pledgeability premium, we exploit a policy shock that significantly changed the pledgeability for a set of bonds on the exchange. In the after-hours on December 8, 2014, the exchange suddenly announced that enterprise bonds with ratings

[2]For more details on a brief history of the development and evolution of these two bond markets in China, see Amstad and He (2018).

below AAA were no longer accepted as repo collateral. This policy was aimed at the exchange market only; effectively it only changed the pledgeability of bonds rated AA+ and AA on the exchange (AA- bonds were already ineligible for repo before the event). Thus, even if the exchange premium is partly due to differences in liquidity factors on the two markets, so long as the pricing impact of such factors varies in the same way over time for the treated bonds (AA+ and AA) and the bonds in the control group (AAA and AA-), we will be able to identify the pricing impact of changes in pledgeability on the exchange via a Diff-in-Diff study on the exchange premia.

We show that AAA and AA- bonds had similar trends in their exchange premia with the treatment group (AA+ and AA) before the Dec 2014 shock. However, in the first two weeks after the shock, the exchange premia of both AAA and AA- ratings rose, while that of the treatment group fell. This suggests that this rating-dependent pledgeability shock adversely affected the bond prices with middle ratings only. Notice that our control group consists of both higher- (AAA) and lower-rated (AA-) bonds, which helps us rule out many alternative fundamental-based explanations: typically, these mechanisms generate asset pricing reactions that are monotone in asset qualities (here, credit ratings).

A main empirical contribution of our paper is to provide an estimate of the effect of changes in pledgeability on asset prices. Using the rating-dependent policy shock as an instrument in a two-stage least squares regression, we find that raising the haircut from zero to 100% leads to a 40 bps (0.4%) increase of the bond yield, implying a circa 4.5% drop in price for a typical enterprise bond in our sample.

While the exchange premia-based estimates help address the issue of endogeneity of policy shock related to unobservable bond fundamentals, they are likely downward-biased for a couple reasons. One leading concern is that despite the limits to cross-market arbitrages in the short-run, the policy shock on the exchange market will be transmitted to the interbank as long as some institutional investors are engaging in arbitrage activities. In addition, investors on the interbank market could also react to the policy shock on the exchange by raising haircuts and becoming more selective in counter-party quality. These market forces will tend to raise the yields on the interbank market and thus offsetting the declines in exchange premium, rendering an underestimate the price impact of the changes in pledgeability on the exchange.

We address this concern by providing an alternative IV estimate that likely overstates the price impact of changes in pledgeability. Thus, the two sets of IV estimates together plausibly bound the magnitude of the pledgeability premium. Specifically, instead of using the prices of the same bonds on the interbank market as benchmark, we compare the price changes of the treated bonds against those of the matched policy-shock-free AAA bonds on the exchange market. These matched AAA bonds have similar haircuts and yields in the pre-event sample as those treated AA+/AA bonds, but their pledgeability were not affected by the policy shock. It is plausible that these matched AAA bonds are with better unobservable fundamentals relative to the treated bonds, which will cause this alternative IV estimate to be upward biased. For instance, a potential flight to quality effect in response to the policy shock can boost the prices of AAA bonds and thus inflate the relative price changes between the treated bonds and the matched AAA bonds, leading to an overestimate of pledgeability. A similar logic applies to the case where the regulator has the private information that AA+/AA rated bonds are worse than the market believes. The resulting IV (over)estimate suggests that raising the haircut from zero to 100% leads to a 83 bps increase of yield (compared to 40 bps based on the exchange premium), or a circa 5.3% drop in price for a typical enterprise bond in our sample. These estimates are in the same range of the effect documented in Ashcraft, Grleanu, and Pedersen (2011) (see more details in literature review).

Recall that the pledgeability premium derives from the convenience yield for a financially constrained investor. Heuristically, it is determined by the following formula, which is modified from Garleanu and Pedersen (2011),

$$\text{Pledgeability premium} = \text{Freq. of liq. shocks} \times \text{shadow cost of capital} \times (1 - \text{haircut}).$$

The pledgeability premium is higher when the marginal investor is more frequently in a liquidity-constrained state, and it is higher when the investor faces high shadow cost of capital in the constrained state. The shadow cost of capital is the gap between the interest-rate spread between collateralized and uncollateralized (but default-adjusted, as in, e.g., Gilchrist and Zakrajsek, 2012) financing, i.e., a form of financing risk premium. Finally, the premium is higher for assets with smaller haircuts.

Through the lens of the formula above, we can infer the shadow cost of capital for investors on the exchange market. Before the policy shock, about 35% of the enterprise bonds on the exchange were used as repo collateral on a typical day. If we interpret this number as the frequency of being liquidity constrained, then the pledgeability premium estimates of 40 to 83 bps correspond to shadow cost of capital of 1.5% to 3.2%.

Literature review. Equilibrium asset pricing with financial constraints is a very active research field; we do not aim to provide an exhaustive list here. Early theoretical contributions include Detemple and Murthy (1997) who study the role of short-sale limit, a constraint that is intrinsically linked to margin requirement or haircuts in equilibrium. For more recent analysis, see Chabakauri (2015). Garleanu and Pedersen (2011) consider a general equilibrium model with two assets that are with identical cash-flows but may differ in their margins/haircuts, and tie their equilibrium pricing differences (bases) to margin differences modulated by the shadow cost of capital. This provides the closest theoretical framework to our empirical study. Other equilibrium asset pricing models with financial constraints include Gromb and Vayanos (2002), Basak and Cuoco (1998), He and Krishnamurthy (2013), and Danielsson, Zigrand, and Shin (2002).[3]

There is no doubt that margin constraints or haircuts are endogenously determined by aggregate conditions in financial markets as well as asset characteristics. Influential theoretical contributions include Fostel and Geanakoplos (2008) and Geanakoplos (2010), in which the riskless lending arises endogenously due to heterogeneous beliefs. The extensions include Simsek (2013) and He and Xiong (2012), among others. Brunnermeier and Pedersen (2009) relate the haircut of assets to a Value-at-Risk constraint and highlight the downward spiral in a general equilibrium model with endogenous leverage constraints.

More generally, equilibrium asset pricing terms can also be endogenously determined in a framework with over-the-counter search markets (Duffie, Grleanu, and Pedersen, 2005; Lagos and Rocheteau, 2009; He and Milbradt, 2014, among others), which is the environment for Chinese interbank bond market in our paper. Based on this framework, Vayanos and Wang (2007) and Vayanos and Weill (2008) study the premia of on-the-run Treasuries as a symptom of the failure of law-of-one-price.

Our paper contributes to the literature that connects pledgeability to asset prices. The related empirical studies include Gorton and Metrick (2012) who document the repo runs during the 2007/08 financial crisis. In contrast, Copeland, Martin, and Walker (2014) show that there lacks a systemic runs on triparty repo–which is the major segment of this market) during the crisis, except for the funding of Lehman in September 2008. Krishnamurthy, Nagel, and Orlov (2014) study the repo funding extended by money market funds (MMF) before and during the 2007/2008 financial crisis. Related, there are also a few empirical studies regarding the failure of law-of-one-price and its connections to margin constraints and liquidity. Examples include Longstaff (2004) and Lewis, Longstaff, and Petrasek (2017), who document the premium of Treasury securities over agency or corporate bonds that are guaranteed by the U.S. government; Krishnamurthy (2002), who document the on-the-run Treasury premium; Bai and Collin-Dufresne (forthcoming), who study the CDS-Bond basis which is the pricing difference between corporate bond and its synthetic replicate (Treasury and selling CDS).

Ashcraft, Grleanu, and Pedersen (2011) present a model where haircut, which represents asset pledgeability, can be used as an effective monetary policy tool besides interest rate. By exploring one of the Term Asset-Backed Securities Loan Facility (TALF)

[3]Our paper is also more broadly related to macroeconomics literature where assets also serve the role of collateral (to name a few, Kiyotaki and Moore, 1997; Caballero and Krishnamurthy, 2001).

programs in 2009, they also empirically examine the price impact of lowering the haircuts of some eligible Mortgage-Backed Securities. Based on market reactions of bonds that were rejected by the program (which, might carry some additional information, the authors find that an increase in haircut from 0 to 100% would result in an increase of 28 to 52 bps in bond yields.[4] This is close to the range based on our IV estimates. Though our paper shares the same spirit with Ashcraft, Grleanu, and Pedersen (2011) in investigating the market reactions of some policy, the dual-listed nature of Chinese enterprise bonds, together with two control groups–one with bonds of higher quality and the other with lower—lends great support in identifying the causal effect of asset pledgeability on asset prices.

Our paper also makes contribution to the burgeoning literature on the Chinese bond market; for the most recent overview for this rapidly growing market, see the handbook chapter by Amstad and He (2018). Bai and Zhou (2018) offer the first comprehensive study on the pricing of Municipal Corporate Bonds (Cheng-tou Bonds), which are the major part of dual-listed enterprise bonds in our sample. Chen, He, and Liu (2018) link China's shadow banking activities to its 2009 stimulus plan by showing that provinces are refinancing maturing 2009-stimulus loans by issuing Municipal Corporate Bonds. Complementary to our angle of rating-dependent pledgeability, Wang, Wei, and Zhong (2015) find that retail investors play a significant role in explaining the pricing wedge between the interbank and exchange markets for the dual-listed bonds. Wang and Xu (2018) develop a model for asset pledgeability, and offer empirical support using the primary bond market data in China. Several papers look at the implicit government guarantee in the Chinese bond market. Among them, Liu, Lyu, and Yu (2017) investigate the role of implicit local government guarantees for the above mentioned MCB bonds; Jin, Wang, and Zhang (2018) study the event of first bond default by a central SOE in 2015 to estimate the value of implicit guarantee; and Huang, Huang, and Shao (2018) are after the same question by looking at financial bonds issued by commercial banks.

2 Institutional Background

In this section, we provide a brief overview of the key features of the Chinese bond markets that are relevant for our study. For more details on the history of the Chinese

[4]The effect of rejection by the TALF is estimated to be around 20 bps; but because the TALF rejection essentially raised the bond haircut by 75% (25% to 100%), the effect of a 100% rise in haircut should be around 28 bps. Ashcraft, Grleanu, and Pedersen (2011) offer another gauge of the effect of TALF; according to the survey participated by both investors and dealers, the effect of haircut is at the range of 400 to 500 bps. However, it is hard to compare the survey evidence with the real transaction prices due to the non-binding nature of survey responses).

bond markets, see Amstad and He (2018).

2.1 Overview of the Chinese Bond Markets

Over the past twenty years, especially the past decade, China has taken enormous strides to develop its bond market as an integral step of the financial reforms, along with the efforts in interest rate liberalization and the internationalization of its domestic currency. Panel A of Figure 1 shows the recent growth path of Chinese bond market capitalization scaled by GDP, which rises from 35% in 2008 to more than 90% in 2017. In comparison, the U.S. bond market has been staying slightly above 200% of the U.S. GDP during the same time period.

There are three major categories of fixed-income securities in the Chinese bond markets based on issuing entities: government bonds, financial bonds, and corporate (non-financial) bonds.[5] Panel B of Figure 1 shows the notional outstanding and market shares of the different types of corporate bonds. In the aggregate social financing statistics released by the PBoC, Corporate bonds correspond to "bonds," contributing 11% of financing to the real sector as shown in Panel C of Figure 1.

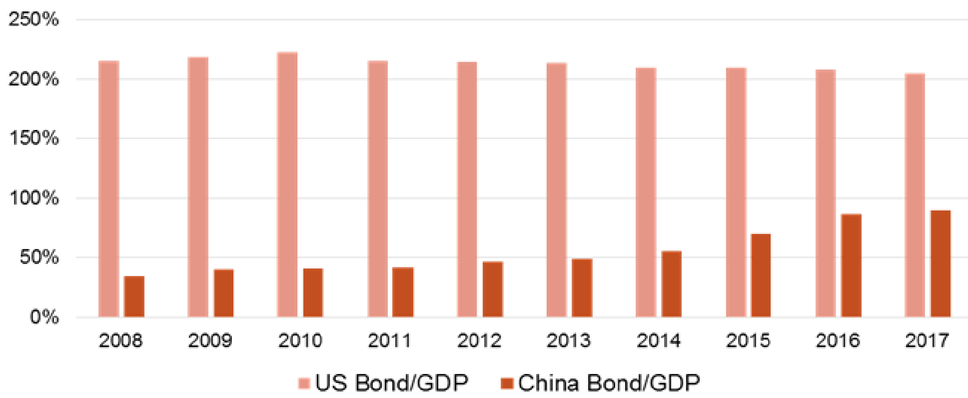
Our paper focuses on enterprise bonds, a type of corporate bonds issued by non-listed State-Owned-Enterprises (SOEs). They account for 15% of total corporate bonds outstanding (or 4% of total bonds outstanding) by 2017. For our analysis, it is important to understand the following features of the Chinese bond markets: (1) the co-existence of the exchange and interbank bond markets; (2) the dual-listing of bonds on the two markets; and (3) the different ways that repo transactions are conducted on these two markets.

2.2 Co-Existence of Exchange and Interbank Market

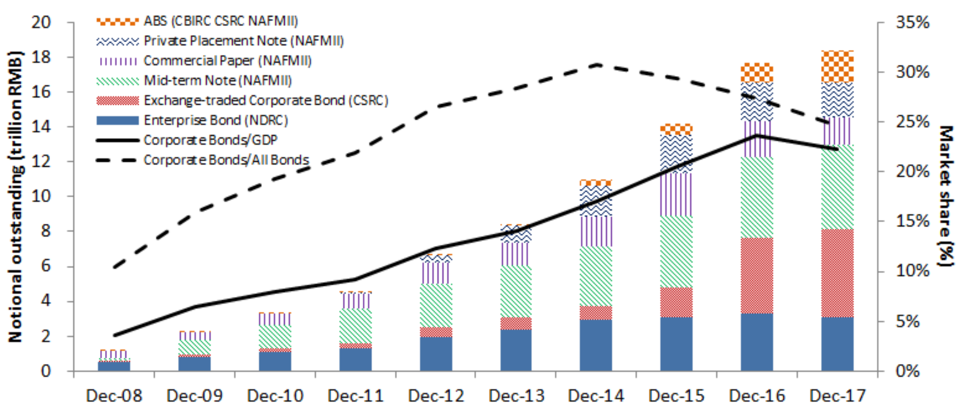
For historical reasons, there are two distinct and largely segmented markets in today's Chinese bond markets: the Over-the-Counter based interbank market and the centralized exchange market. The interbank market is largely a "wholesale" market, similar to the interbank markets in developed economies like the United States, while the exchange

[5]Government bonds are issued by formal government agencies (e.g., Ministry of Finance and policy banks in China) and account for 56% of bonds outstanding in 2017. Financial bonds, which account for 17% of bond outstanding in 2017, are issued by financial institutions which are almost all state-owned. Corporate bonds, which represent 27% of the market, are issued by non-financial firms. Though corporate bonds in some international context also include long-term bonds issued by financial institutions, we specifically separate out bonds issued by financial institutions, given that almost all entities in Chinese financial sector are state-owned. There is also another widely used classification among practitioners in China, which groups financial bonds and corporate bonds together as the so-called credit bonds.

Panel A: Bond outstanding as % of GDP



Panel B: China's corporate bond outstanding by category



Panel C: China's aggregate social financing outstanding by category

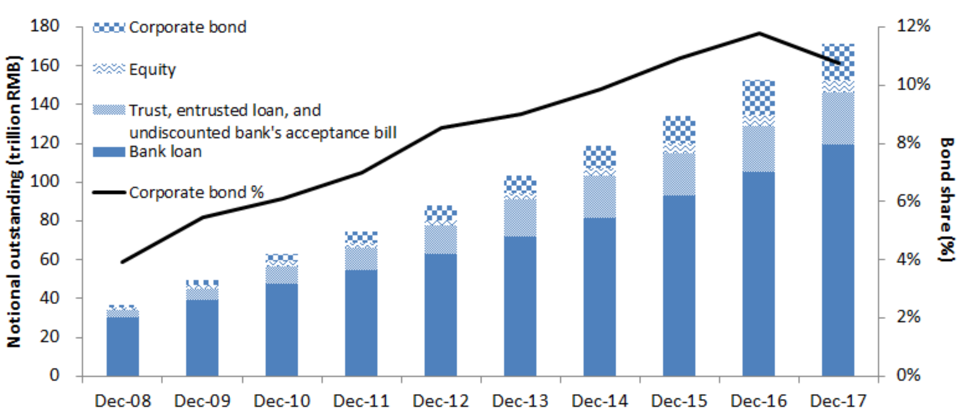


Figure 1: **China's Bond Market.** This figure plots statistics of China's bond market from 2008 to 2017. Panel A plots the bond outstanding as a percentage of GDP in China and US, Panel B plots China' corporate bond outstanding by category, and Panel C plots PBOC aggregate social financing outstanding by category.

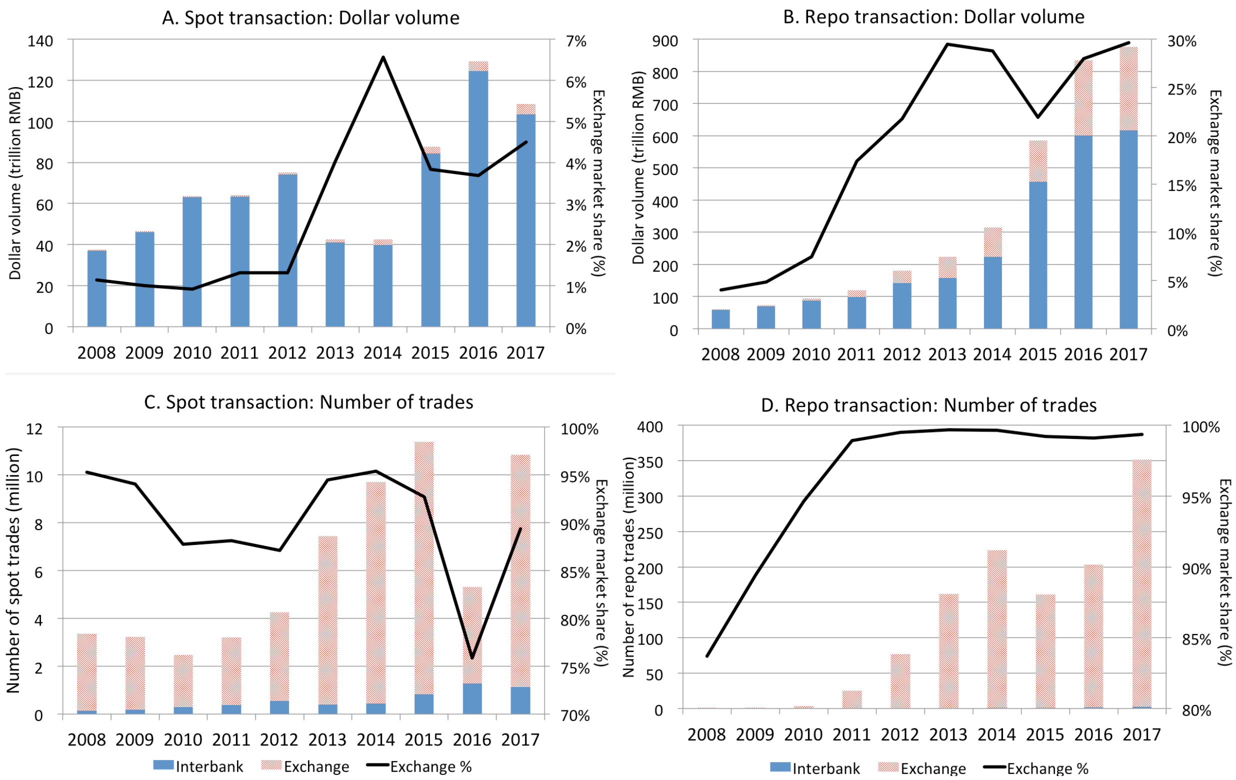


Figure 2: **China's Interbank and Exchange Bond Markets.** This figure plots China's two bond markets from 2008 to 2017. Panel A plots spot and repo transaction RMB volume of all bonds on the interbank and exchange markets. Panel B plots number of trades for spot and repo transactions in these two markets. Data on interbank-market transactions are from China Foreign Exchange Trade System and data on exchange-market transactions are from the Statistics Annuals of Shanghai exchange and Shenzhen exchange.

market is more "retail" oriented (including smaller institutions and high net-worth individual investors).

The exchange bond market resides within the Shanghai and Shenzhen stock exchanges, which were established in 1990 in the wake of the SOE reforms. Repo (repurchase agreement) transactions, which allow investors to borrow against the bond collateral, have been popular on the exchange since their inception. The interbank market was established in 1997. During the first half of 1997, the Chinese stock market experienced an unprecedented boom (with the Shanghai Stock Exchange composite index rising by over 50% from January to May). Due to the concern that repo financing might have fueled the stock market boom, in June 1997 the People's Bank of China (PBoC), the central bank in China, ordered all commercial banks to fully switch from the exchange to the newly established interbank market.[6] Both markets have grown significantly in the last twenty years. The participants on the interbank market grew from the 16 head offices of commercial banks initially in 1997 to a total of 3,469 financial institutions by the end of 2017, including urban and rural credit cooperatives, securities firms, and insurance companies. The participants on the exchange market include non-bank financial institutions (such as mutual funds and securities firms), corporate investors, and retail investors.[7] The exchange market has been aggressively competing with the interbank market. One product of this competition is dual-listed enterprise bonds, which we discuss in Section 2.3.

The interbank market adopts a quote-driven Over-the-Counter trading protocol, in which the terms of trades are finalized through bilateral bargaining between relevant parties. The trading protocol on the exchange is facilitated by a transparent order-driven mechanism, with electronic order books aggregating orders from all participants. Matched trades are settled via China Securities Depository & Clearing Corporation (CSDC), an entity fully owned by the Shanghai and Shenzhen Exchanges that provides the depository and settlement services for the exchange market.

Consistent with the "wholesale vs. retail" distinction, the average trade size for spot transactions is 100 to 200 million RMB on the interbank market and 0.5 to 1 million on the exchange. For repos, the average trade size is 200 to 500 million RMB on the interbank market and 1 to 3 million on the exchange. This helps explain the fact that while the interbank market has the dominant market share for both spot and repo transactions based on dollar volume, the opposite is true based on number of trades. As Panel A of Figure 2 shows, the interbank market accounts for more than 90% of the dollar volume of the spot transactions for all bonds and over 70% of the repo transactions. On the other hand, when it comes to the number of trades (Panel B), the exchange market accounts for 75% to 95% of all spot transactions and over 98% of the repo transactions.

Figure 2 highlights that while two bond markets in China serve different clienteles with different trading needs, they are both quite active. In short, the wholesale interbank market satisfies infrequent but large transaction needs, while the exchange market accommodates frequent but small trades. This is in sharp contrast to the bond markets in the U.S., where the exchange attracts very limited trading in corporate bonds (see e.g., Biais and Green, 2018). Table A1 in the Appendix provide a more detailed comparison

[6]Technically, the interbank market is now self-regulated by the National Association of Financial Market Institutional Investors (NAFMII). However, the PBoC is the de-facto gate keeper of this market.

[7]Although commercial banks could participate in the exchange market after certain restrictions were removed by the Chinese banking regulators in 2010, they still face significant trading constraints even nowadays and the presence of commercial banks in the exchange market is negligible. In particular, commercial banks are still prohibited from repo transactions on the exchange market.

of the secondary market liquidity in the two bond markets in China and in the U.S. corporate bond market. Market (il)liquidity is similar between the interbank market and exchange market in China based on the fraction of bonds that do not trade on a given day. Compared to U.S. corporate bond market, China's bond markets are slightly less liquid based on non-trading days, but are more liquid if we look at turnovers.

2.3 Dual-listing of Enterprise Bonds

Due to the possibility of dual-listing, the exchange and interbank market overlap in several key bond products, mainly government bonds and enterprise bonds.

The issuance of enterprise bonds is regulated by the National Development and Reform Commission (NDRC), a powerful government agency which oversees the SOE reforms in China. The interbank market, after its establishment in 1997, became the only market where enterprise bonds were issued and traded, as most SOEs were not publicly listed at that time and hence excluded from the exchange market. In 2005, to expand the potential investor base, the NDRC carried out a series of financial reforms that granted non-listed SOEs access to the exchange market. The exchange market embraced this reform with great enthusiasm, and applications for dual-listing on the exchange are almost always approved. Consequently, over 90% of the enterprise bonds outstanding are dual-listed. Equally important, our final bond sample which requires "simultaneous trading" on both markets covers about 55% of dual-listed bonds.

Limits to arbitrage Despite having identical fundamentals, the prices of a dual-listed bond on the two markets can differ significantly, and such differences can persist for a long time. This is because there are major frictions that prevent "textbook" cross-market arbitrages.

As explained in the previous section, commercial banks, the largest financial institutions in China, are prohibited from conducting repo transactions on the exchange and are virtually nonexistent in spot trading on the exchange. That leaves only a subset of investors (i.e., mutual funds, insurance companies, and securities firms) who can trade bonds on both markets.

Even for those investors with access to both markets, there exist significant frictions for cross-market arbitrage, the most significant one being the settlement delays. Suppose an investor wants to sell some interbank-market acquired bonds on the exchange (or use it to do repo on the exchange). To do so, she needs to apply for transfer of depository from the interbank market to the exchange, which takes five working days or more in 2014.[8]

[8]The depository and clearing agency in the interbank market is China Central Depository & Clearing

A transfer in the opposite direction is slightly faster and takes two to three working days. Such delays expose an arbitrageur to significant price risks. Moreover, due to limited liquidity, it is quite difficult to simultaneously buy and sell a large quantity of the same bond on the two markets.

The limits to arbitrage explain why the prices of the same bond on the two markets may not converge quickly. We argue that the differences in pledgeability on the two markets are a major factor that causes the prices to differ in the first place. To explain this point, we next turn to the differences in repo transactions on the two markets.

2.4 Repos on the Exchange and the Interbank Market

A repurchase agreement, or "repo", is the sale of a security coupled with a commitment by the seller to buy the same security back from the buyer at a pre-specified price on a pre-specified future date. It is effectively a form of collateralized borrowing with the security serving as collateral. As shown in Panel B of Figure 2, repos are quite active on both the exchange and interbank market. In 2017, repo transactions account for 90% of total volume of bond transactions in China (include both repo and spot trading).

Our research design crucially depends on the different mechanisms for repo transactions on these two markets, which we explain below.

Repos on the interbank market In a repo transaction on the Chinese interbank market, a seller (the borrower) contacts a buyer (the lender), and both parties reach agreement on the terms of trade based on bilateral bargaining. The trading protocol is nearly identical to the tri-party repos in the U.S., with the China Central Depository & Clearing Co., Ltd (CCDC) serving the role of the third-party agent who processes the post-trading settlement.[9] As explained in Section 2.2, the interbank market is dominated by large institutions who have institution-specific funding needs and constraints, and hence each repo contract tends to be highly customized, including the specification of collateral, the repo rate, and the method of delivery.

Repo terms, including types of collateral, haircuts, and repo rates, are set through private bargaining on the interbank market. The haircuts and repo rates primarily reflect

Co. Ltd (CCDC) and Shanghai Clearing House, while in the exchange market it is China Security Depository & Clearing Co. Ltd (CSDC). Before the system upgrade in 2012, the process of transferring from interbank to exchange was even longer which took about six to eight working days.

[9]Tri-party repo is a transaction for which post-trade processing – collateral selection, payment and settlement, custody and management during the life of the transaction – is outsourced by the parties to a third-party agent, which is called the custodian bank. Bank of New York Mellon and JP Morgan are the two custodian banks in the U.S., while in Europe they are Clearstream Luxembourg, Euroclear, Bank of New York Mellon, JP Morgan and SIS.

the risks of the underlying securities and that of the counter-party. For example, the perceived default risk is almost zero for large state-owned Big-4 banks.[10] Unfortunately, we do not have access to trade-level repo data on the interbank market.

Repos on the exchange For repos on the Chinese exchange market, the exchange (specifically the CSDC) not only facilitates the transactions, as the CCDC does for interbank repos, but also acts as the Central Counter-Party (CCP) to all repo buyers and sellers. Different from the third-party agent in tri-party repos, the CCP guarantees that obligations are met to all non-defaulting parties regardless of whether obligations to the CCP have been met or not. This market mechanism is similar to some CCP-based European electronic platforms (Mancini, Ranaldo, and Wrampelmeyer, 2016).

Furthermore, unlike on the interbank market, the CSDC unilaterally sets the collateral pool (i.e., the list of securities eligible as collateral) and haircuts on a daily basis. For each eligible bond security, the CSDC announces the conversion rate CR, which is the borrowed amount quoted as a fraction of the face value of the security. For instance, suppose Treasuries receive a conversion rate of 1, while that of a AAA corporate bond is 0.9. Then an investor posting one unit each of the two types of bonds as collateral, both with face value of 100 RMB, will be able to borrow 190 RMB from the exchange. Suppose a bond has face value FV and market price P. We can translate its conversion rate into the haircut using the following formula:

$$(1 - haircut) \cdot P = CR \cdot FV \Rightarrow haircut = 1 - \frac{FV \cdot CR}{P}. \quad (1)$$

Notice that haircut moves in the opposite direction with conversion rate; a haircut of 100% implies zero pledgeability for that security. Effectively, all eligible securities become completely fungible after adjusting for their respective conversion rates. This feature is necessary for the exchange market whose function crucially relies on standardization.

While the exchange sets the haircuts, the equilibrium repo rate for any given maturity is determined by the market and is common across all repo sellers after the standardization of collateral. A central limit order book aggregates all bids and asks from repo sellers (borrowers) and buyers (lenders) in continuous double auctions. Even though repo buyers and sellers have limited information on each other and on the actual composition of the collateral pool (the exchange does not publish such information), the counterparty risk component in the repo rates should be negligible due to the exchange's implicit government backing.[11] Consequently, the exchange repo rates mainly reflect the market

[10] The Big-4 banks are Commercial and Industrial Bank of China, China Construction Bank, Bank of China, and Agricultural Bank of China.

[11] The Shanghai and Shenzhen exchanges are owned and run by the CSRC, one of the most powerful

supply and demand for short-term funding.

The fact that the exchange's CCP structure offers counterparty-risk-free repo transactions with desirable transparent standardization is likely a major reason behind the popularity of the exchange repo market. As Figure 2 shows, in contrast to its small market share for spot transactions (Panel A), which is in the range of 1-4% post 2012, the exchange market's share of repo transactions is over 20% during the same period (Panel B). This comparison highlights the significant role that the exchange repo market plays in China's short term financing market.

2.5 The 2014 Policy Shock in the Exchange Market

To identify the effects of changes in pledgeability on bond pricing, we exploit a policy shock on the exchange market. In a nutshell, after market closing on December 8, 2014, the exchange suspended the repo eligibility of all enterprise bonds that are rated below AAA.[12]

The background of this policy shock is the local government debt problem in China. In 2009, Beijing responded to the 2007/08 global financial crisis with the four-trillion RMB stimulus package, in which Local Government Financing Vehicles (LGFVs, which are state-owned enterprises) funded heavy infrastructure investment mainly through bank loans. Three to five years later, the back-to-normal credit policy forces LGFVs to turn to the bond market and aggressively issue Municipal Corporate Bonds (MCBs) — a type of enterprise bonds issued by non-listed SOEs — to either refinance the maturing bank loans or continue the ongoing long-term infrastructure projects (Chen, He, and Liu, 2018).[13] As a result, the bond market became flooded with MCBs, with the share of enterprise bonds rising from about 52% in 2012 to about 76% by the end of 2017.

Increasingly concerned about local government debt problems, the central government

government agencies in China with the rank of ministries. Of course, the rising bond default risk since 2014 triggers the concern whether the CSDC (and the CSRC behind) has the capacity to absorb these losses. Based on realized default and recovery rates since 2014, Chen, Chen, He, and Xie (2018) estimate that, during 2014 and 2015, annual expected losses due to default of bond collaterals are about 50% of the CSDC's registered capital. This dwarfs annual non-performing loans as a fraction of the equity capital of China's banking system (which sits slightly below 10%). The CSDC increased its capital from 0.6 Billion RMB to 1.2 Billion RMB in 2016, and further to 10 billion RMB in 2017, perhaps partly due to this consideration.

[12]Among the AAA bonds, those with below-AA issuer ratings or having an AA issuer rating but with negative outlooks also lost their repo eligibility. In this paper, we reclassify these two types of AAA enterprise bonds as AA- bonds. See Appendix A for details.

[13]MCBs, also known as Urban Construction Investment Bonds or Chengtou Bonds, are one of the perfect examples of the mixture between planning and market in today's Chinese economy: in a strict legal sense they are issued by LGFVs, which are regular corporations, yet the market views them as being implicitly backed by the corresponding local governments.

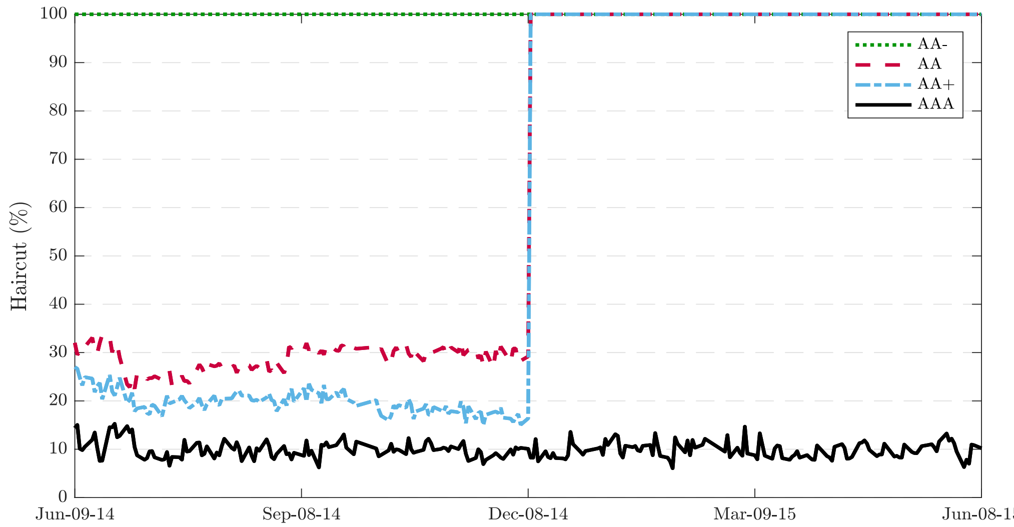


Figure 3: **Average repo haircut on the exchange market.** This figure plots the daily average haircuts on the exchange repo market across dual-listed enterprise bonds in each of the four rating categories. The sample period is 6/9/2014 to 6/8/2015.

released the tone-setting guideline "Document 43" in 2014, which explicitly banned the backing of MCBs by local governments. Soon it became a coordinated effort by financial regulators to support Beijing on this agenda. At that time, MCBs were quite popular on the exchange market, for their low perceived credit risk (thanks to the implicit guarantee) and transparency in pledgeability (thanks to centrally published haircuts). To curb the overheated demand of MCBs, the CSDC decided to slash the conversion rates for enterprise bonds with ratings below AAA during the after-hours on December 8, 2014. This sudden move by the CSDC surprised the exchange market investors to a large extent. It is well documented that the local government debt problem is rooted in the commercial banking system (Bai, Hsieh, and Song, 2016; Chen, He, and Liu, 2018), which heavily relies on the interbank market for liquidity management. Consequently, market participants were expecting some tightening in the competing interbank market instead.

As shown in Figure 3, the policy change on December 8, 2014 led to immediate and significant increases in the haircuts for AA+ and AA enterprise bonds on the exchange. In contrast, the average haircut for AAA bonds on the exchange remained steady after the event. Finally, since AA- bonds were already ineligible as repo collateral on the exchange in six months before the event, their haircuts were also unaffected by the new policy.

In contrast to the dramatic changes in haircuts on the exchange, there were only minor changes in the haircuts on the interbank market during the same period. Table 3 reports the average haircuts for enterprise bonds on the interbank market during the

1-month and 6-month windows before and after December 8, 2014, which are based on all the repo transactions conducted by an anonymous major dealer. The average haircuts increased by about 10% for AAA bonds and 3-5% for the other rating categories, which likely reflected the tightening of liquidity on the interbank market.[14]

The adjustments in exchange haircuts were a surprise to the market. As a first pass, we examine the average credit spreads for all enterprise bonds (not necessarily dual-listed) in the four rating categories around the event. On the exchange, the average credit spreads for AA+ and AA bonds jumped up on the event date (by 55 and 50 bps, respectively), while the average spreads for AAA and AA- bonds fell on the event date (by 13 and 18 bps, respectively). In contrast, on the interbank market, the average credit spreads for AA+ and AA bonds actually fell slightly on the event date (by 7 and 10 bps) while AAA and AA- changed in a slightly greater magnitude (-23 bps and 27 bps). These market reactions are consistent with the premise that the policy shock hit AA+ and AA rated bonds on the exchange market only.

3 Exchange Premia

As described in the previous section, the policy shock on December 8, 2014 significantly reduced the pledgeability of AA+ and AA-rated entperise bonds on the exchange market, yet at the same time these bonds' haircuts were largely intact on the interbank market. Such a unique setting provides us with the opportunity to study the impact of shocks to pledgeability on bond pricing through the exchange premia – the price gap for the dual-listed enterprise bonds between the exchange and interbank markets. In this section, we first describe our data, and then examine the empirical properties of the exchange premia.

3.1 Data

Our empirical analysis focuses on the enterprise bonds that are dual-listed on the interbank and exchange markets. We obtain enterprise bond characteristics and exchange-market trading data from WIND. Data on interbank market trading are from the China Foreign Exchange Trade System (CFETS), the platform for all interbank bond trading. Our sample period ranges from June 9, 2014 to June 8, 2015, a twelve-month window around

[14] Since the repo terms are bilaterally negotiated, one would ideally like to control for the credit quality of the dealer's counter-parties when comparing the interbank market haircuts from two different periods. Unfortunately this is not feasible due to the lack of trade-level data. Anecdotal evidence shows that the counterparties for this major dealer remained stable over this period.

the event date (the policy shock on December 8, 2014). This dual-listed enterprise bond sample covers 82.7% of the total trading volume of all the enterprise bonds during the same period (79.3% in terms of outstanding notional), or 28.8% of the total volume of all corporate bonds (27.1% in terms of outstanding notional). Table A2 reports the detailed coverage of our sample.

For each bond-day observation, we obtain the conversion rates quoted by the exchange and convert them into haircuts based on the formula in Eq. (1). We also calculate the enterprise bond yields based on the RMB volume-weighted average clean prices. These yields are winsorized at 0.5% and 99.5% on the exchange and interbank markets, respectively. Following the industry practice, the credit spreads of the enterprise bonds are calculated relative to the matching China Development Bank bond (CDB) yields following the similar procedure of Bai and Zhou (2018) and Liu, Lyu, and Yu (2017).[15]

As the main empirical object, we construct the "exchange market premium" or simply "exchange premium," which is defined shortly in Equation 2 as the yield difference between two markets, based on synchronous trading of dual-listed bonds. On a given day t when there is at least one transaction for a bond on one of the two markets, we use the nearest transaction data from the other market within the time window $[t-2, t]$ to form the pair. We refer to this sample as the "simultaneous trading sample," which contains about 10,000 bond-day observations from 995 unique bonds. The simultaneous trading sample covers 55% of all dual-listed bonds in our sample period; see Table A2 for details. The exchange premium for each pair is calculated as the yield on the interbank market minus the exchange market counterpart. To reduce the potential impact of outliers, we trim the sample at the bottom 0.5% and the top 99.5% in terms of exchange premium. See Appendix A.2 for details on the construction of the simultaneous trading sample. In the robustness test, we also repeat our empirical exercises using a more strict same-day trading and hence a smaller sample, which requires the trades of the very same bond in two markets take place on the same day.[16]

[15]Bonds issued by the China Development Bank, the largest one of the three policy banks in China, are fully backed by the central government, although they do not enjoy the tax-exempt status that Treasuries do. Thanks to this identical-tax-treatment as well as its superior liquidity, the CDB yield curves are commonly used as the benchmark by the bond market participants in China, especially institutional investors. Specifically, we first compute the implied prices of the CDB bonds with matching cash flows, i.e. the NPV of the same cash flows as promised by the enterprise bond discounted at the CDB bonds' zero-coupon rates, and then calculate the matching CDB yields. All of our empirical results are robust to using Treasury yields instead of CDB yields.

[16]See Appendix A.2 for details on the construction of these two trading samples. The "same-day" trading requires that a bond-day observation to have transactions on both markets on the same day to be included in the sample. Since enterprise bond transactions are relatively sparse on both markets, this definition significantly limits the sample size to about 3400 bond-day observations, compared to about 10,000 bond-day observations in the simultaneous trading sample.

We also conduct analysis on an alternative spread measure, called "spread over matched AAA," which is the spread between the yields of AA/AA+ rated bonds and that of the matched AAA bonds but with similar haircuts and yields, both traded in the same exchange market (for more details, see Section 4.3).

Other market variables, including the standardized collateral repo rates and volume on the exchange market,[17] Shanghai Interbank Offering Rate (SHIBOR), term spread between 10-year Treasury yield and 3-month Treasury yield, and the aggregate stock market returns are from WIND, while the interbank market repo rates and volume are from CFETS.[18]

Table 1 provides detailed definitions of variables, and Table 2 reports the summary statistics for the simultaneous trading sample. The summary statistics for the same-day trading sample are reported in Table A3 in the Appendix. In Table 2, we separately report the summary statistics for exchange premia, conversion rates, and haircuts before and after the policy shock.

3.2 Haircuts and Credit Ratings

Before studying the impact of changes in exchange haircuts on bond prices, it is important to understand the determinants of haircuts on the exchange during normal times. As shown in Eq. (1), the haircut is equivalent to the conversion rate for a given bond price. The conversion rates on the exchange are set by the CSDC and depend on security-level characteristics exclusively. The CSDC used to publish the exact formula for the conversion rates, which involves the bond's credit rating, market price, and its volatility.[19] However, the CSDC also made it clear that the formula was only suggestive; by inserting an opaque term called "discount coefficient", the CSDS reserved the discretion in setting the conversion rate for each bond.

To check the extent that one can "recover" the conversion rate formula prior to the policy shock, in the half-year period before the policy shock we regress the conversion rates on four bond rating dummies (AAA, AA+, AA, AA-), market price, coupon,

[17] A total of 18 standardized collateral repo products are available on the exchange market, including 9 on the Shanghai stock exchange ("GC" series) and 9 on the Shenzhen stock exchange ("R-" series). These products have maturities of 1, 2, 3, 4, 7, 14, 28, 91, and 182 days. The one-day repo transactions account for 85% to 90% of total exchange market transactions.

[18] CFETS reports daily transaction volume and volume-weighted repo rates for the interbank market. "R" series represents collateralized repo transactions for all participants in the interbank market and "DR" series represents collateralized repo transactions between two deposit-type institutions. Maturity ranges from 1, 7, 14, and 21 days to 1, 2, 3, 4, 6, and 9 months, to 1 year.

[19] The exact definitions of "market price" and "volatility" are given by the relevant regulatory documents and slightly different from what are commonly accepted in academia. We replicate these variables and use them in later regressions.

maturity, volatility, and turnover, issuer characteristics such as size and leverage, plus additional market variables such as CDB spot rate, term spread, and stock market returns. The results for both the full sample and the simultaneous-trading sample are shown in Table 4. By far the most important determinant of the conversion rates are credit ratings. For the full sample of dual-listed enterprise bonds, the rating dummies explain 96.8% of the total variation in conversion rates, while the a kitchen-sink type regression only raises the R^2 to 97%. The results are quite similar in the simultaneous trading sample.

[Insert Table 4]

The fact that bond haircuts largely depend on credit ratings implies that the policy shock that explicitly targets AA+ and AA bonds will result in significant changes in exchange haircuts across bonds, i.e, a strong first stage for the policy shock as IV. The main reasons that the CSDC appears to rely primarily on credit ratings when setting the conversion rates include poor secondary market liquidity and the transparency and third-party objectiveness of credit ratings.

3.3 Exchange Premia and the Policy Shock

Our main empirical analysis focuses on the cross-market price difference for the dual-listed enterprise bonds. With dual-listed bonds, the price of the same bond on the interbank market provides an ideal control for all the fundamental factors of its exchange counterpart, as any information related to the fundamentals should affect the pricing of the bond in the two markets similarly. At the same time, as discussed in Section 2.3, market segmentation implies that the differences in haircuts on the exchange and the interbank market will lead to persistent differences in prices for the same bond on the two markets.

Define the exchange premium measure, $EXpremium_{ijt}$, as the cross-market difference in credit yields for bond i from rating category j on day t,

$$EXpremium_{ijt} = yield^{IB}_{ijt} - yield^{EX}_{ijt}, \tag{2}$$

where $j \in \{AAA, AA+, AA, AA-\}$. A positive premium means the price of a bond is higher on the exchange than on the interbank market. With common fundamentals, $EXpremium_{ijt}$ should reflect the differences in pledgeability on the two markets, plus the differences in other liquidity factors (e.g., trade size and frequency).

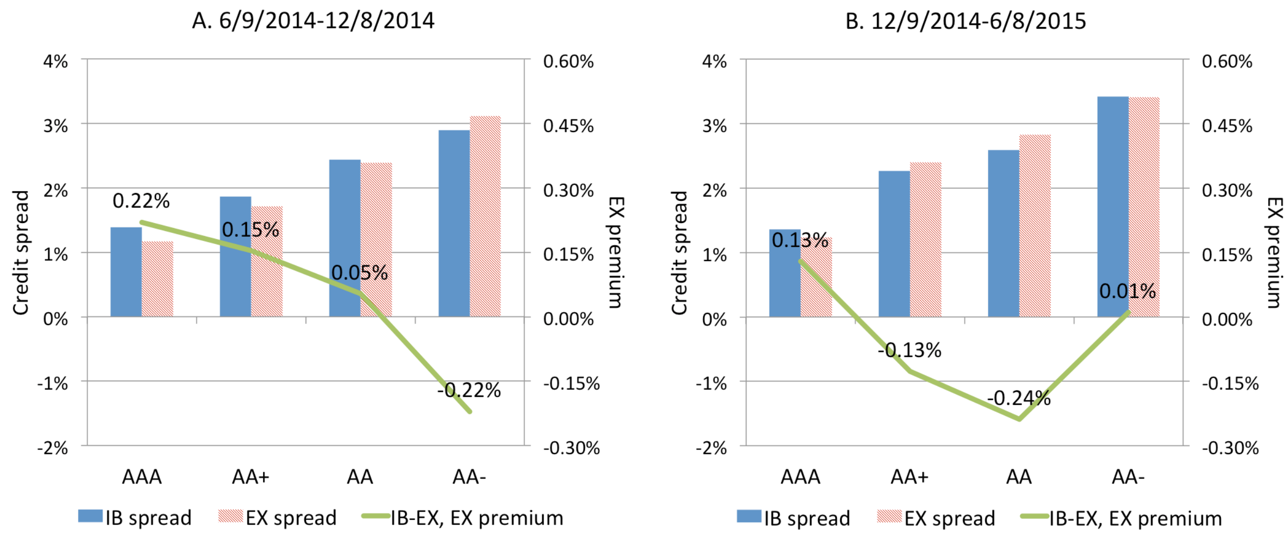


Figure 4: **Exchange premia before and after the event.** This figure plots the average credit spreads for each of the four rating categoris on the interbank market and the exchange, alogn with the average exchange premium. Panels A and B show the results for the 6 months before and after the event date 12/8/2014, respectively.

Exchange premia before the policy shock In Panel A of Figure 4, we plot the average credit spreads on the two markets, along with the average exchange premia, in the 6-month window prior to the policy shock. The sample is restricted to the dual-listed enterprise bonds that satisfy the simultaneous trading criterion defined in Section 3.1. The AAA bonds enjoy a positive exchange premium of 22 bps, which, at roughly a fifth of the average credit spread of these high quality bonds, is significant in terms of economic magnitude. The exchange premia decline monotonically with lower credit ratings: 15 bps for AA+ bonds, 5 bps for AA bonds, and -22 bps for AA- bonds.

To check whether an exchange premium of 22 bps for AAA bonds implies a near-arbitrage opportunity (i.e., whether it is reasonable to expect such an average exchange premium within the arbitrage bounds illustrated by Figure 6), we calculate the returns of a cross-market arbitrage strategy in our sample. Specifically, for the half-year period before the policy shock, we buy AAA bonds on the interbank market whenever the exchange premium exceeds zero (10 bps), hold the bonds for 5 working days, and then sell the holdings on the exchange. We use the volume-weighted average invoice prices on the interbank market as buying prices. The volume-weighted invoice bid prices on the exchange market are used as selling prices. According to industry practice, a minimum trade size of 10 million RMB is assumed on the interbank market. The pace of selling on the exchange is capped at 20% of its daily volume. The annualized Sharpe ratio of this strategy is 0.66 (0.72) based on the IID assumption. Taking into account the correlation in returns across bonds will likely further reduce the Sharpe ratio.

To understand the intriguing pattern of rating-dependent exchange premia, we examine how pledgeability differs on the two markets for bonds with high and low ratings (assuming the other components of exchange premia are common across ratings). On the exchange, the pledgeability of a bond is essentially determined by the haircut. We have explained that the Central Counter-Party system on the exchange features fungibility across various bond securities. In other words, the CSDC treats Treasuries and corporate bonds with different ratings the same way after adjusting for their conversion rates. In addition, the conversion rates are set in a relatively transparent manner, are available to all investors on the exchange, and are committed by the CCP. Such standardization helps improve the liquidity of repo transactions on the exchange.

On the interbank market, however, the haircut for a bond can vary significantly for different counter-parties. The smaller institutional investors – especially those local rural credit unions or small security firms without explicit support from the central government – often complained about the difficulty of using even AAA corporate bonds as collateral for repo transactions, whereas the large commercial banks can get very favorable haircuts on the same type of bonds.[20] Thus, despite the fact that the average haircut for AAA bonds based on the reported repo transactions on the interbank market (about 5%, see Table 3) is lower than the quoted values on the exchange (about 10%, see Table 4), the AAA bonds will actually be more pledgeable on the exchange from the point of view of small institutions. Furthermore, due to tighter financial constraints, we expect these small institutions to value asset pledgeability more than the large commercial banks. These factors would tend to raise the valuation for AAA bonds on the exchange relative to the interbank market, which contributes to the positive exchange premium.

On the other end of the rating spectrum, while the OTC-based bilateral bargaining on the interbank market would allow some reputable institutions to borrow against bonds with AA- ratings, the haircuts for these bonds are essentially at 100% on the exchange even before the policy shock. This makes AA- bonds more pledgeable on the interbank market for the large institutions, which contributes to a negative exchange premium.

[20]Large commercial banks are in a dominating position in Chinese interbank market. According to the official statistics released by the interbank market's clearing and settlement agencies (China Central Depository & Clearing Corporation, and Shanghai Clearing House), at the end of 2014, large state owned commercial banks, "joint-stock" commercial banks, and city commercial banks held 57% of total bond outstanding, while small banks like rural commercial banks, rural credit unions, and postal savings bank only held about 6%. For non-bank financial institutions, mutual funds held about 15%, insurance companies about 7.5%, and security firms about 1%.

Exchange premia after the policy shock We examine the impact of the policy shock on the exchange premia across ratings in the raw data. If the exchange premia are indeed driven by the rating-dependent haircut policy employed by the CSDC, then because the policy shock alters the rating-haircut relationship, one should expect corresponding changes in rating-dependent exchange premia afterwards. This is indeed the case, as shown in Panel B of Figure 4. After the policy shock, exchange premia turned negative for bonds with both AA+ and AA ratings, consistent with these two type of bonds completely losing their pledgeability edge on the exchange. In contrast, the exchange premia for the two control groups either did not drop as much (AAA bonds) or rose (AA- bonds) after the policy shock.[21]

Finally, we plot in Figure 5 the time series of average exchange premia for three rating groups: AAA, AA+/AA (combined into one "mid-rating group"), and AA-. We observe that "mid-rating group" share a similar trend with both the higher-credit-quality AAA control group and the lower-credit-quality AA- group. What is more, while the exchange premia for the AA+/AA bonds were in between those of the AAA and AA- bonds before the event, they fell upon the policy shock while the exchange premia for the two other control groups rose. We highlight that our unique empirical setting allows researchers to use higher- and/or lower- credit rating groups as control to rule out many alternative mechanisms. In these alternative mechanisms, the policy event represents some aggregate fundamental shock, and the treatment and control groups just differ in their sensitivities to the fundamental shock. However, typically the implied responses tend to be monotone in credit ratings, which is not what the data shows.[22]

Notice that the exchange premia for bonds in the two control rating categories (AAA and AA-) rose after the policy shock instead of staying flat. This is mainly because the credit spreads for these bonds became higher on the interbank market after the event; perhaps the policy shock made interbank market investors more reluctant to hold enterprise bonds or accept them as repo collateral. Since such changes would likely also affect (lower) the pricing of AA+/AA bonds on the interbank market, failing to control for the changes in exchange premia in the AAA and AA- bonds will lead us to understate the magnitude of the drop in exchange premia in response to the drop in haircut.

[21] In particular, the rise in exchange premium for AA- bonds in the absence of any meaningful change in haircuts on the exchange suggests that either liquidity on the interbank market deteriorated following the event, or haricuts for AA- bonds on the interbank market rose in ways not captured by Table 3.

[22] Figure 5 also shows that the gap in exchange premia between AAA an AA- bonds closed after the event, which is due to the more significant rise in exchange premia following the event for AA- than AAA bonds. This difference raises the question about which of these two rating categories is a more appropriate control group for our study. We will examine the sensitivity of our Diff-in-Diff analysis and the pledgeability premium estimates to alternative control groups.

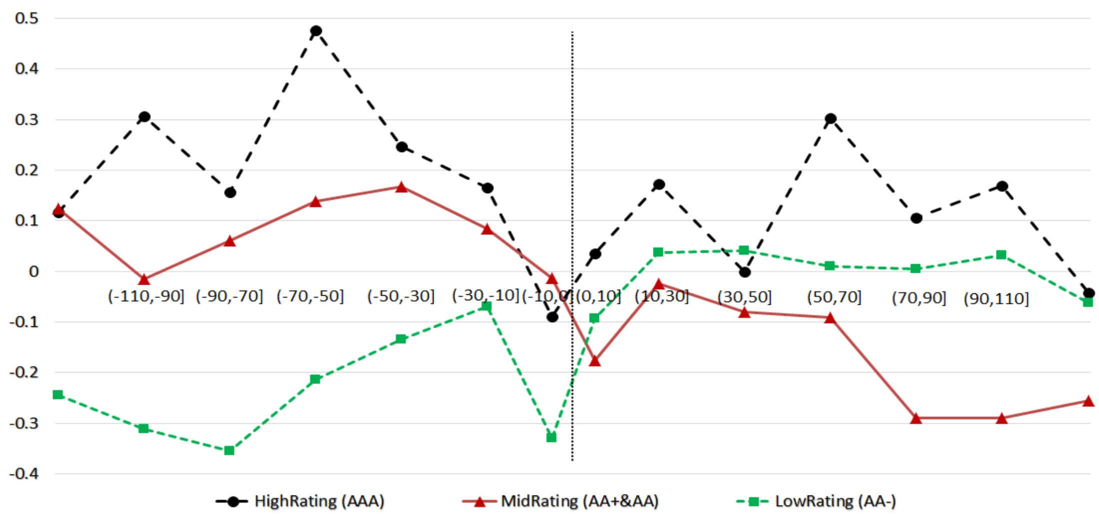


Figure 5: **Exchange premia dynamics.** This figure presents the average exchange premia by bond ratings and subperiods. The three bond-rating groups include the treated group (AA+ and AA), the AAA group, and the AA- group. The sample of simultaneous trading is a [-6,6]-month window around the event day 12/8/2014. The sample is divided into 14 subperiods, with two subperiods of 10 trading days each before and after the event day, and the remaining 12 subperiods of 20 trading days each.

The empirical pattern revealed by the raw data in Figure 5 is encouraging, as they show that the exchange premia in the treatment rating group (AA+ and AA)react differently to the policy shock than the control rating groups (AAA and AA-). However, Figure 5 does not control for the potential changes in the composition of the simultaneous-trading sample before and after the event. These concerns will be formally addressed based on a formal regression-based Diff-in-Diff approach with various fixed effects, to which we turn next.

4 Empirical Analysis

We present our formal empirical analysis in this section. After highlighting the identification challenge in estimating the pledgebility effect on asset pricing, we explain our research design to tackle this empirical challenge. In a nutshell, we focus on the cross-market price difference for the dual-listed enterprise bonds while using the policy shock as an instrument for changes in haircuts. We then perform the IV estimation for the range of the pledgeability effect on asset prices.

4.1 Research Design

To identify the effects of changes in pledgeability on bond pricing, we would ideally like to compare how the price of the same bond behaves with and without an exogenous shock to its haircut. As is evident in Figure 3, the policy shock brought drastic changes to the haircuts of AA+ and AA bonds, while leaving those of AAA and AA- bonds largely unaffected. It is tempting to use the policy shock as an instrument to examine how the prices of the treated bonds (e.g., AA+ and AA bonds on the exchange) and non-treated bonds (e.g., AAA bonds on the exchange) behaved differently with the changes in haircuts.

The problem is that the bonds in the treatment group are obviously not randomly selected. Besides the differences in the observable characteristics, it is possible that the exchange's new policy specifically targeted AA+ and AA bonds for reasons that are not controlled for. In particular, the policy makers might have private information about the rising risks of the treated enterprise bonds, which are signaled to the market through the policy action. If so, the instrument will be correlated with unobserved determinants of the changes in bond prices and hence violates the exclusion restriction. Then we may not be able to attribute the relative changes in yields of the treated bonds to the changes in haircuts.

We tackle this challenge by the following ways. As the main empirical strategy, we first exploit the advantage of dual-listed bonds, so that the cross-market yield spread (i.e., exchange premia) are free of any potentially unobservable variations of asset fundamentals and hence only reflect the changes in their pledgeability across two markets.

However, the resulting IV estimates based on the exchange permia are likely to be downward biased; one of the leading concerns is the cross-market (limited) arbitrage activities. To offer an overestimate of the pledgeability effect, we then repeat the IV estimate procedure on an alternative spread, benchmarking the treated bonds to non-treated AAA bonds but with similar haircuts and credit spreads. All plausible theoretical mechanisms suggest upward biases in the resulting estimate, and hence our approach allows us to provide a range for the economic magnitude of the pledgeability effect.

4.1.1 Exchange premia based on dual-listed bonds

As explained, the exchange premia defined in (2), as cross-market differentials, isolate any potential variations in bond fundamentals but capture the differences in pledgeability (haircuts) on these two markets.

Recall that for each bond i with rating j, we construct its exchange premium

$EXpremium_{ijt}$ at some trading-day t. Let D_{jt} be the dummy variable for the treatment-group rating categories and post-policy-shock periods, i.e.,

$$D_{jt} = \begin{cases} 1 & j \in \{AA+, AA\} \quad \& \quad t > 12/08/2014 \\ 0 & otherwise \end{cases} \tag{3}$$

To use D_{jt} as an instrument to estimate the impact of changes in haircuts on the exchange premium, we first estimate the first stage as follows:

$$haircut_{ijt} = \rho_i + \kappa_j + \eta_t + \beta\, D_{jt} + X'_{i,t}\gamma + v_{ijt}. \tag{4}$$

The regression includes bond fixed effects, rating fixed effects, weekly time fixed effects,[23] bond-level controls including maturity, turnover, price, and volatility, and market-level controls including CDB spot rates, term spreads, the spread between one-day exchange repo rate and interbank lending rate, and stock market returns. Notice that rating fixed effects can be included in the presence of bond fixed effects because a bond's rating can change over time.

The dependent variable in (4), $haircut_{ijt}$, is the exchange haircut for bond i of rating category j on day t. Ideally, we would like to use the differences in haircuts between the exchange and the interbank market, but we do not have access to the latter at bond level. Thus, if the haircuts on the interbank market also changed during this period, it will likely lead to a bias in the estimator $\hat{\beta}$, which in turn biases the 2SLS estimator. We will return to this issue shortly in this section.

The second stage of the 2SLS is

$$EXpremium_{ijt} = \alpha_i + \mu_j + \lambda_t + \delta\, \widehat{haircut}_{ijt} + X'_{it}\theta + \xi_{ijt}, \tag{5}$$

where $\widehat{haircut}_{ijt}$ are the first-stage fitted values for bond haircuts.

For D_{jt} to be a valid instrument, besides a strong first stage, we need to assume that any unobservable fundamental or liquidity factors either affect the bond prices on the two markets in the same way (so that they cancel out in the exchange premia), or that they share common variations between the treated and untreated bonds over time (so that they are captured by the time fixed effects).

Potential downward biases of $\hat{\delta}$. As mentioned above, our estimator $\hat{\beta}$ in the first stage is likely biased if the haircuts on the interbank market also changed after the policy

[23] Daily time fixed effects are too stringent since bond trading is not sufficiently frequent in our sample.

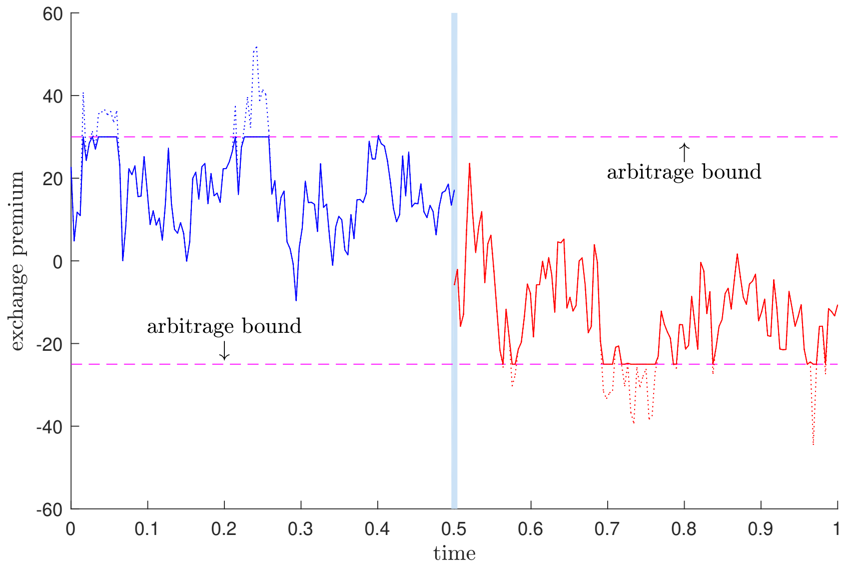


Figure 6: **The impact of arbitrage on the estimate of pledgeability premium.** With simulated data, this figure illustrates how the cross-market arbitrage forces can lead to a reduction in the exchange premium, which in turn leads to a downward-biased estimate of δ.

shock, perhaps because the participants on the interbank market updated their beliefs about the riskiness of enterprise bonds after observing the exchange action. The evidence in Table 3 suggests that this is indeed the case, where the haircuts on the interbank market after the event rose moderately (by between 3-10% in the 1-month window, less in the 6-month window). This means that the first stage will likely overstate the relative changes in haircuts on the exchange, which would in turn understate the effect of the relative changes in haircuts on the exchange premia. In other words, the estimator $\hat{\hat{\delta}}$ in (5) is likely downward biased.

Another perhaps more relevant reason that $\hat{\hat{\delta}}$ is downward biased is the (limited) cross-market arbitrage activities. As illustrated in Figure 6, despite the trading frictions (in particular the delays caused by transfer of depository), market forces will prevent the exchange premium from drifting too far away from zero. Such arbitrage forces will likely reduce the exchange premium prior to the policy shock and increase it afterwards.[24] Consequently, the changes in exchange premia would tend to understate the effect of the pledgeability changes on bond prices.

[24]The presence of arbitrage forces will also likely alter the equilibrium dynamics of the exchange premium, a factor that is ignored in our illustration.

4.1.2 Premia over matching AAA exchange-market bonds

With the consideration of the downward bias of the 2SLS estimator in mind, we consider the following alternative approach that is designed to deliver an upward-biased estimate. Recall that the unexpected policy shock only applied to enterprise bonds on the exchange market by dis-qualifying AA+ and AA bonds' pledgeability while not affecting AAA bonds. We hence construct the pledgeability premium of AA+ and AA enterprise bonds using similar exchange-traded AAA bonds as the benchmark on the exchange market only. The rest of IV estimation procedure is the same.

We match each bond-day observation of AA+ and AA enterprise bonds on the exchange market with AAA bond-day observations that have the same haircut and yield spread during the pre-event window. Our matching procedure results in very similar pre-event haircuts and yield spreads for the treatment group (AA+ and AA) and the matched AAA benchmarks. The average haircuts are 13.0% and 12.8% for treatment and control bonds, respectively; the numbers are 5.3% and 5.4% for the 10th percentile; and the numbers are 29.7% and 27.8% for the 90th percentile. The average yield spreads are 1.31% and 1.26% for treatment and control bonds; the numbers are 0.78% and 0.75% for the 10th percentile; and the numbers are 1.80% and 1.75% for the 90th percentile. The pledgeability premium is thus the difference between a treatment bond's (AA+ or AA) exchange market yield and the average yield of all matched AAA bonds on the same day of trade. Detailed procedures for matching are in Appendix A.3.

This alternative exchange-market AAA benchmark improves our previous estimate in addressing the downward-bias problem, as we can perfectly control for the haircuts of matched AAA bonds (as the benchmark AAA bonds are on the exchange market now), and there is no cross-market arbitrage involved between the treatment bonds and benchmark bonds. What is more, Section 4.3 argues that several leading endogeneity concerns all points to an upward bias of this alternative approach. For instance, as mentioned above, suppose that the policy makers had private information about the rising risks of the treated AA+/AA bonds and the market repriced the treated bonds downward accordingly; then this methodology will attribute this fundamental-driven effect to the pledgeability effect, leading to an upward bias.

4.2 Pledgeability and Asset Prices: Exchange Premia

This section conducts our formal empirical analysis on exchange premia, by first presenting a Diff-in-Diff estimation and then the IV estimate of the pledgeability on asset prices.

4.2.1 Diff-in-Diff analysis

We have presented some preliminary evidence in Figure 4 and Figure 5 that exchange premia across ratings react differently to the policy shock. Overall, they are consistent with the interpretation that the drop in pledgeability on the exchange adversely affects the bond prices. These results, however, have important limitations, as they do not control for the potential changes in the composition of the sample before and after the event. To have a higher chance of being included in the simultaneous trading sample (i.e., being traded on both markets within a three-day window), a bond needs to be traded relatively frequently on the two markets. The trading frequencies are endogenous and could change with market conditions and the policy shock. For example, the trading of corporate bonds, especially AAA bonds, became more frequent after the event, which could have raised the average quality of the AAA bonds in the simultaneous trading sample.

To address the above concerns, we conduct a formal Diff-in-Diff analysis in the 12-month window around the policy shock, controlling for bond, rating and weekly fixed effects, as well as additional market and bond-level variables. The model specification is given in Equation (6). To see the dynamics of the differences in exchange premia between treated and untreated bonds, we divide the 12-month window into 26 sub-periods, with 10 trading days (2-week window) in each period, to ensure there are sufficient number of observations in each sub-period. The dummy variable D^k_{jt}, $k \in \{1, \cdots, 26\}$, equals 1 for the treatment group bonds ($j \in \{AA+, AA\}$) in the sub-period k and 0 otherwise. Following Freyaldenhoven, Hansen, and Shapiro (2018), we normalize the point estimate of the DiD coefficient immediately before the event date to zero. We plot the point estimate d_k of each sub-period and the associated 95% confidence interval.

$$EXpremium_{ijt} = a_i + b_j + c_t + \sum_{k=1}^{26} d_k D^k_{jt} + X'_{it} e + u_{ijt} \tag{6}$$

As Figure 7 shows, the average exchange premia for the treated AA+/AA bonds and the untreated AAA/AA- bonds share a common trend before the event. The DiD coefficients up to 100 days before the event are insignificantly different from the one immediately before the event. After the event, the exchange premia for the treated group became significantly lower relative to the untreated group. The gap ranges between -30 to -50 bps and remained significant in the 6 months after the event. This is consistent with the results in Figure 4.

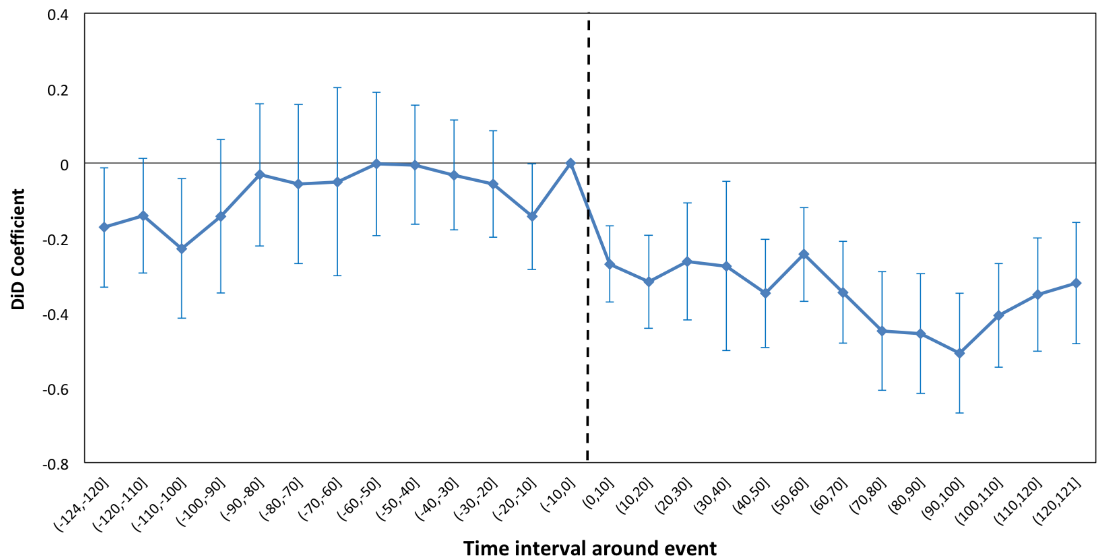


Figure 7: **Difference-in-Difference Estimation of Exchange Premia.** This figure plots the estimated coefficients $\hat{d}_k$ along with their confidence intervals in the difference-in-difference specification of (6). The point estimate immediately before the event date is normalized to zero (hence a zero standard error). The dotted line indicates the event on 12/08/2014. The sample is from 2014/6/9 to 2015/6/8, which is divided into 26 10-day sub-periods.

4.2.2 IV estimation

Next, we conduct the IV estimation following the procedure outlined in Section 4.1. The results are shown in Table 5. We report the estimation results based on three different samples. The first (columns 1 and 2) is the full simultaneous trading sample. The second (columns 3 and 4) is the subsample that excludes AAA bonds (i.e., using only AA- bonds as the control group). The third (columns 5 and 6) is the subsample with AA+ and AA bonds. With only treated bond groups in this sample, the identification comes entirely from time-series variations. By comparing the results across the three samples, we can learn about the sensitivity of the IV to the assumption that how the exchange premia of the treated group and that of the two control groups share common variations over time.

[Insert Table 5]

In all regressions we always include rating fixed effects and time fixed effects at the weekly level. We then report the results based on two different specifications, one without bond fixed effects or other bond and market level regular controls, the other with.[25] The

[25]To simplify the interpretation of estimation magnitude, the exchange premium is quoted in percentage while explanatory variables are quoted in raw values, and the estimated coefficients in the first stage are reported in percentage.

regular control variables include bond level characteristics (time to maturity, turnover ratio, market price, and volatility) and various macro factors (term spread, CDB yield, GC001 over SHIBOR spread, and stock market index).

The first stage, which regresses bond-level haircuts on the exchange on the policy shock dummies and other controls (see Eq. (4)), is quite strong. This is to be expected given the strong dependence of bond-level haircuts on credit ratings (see Table 4) and the nature of the policy shock (which specifically targeted on ratings). The magnitude of the coefficient on the policy shock dummy is consistent across all three samples. Without bond fixed effects and the regular controls, the value of around 70% reflects the average rise in haircut for AA+ and AA bonds (see Figure 3). The magnitude of the coefficient drops slightly after the bond level controls are included, likely reflecting the changes in the composition of the sample due to the "simultaneous trading" requirement.

In the second stage, we regress the exchange premia on the fitted haircuts $\widehat{haircut}$ from the first-stage regression (see Eq. (5)), with the coefficient δ measuring the effect of changes in haircut on exchange premia. The coefficient estimate is again quite stable across different samples and specifications. In the full sample, the estimated $\hat{\delta}$ of -0.40 implies that a rise in haircut from 0 to 100% would raise the bond yields on the exchange by 40 bps.

Next, dropping the AAA bonds from the sample raises the magnitude of the estimated $\hat{\delta}$ to -0.53. This is consistent with the diff-in-diff results presented earlier (see Figure 7), where we saw the average exchange premium of AA- bonds rising more than that of the AAA bonds after the event. Recall that our identification assumption is that any residual (uncontrolled) movements in the exchange premia of the control group are shared by the treated group. Thus, a more pronounced increase in the AA- exchange premia implies that there has been more deterioration in liquidity on the interbank market relative to the exchange during this period, which in turn means that the haircut increases must have caused a larger decline in prices on the exchange relative to the interbank market in order to offset the effects of liquidity changes.

Finally, when restricting the sample to the one without the AA- bonds, we are essentially using only the AAA bonds as the control group. The estimated $\hat{\delta}$ is -0.21. This is the most conservative estimate among the three samples, implying that a rise in haircut from 0 to 100% would raise the bond yields on the exchange by 21 bps.

Standard errors in all the above regressions are computed using two-way clustering by bond and week. For robustness, we also compute the standard errors based on clustering by rating and week. The results (see Table A4 in the Appendix) are quantitatively similar to Table 5. In addition, we also repeat our analysis for a shorter sample length with a half-year event window (Table A5 in Appendix) and using the same-day trading sample (Table A7 in Appendix), and find all the findings are quantitatively similar.

4.3 Pledgeability and Asset Prices: Matching AAA Bonds

The exchange premium, defined as the spread between the interbank yield and the exchange yield of the same bond with simultaneous trading, takes out the unobservable bond quality and hence addresses the important endogeneity concern caused by asset difference in fundamentals. This, together with the quasi natural experiment of policy shock on the pledgeability of bonds with certain ratings, forms the basis of our IV estimate for the effect of pledgeability on bond pricing in the previous section.

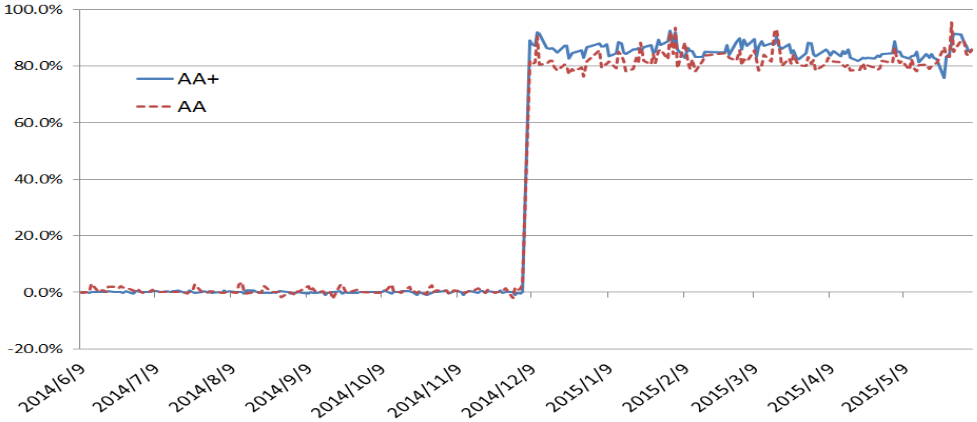
As mentioned toward the end of Section 4.1.1, our IV estimate based on exchange premium is likely biased downward. In the data, although there were no significant reactions on the interbank market for AA+ and AA rated bonds on the day of the policy shock, the yield spreads of these rating classes rose slowly in the days afterwards, potentially due to arbitrage activities between these two markets. In other words, the interbank-market yield spreads could also be adversely affected by the policy shock on the exchange. This implies that our results based on the exchange premium are likely to underestimate the price impact of the increases in haircuts.

In this section, we consider an alternative benchmark for the treatment group (AA+ and AA) enterprise bonds to construct their exchange pledgeability premium, whereby the resulting estimate is likely to be an overestimate for the price impact of haircut changes. We choose the benchmark to be the "matched" AAA enterprise bonds traded on the exchange. These matched AAA bonds have similar haircuts and yield spreads as those AA+/AA bonds (the treatment group) on the same day of trades in the six-month pre-event window, but their haircuts were largely intact after the policy shock. Figure 8 shows the differences in haircuts and yield spreads of the bonds in the treatment group and those matched AAA bonds. For detailed matching procedure, see Appendix A.3.

The rationale for our empirical design is as follows. For the treatment AA+/AA group, we want to find those AAA bonds with the same pledgeability and prices before the policy shock, so that the pledgeability premium components in the prices of the bonds from the treatment group and the control group are comparable in magnitude prior to the event. The policy shock completely eliminates the pledgeability of the treatment group AA+/AA bonds while leaving that of the matched AAA bonds untouched. Hence, the spread increase of the treated AA+/AA bonds relative to the matched AAA bonds should reflect the value of pledgeability.

In contrast to the exchange premium studied in Section 4.2, the premium over the

Panel A: Differences in haircuts



Panel B: Differences in credit spreads

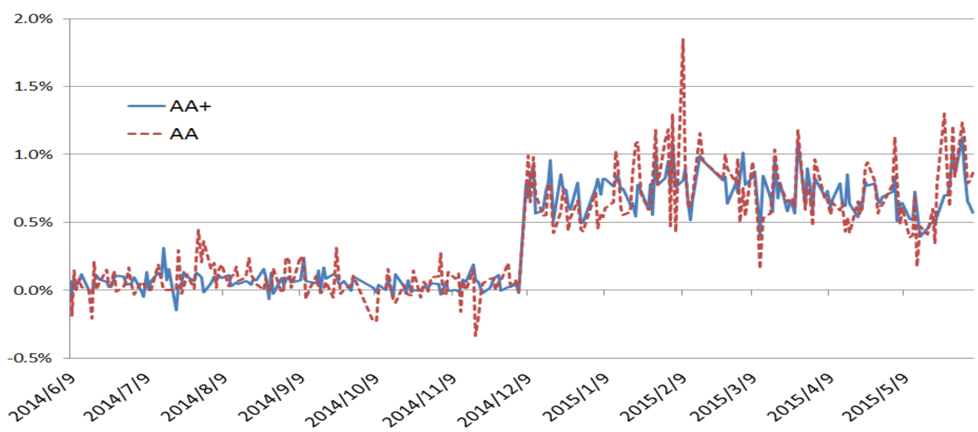


Figure 8: **Differences in Haircuts and Exchange Credit Spreads between the AA+/AA and Matched AAA Bonds.** This figure plots differences of AA+/AA dual-listed enterprise bonds' haircut and exchange market credit spread w.r.t matched AAA bonds. Panels A and B plot the difference in haircut and credit spread for AA+/AA bonds with matched AAA bonds, respectively. The matching variables include the pre-event exchange market credit spread and haircut with the details in the Appendix. The sample period is 6/9/2014 to 6/8/2015.

matched AAA bonds tends to be upward biased. To illustrate this point, consider the following decomposition of the premium, which is the yield of matched AAA-bonds minus that of treated AA+/AA rated bonds:

$$\begin{aligned} \text{Yield}_{it}^{AAA} - \text{Yield}_{it}^{AA+/AA} = & \left(\text{Pledgeability}_{it}^{AAA} - \text{Pledgeability}_{it}^{AA+/AA}\right) \\ & + \left(\text{Fundamental}_{it}^{AAA} - \text{Fundamental}_{it}^{AA+/AA}\right). \end{aligned} \tag{7}$$

Here, the first difference on pledgeability of these two groups of bonds is what our empirical design tries to pick up. The second bracket, which concerns the unobservable difference between these two bond groups, is what challenges identification in general. Note, given the Diff-in-Diff nature of our empirical methodology (our IV is a policy shock), researchers only need to worry about potential correlations between the second bracket and the policy shock (on pledgeability).

The advantage of our approach is that we are interested in an overestimate of the value of pledgeability; in other words, we are tolerant on potential mechanisms which produce a positive correlation between the second bracket and the policy shock (which is a negative shock to pledgeability). All plausible mechanisms in our context seem to satisfy this condition. The following are three leading endogeneity concerns that could contaminate our estimate; however, all of them are generating overestimate of the value of pledgeability:

1. Suppose that the policy maker has some private information that AA+/AA rated bonds are with worse quality than the market believes, and hence released the liquidity-tightening rules on these bonds. The market viewed the policy shock as the negative signal of the treated AA+/AA bonds, leading to a spike of spreads of AA/AA+ bonds and hence a negative shock to the second term. This implies a negative shock to the premium (yield of AAA over that of treated AA/AA+), hence a positive correlation between the second bracket and the negative policy shock.

2. Alternatively, suppose that the policy shock represents a liquidity-tightening event, and the resulting flight-to-liquidity lowers the yield of matched AAA bonds, perhaps due to better uncontrolled fundamentals (i.e., beyond the observable controls we add in the regressions). This again leads to a negative shock to the premium and hence a positive correlation in consideration.

3. Finally, suppose that the matched AAA bonds are with better fundamentals and hence with a smaller beta than treated AA/AA+ bonds. Since the liquidity-tightening policy shock represents a negative aggregate market shock, the difference in beta translates the tightening policy shock to a positive fundamental shock. Since higher fundamentals correspond to lower yields, this mechanism again gives rise to a positive correlation between the second bracket and the negative policy shock.

Table 6 reports the results of the two-stage IV estimation using the matched AAA bonds as benchmark.[26] The first-stage is reported in Panel A and confirms the the policy

[26]For the sample of only treated AA+ and AA bonds, we do not include the weekly time fixed effects as our treatment dummy only reflects the time series variation coming from pre and post the event.

shock is a strong instrument variable. The estimated coefficients of the second-stage regressions are consistent with our conjecture (Panel B of Table 6): a 1% increase in haircut of AA+/AA bonds transfers to a 0.83 bps decrease in the pledgeability premium,[27] the effect of which is larger than that of 0.40 bps when the interbank yield spread of the simultaneous trading sample is used as benchmark (Column 2 of Table 5). Overall, our IV estimation provides a lower bound of 40 bp and an upper bound of 83 bps on bond yields when the haircut increases from 0 to 100%. Taking the two numbers together, the average impact on yield spread for a 100% increase in haircut is around 61 bp, which translates to 3.84 RMB price change for an average dual-listed enterprise bond.[28]

5 Conclusion

The equilibrium price of an asset not only depends on its fundamentals but also its pledgeability. The Chinese corporate bond markets provide an ideal laboratory to study the effect of pledgeability empirically, thanks to the fact that bonds with identical fundamentals are simultaneously traded in two parallel markets, the centralized exchange market, and the decentralized OTC interbank market. The differences in pledgeability lead to identical corporate bonds having different prices on the two markets. By exploiting a policy shock that dramatically reduced the pledgeability of bonds rated below AAA and above AA- on the exchange market, we are able to establish a causal effect of asset pledgeability on prices. Estimates based on instrumental variables imply that a 100% increase in haircut increases yield spreads by 40-83 bps.

[27]To be consistent with the definition of exchange premium and the interpretation of the economic magnitude, the premium in question is the yields of AA+/AA enterprise bonds minus those of matched AAA enterprise bonds.

[28]An average dual-listed enterprise bond in China's bond market has a face value of 100, a maturity of 7.6 years, a coupon rate of 6.62%, and a YTM of 6.45%.

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Table 1: Definition of Variables

Variables	Definition
Dependent variables	
EX premium	Exchange premium in terms of percentage is the interbank market yield spread minus the simultaneous exchange market yield spread
EX premium$_{pre}$	Exchange premium of the subsample before the policy shock from 6/9/2014 to 12/8/2014
EX premium$_{post}$	Exchange premium of the subsample after the policy shock from 12/9/2014 to 6/8/2015
Matched spread	Credit spread in terms of percentage is the exchange market AA+/AA-rated bond yield spread minus the matched AAA-rated bond yield spread
Explanatory variables	
Haircut	The percentage of levered investors' own money needed for the margin account to borrow using the underlying bond as collateral
Haircut$_{pre}$	Haircut of the subsample before the policy shock from 6/9/2014 to 12/8/2014
Haircut$_{post}$	Haircut of the subsample after the policy shock from 12/9/2014 to 6/8/2015
Conversion	The rate (%) between the value of exchange market standard bond that can be converted from one unit of pledgeable bonds
Conversion$_{pre}$	Conversion rate of the subsample before the policy shock from 6/9/2014 to 12/8/2014
Conversion$_{post}$	Conversion rate of the subsample after the policy shock from 12/9/2014 to 6/8/2015
Bond-day level variables	
IB spread	The interbank market credit spread defined as bond trading price implied YTM minus the matching China Development Bank bond yield
EX spread	The exchange market credit spread defined as bond trading price implied YTM minus the matching China Development Bank bond yield
Maturity	The number of years to maturity as of the day of trade
Turnover	The total number of shares traded in both interbank and exchange markets over the number of shares outstanding
Market price	The average invoice trading price of the most recent five non-zero trading days of the exchange market
Volatility	The highest close price minus the lowest close price divied by the average of the two over the past five non-zero trading days of the exchange market
Day level variables	
CDB$_{spot}$	10-year China Development Bank spot yield as of the day of trade
Term spread	10-year Treasury yield minus 1-year Treasury yield as of the day of trade
GC001-SHIBOR	Spread of 1-day Shanghai exchange repo rate over 1-day Shanghai Interbank Offering Rate as of the day of trade
Ret$_{stock}$	Daily return of Shanghai Composite Index as of the day of trade

Table 2: Summary Statistics

This table reports the summary statistics the simultaneous trading sample from 6/9/2014 to 6/8/2015. Number of observations, the mean, the standard deviation, the 10th percentile, the median, and the 90th percentile are presented. Panel A presents the summary statistics of key variables. Panel B presents the summary statistics of exchange premium by rating. Panel C presents the summary statistics of haircut by rating.

Panel A: All variables

	N	Mean	STD	P10	Median	P90
EX premium	9976	-0.03	0.45	-0.62	-0.02	0.50
EX $premium_{pre}$	4882	0.08	0.40	-0.38	0.05	0.56
EX $premium_{post}$	5094	-0.14	0.47	-0.73	-0.11	0.41
Haircut	9976	63.79	38.50	14.41	100.00	100.00
$Haircut_{pre}$	4882	32.35	23.50	7.42	30.51	44.63
$Haircut_{post}$	5094	93.93	22.75	100.00	100.00	100.00
Conversion	9976	38.34	40.85	0.00	0.00	90.00
$Conversion_{pre}$	4882	71.68	25.19	58.00	74.00	98.00
$Conversion_{post}$	5094	6.39	23.95	0.00	0.00	0.00
IB spread	9976	2.40	0.80	1.40	2.41	3.41
EX spread	9976	2.44	0.85	1.31	2.49	3.46
Matched spread	9961	0.56	0.68	-0.12	0.47	1.40
Matched $spread_{pre}$	2176	0.05	0.15	-0.12	0.04	0.26
Matched $spread_{post}$	7785	0.70	0.70	-0.12	0.71	1.50
Matched $spread_{AA+}$	7246	0.55	0.65	-0.11	0.45	1.38
Matched $spread_{AA}$	2715	0.58	0.75	-0.18	0.50	1.48
Maturity	9976	5.11	1.62	2.96	5.29	6.74
Turnover	9976	0.08	0.08	0.01	0.05	0.17
Market price	9976	105.06	5.64	100.46	105.37	110.81
Volatility	9976	0.02	0.02	0.00	0.01	0.04
CDB_{spot}	9976	4.36	0.51	3.80	4.15	5.18
Term spread	9976	0.54	0.31	0.27	0.44	0.95
GC001-SHIBOR	9976	1.89	3.86	-0.46	0.61	5.46
Ret_{stock}	9976	0.40	1.59	-1.13	0.32	2.31

Panel B: Exchange premium by rating (%)

	N	Mean	STD	P10	Median	P90
AAA	538	0.16	0.45	-0.34	0.07	0.72
AA+	3082	0.02	0.42	-0.53	0.01	0.55
AA	5181	-0.08	0.45	-0.69	-0.04	0.45
AA-	1175	-0.05	0.45	-0.61	-0.05	0.48

Panel C: Haircut by rating (%)

	N	Mean	STD	P10	Median	P90
AAA	538	10.62	8.82	5.21	6.74	26.00
AA+	3082	60.56	40.65	7.14	100.00	100.00
AA	5181	63.02	35.57	26.39	43.20	100.00
AA-	1175	100.00	0.00	100.00	100.00	100.00

Table 3: Haircuts on the Interbank Market

This table reports the average haircuts on the interbank market one and six months prior to and post the policy shock on the exchange on December 8, 2014. The average values are computed based on all the enterprise bond repo transactions conducted by an anonymous major bank on the interbank market. The numbers in parentheses are standard errors.

Sample period	AAA	AA+	AA	AA- & below
11/09/14 – 12/08/14	7.41	11.44	28.85	33.64
	(0.85)	(1.87)	(3.12)	(14.11)
12/09/14 – 01/08/15	17.24	16.53	32.14	37.18
	(1.10)	(2.24)	(2.88)	(22.37)
06/09/14 – 12/08/14	8.38	12.93	32.03	35.66
	(0.56)	(0.96)	(1.53)	(7.01)
12/09/14 – 06/08/15	13.76	14.38	31.23	37.20
	(0.44)	(1.25)	(1.28)	(8.89)

Table 4: Determinants of Conversion Rate

This table reports the regression results of dual-listed enterprise bonds' exchange market conversion rates on rating dummies and control variables. The sample in Columns (1) to (3) includes all dual-listed enterprise bonds' daily observations including those without transaction. The sample in Columns (4) to (6) includes daily observations with simultaneous trading within a two-day window in two markets. Heteroscedasticity consistent t-statistics clustered by bond are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively. The sample period is 6/9/2014 to 12/8/2014.

	Full			Simultaneous		
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy_{AAA}	91.41***		36.13***	93.20***		-95.80***
	(125.22)		(3.13)	(25.37)		(-3.49)
Dummy_{AA+}	80.83***		26.67**	82.26***		-105.66***
	(89.78)		(2.26)	(47.72)		(-4.00)
Dummy_{AA}	72.53***		18.85	72.00***		-113.19***
	(178.62)		(1.60)	(67.93)		(-4.29)
Dummy_{AA-}	1.89		-49.74***	3.84		-177.49***
	(1.10)		(-4.32)	(1.01)		(-7.06)
Market price		0.71***	0.57***		0.70***	1.50***
		(98.04)	(4.94)		(42.08)	(6.16)
Volatility		-26.31	-48.56**		-110.66**	-64.46**
		(-0.88)	(-2.36)		(-2.27)	(-2.11)
MCB			-2.03**			-2.96
			(-2.27)			(-1.37)
Coupon			-0.93			-2.61*
			(-1.34)			(-1.92)
Maturity			0.28			1.07
			(1.17)			(1.40)
Turnover			386.22***			3.88
			(5.67)			(0.85)
$\text{Yield}^{CDB}_{matching}$			53.23			1180.65**
			(0.25)			(2.13)
Size			1.21***			1.00
			(2.85)			(1.25)
Leverage			-8.75***			-6.34
			(-3.42)			(-0.95)
CDB_{spot}			-2.47			-9.31*
			(-1.23)			(-1.69)
Term spread			-2.95**			-2.64
			(-2.55)			(-0.63)
SHIBOR			4.17***			12.19***
			(6.84)			(4.13)
Ret_{stock}			0.12***			0.18
			(4.65)			(0.75)
Industry FE	No	No	YES	No	No	YES
N	117780	117780	117780	4882	4882	4882
R-square	0.968	0.921	0.970	0.952	0.898	0.958

Table 5: IV Estimation

This table reports the results of IV regressions using the simultaneous trading sample. Panels A and B present the results for the first and second stage regressions. Columns (1) and (2) present the results using full sample. Columns (3) and (4) present the results using a subsample of AA+, AA, and AA- bonds. Columns (5) and (6) present the results using a subsample of AA+, AA, and AAA bonds. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent t-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Haircut	(1)	(2)	(3)	(4)	(5)	(6)
Shock	72.89***	67.80***	72.12***	64.96***	74.35***	72.31***
	(66.20)	(25.62)	(71.89)	(16.26)	(47.09)	(54.45)
Controls	No	Yes	No	Yes	No	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	9976	9799	9438	9282	8801	8631
R-square	0.93	0.97	0.92	0.96	0.92	0.97

Panel B: Second stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Exchange premia	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Haircut}$	-0.50***	-0.40***	-0.64***	-0.53***	-0.24**	-0.21*
	(-5.36)	(-3.93)	(-6.25)	(-4.38)	(-2.01)	(-1.95)
Maturity		1.97***		2.10***		0.24***
		(3.03)		(3.02)		(3.33)
Turnover		0.07		0.05		0.10
		(0.78)		(0.60)		(0.93)
Market price		0.01**		0.01**		0.01***
		(2.59)		(2.11)		(3.05)
Volatility		0.08		-0.03		0.01
		(0.27)		(-0.10)		(0.03)
CDB_{spot}		-8.47		-4.95		-13.36
		(-0.86)		(-0.49)		(-1.13)
Term spread		5.48		1.37		10.80*
		(1.06)		(0.23)		(1.98)
GC001-SHIBOR		-0.25**		-0.25**		-0.23*
		(-2.19)		(-2.34)		(-1.88)
Ret_{stock}		-0.14		-0.26		0.09
		(-0.46)		(-0.71)		(0.26)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	9976	9799	9438	9282	8801	8631
R-square	0.15	0.50	0.14	0.48	0.17	0.52

Table 6: IV Estimation using Matched AAA Bonds as Benchmark

This table reports the results of IV regressions using the matched AAA bonds as benchmark. The pledgeability premium is the credit spread between AA+/AA dual-listed enterprise bonds and their matched AAA bonds, where the matching criteria include yield spread and haircut before 12/8/2014. Panels A and B present the results for the first and second stage. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent t-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent: Haircut	(1)	(2)
Shock	86.89***	85.77***
	(71.00)	(64.87)
Controls	No	Yes
Rating FE	Yes	Yes
Bond FE	No	Yes
N	9961	9916
R-square	0.98	0.99

Panel B: Second stage

Dependent: Pledgeability premium	(1)	(2)
$\widehat{Haircut}$	-0.74***	-0.83***
	(-13.57)	(-11.93)
Maturity		-0.03
		(-0.26)
Turnover		2.18**
		(2.61)
Market price		0.02***
		(3.50)
Volatility		0.39
		(0.74)
CDB_{spot}		-3.53
		(-0.81)
Term spread		4.40
		(0.83)
GC001-SHIBOR		-0.19
		(-0.73)
Ret_{stock}		0.32
		(0.74)
Rating FE	Yes	Yes
Bond FE	No	Yes
N	9961	9916
R-square	0.15	0.63

Appendix

A Details of Data Construction

A.1 Bond rating classification

Multiple bond ratings or issuer ratings. In China, there are five major rating agencies offering rating services to bond issuers.[29] Moreover, credit ratings are available at both the bond level and the issuing entity level. Consequently, not only can a bond have multiple bond ratings, it can also have multiple issuer ratings. We use the following procedure to determine the unique bond and issuer rating for a given bond on a given day. First, for bond rating, we follow the market convention of "lowest rating principle." That is, if there are multiple ratings available for the same bond on a given day, we use the lowest rating as the bond rating.

We then determine the issuer rating for this bond. For the sample before October 24, 2014, the issuer rating would be the one from the same rating agency where the lowest bond rating is obtained. The CSDC refers to this as the "issuer-bond rating matching principle." For the sample after October 24, 2014, following the new CSDC policy, we set the issuer rating to be the lowest one among all the issuer ratings for the same bond.

Bond rating reclassification. As explained in Section 2.5, on the evening of December 8, 2014, the exchange not only made the enterprise bonds rated below AAA ineligible as repo collateral, but also disqualified the AAA enterprise bonds with below-AA issuer ratings or having an AA issuer rating but with negative outlooks. To be conservative, we reclassify these two types of AAA bonds as AA- bonds in the after-event period.

Our final sample has four re-defined rating groups for each bond-day observation: AAA, AA+, AA, and AA- (including those bonds with below AA- rating). AA+ and AA bonds are classified as treatment group and AAA and AA- bonds are classified as control group.[30] We also drop observations whose bond rating switches between treatment group and control group within the [-2,2] month window around the event date.

The exchange's criteria regarding repo eligibility of various bonds have changed several times just in 2014. Before June 27, 2014, bonds with both the issuer rating and bond

[29] These five rating agencies are Chengxin (Chengxin Securities Rating and Chengxin International Rating), Lianhe (China United Rating and China Lianhe Rating) and Dagong Global Credit Rating; for a comprehensive review of the rating agency, see Amstad and He (2018).

[30] AA- bonds are included in the control group as few AA- bonds are pledgeable even before the policy shock.

rating no lower than AA were eligible as repo collateral on the exchange. Regulations released on May 29 and June 27 that year required that starting from June 27, bonds in pledge with issuer rating of AA should have the issuer status either "Positive" or "Stable" (instead of "Negative"). The issuer rating refers to the rating given by the specific rating agency that rates its bond. However, as more and more firms issue more than one bond, it is highly probable that one issuer has conflicting issuer rating from different agencies rating different bonds that the firm issues. Therefore, the policy released by CSRC on October 24 further designate the issuer rating as the lowest one among all these applicable ratings. In accordance with the policies, we make adjustment to the bond rating grouping to guarantee the consistency of bonds' pledgeability. Specifically, for the trading days after October 24, we define the issuer rating according to the "Lowest Rule"; and by jointly considering bond rating, issuer rating and status, we re-categorize all the bonds without repo eligibility into the "Low Rating" group.[31]

A.2 Construction of exchange premium

The exchange premium is the yield spread between the interbank yield and the exchange yield for the same bond, based on the prices of either "simultaneous" or "same-day" transactions from the two markets.

The pairing procedure for "simultaneous trading" is as following:

1. For days with interbank market trading, we match day t's interbank market yield spread with the closest exchange market daily yield spread within the window [t-2, t]. Specifically, if this bond has non-zero trading on day t in exchange market, the exchange premium is the difference between day t interbank market yield spread and day t exchange market yield spread. If this bond does not have any trading on day t on the exchange market but has non-zero trading on day t-1 (t-2), the exchange premium is the difference between day t interbank market yield spread and day t-1 (t-2) exchange market yield spread.

2. For days with exchange market trading, we match day t's exchange market yield spread with the closest interbank market daily yield spread within the window [t-2, t]. Because we have already paired the same-day two-market trades in step 1, exchange market day t observation is dropped if the bond has non-zero interbank market trading on day t. Otherwise, the exchange premium is the difference

[31]Since for certain reasons, certain bonds not reaching the pledgeability criteria shows positive converting rate, we perform a conservative practice in rating adjustment that only re-categorize those below-criteria with very low converting rate (below 0.1) bonds into the "Low Rating" group.

between day t-1 (t-2) interbank market yield spread and day t exchange market yield spread.

A.3 Matching procedures of AA+ and AA enterprise bonds with AAA enterprise bonds

We match exchange market listed AA+ and AA-rated enterprise bonds with AAA-rated enterprise bonds as benchmark in two dimensions: haircut and matching CDB yield spread. The matching is conducted at bond-day level in the six-month window before the event date, i.e., from June 9 to December 8, 2014. For any AA+/AA bond that was ever traded in the six-month window after the event date (December 9, 2014 to June 8, 2015), the average yield of all non-zero trading AAA bonds that belong to the set of pre-event matched AAA bonds w.r.t. the AA+/AA bond is used as the benchmark yield. The following steps describe the detailed pre-event matching procedure and how we benchmark AA+/AA bonds with matched AAA bonds.

1. For a daily observation of an AA+ or AA rated bond with non-zero exchange market trading in the [-6, 0] month pre-event window, five non-zero trading AAA-rated bonds that have the five smallest absolute differences in haircut w.r.t. the AA+/AA bond on the day of trade are kept as candidate benchmark bonds.

2. To ensure that an AA+ or AA bond's haircut is close enough to those of the candidate AAA bonds, an AA+ or AA bond's bond-day observation is dropped if the fifth smallest absolute haircut difference between an AA+ or an AA bond and the candidate AAA bond is larger than the median value of all absolute haircut differences. The candidate AAA bond pool for the AA+ or AA bond i on day t is denoted by $\text{AAA}_{i,t}^{haircut}$.

3. For a daily observation of an AA+ or AA rated bond with non-zero exchange market trading in the [-6, 0] month pre-event window, five non-zero trading AAA-rated bonds that have the five smallest absolute differences in matching CDB yield spread w.r.t. the AA+/AA bond on the day of trade are kept as candidate benchmark bonds.

4. To ensure that an AA+ or AA bond's matching CDB yield spread is close enough to those of the candidate AAA bonds, an AA+ or AA bond's bond-day observation is dropped if the fifth smallest absolute yield spread difference between an AA+ or AA bond and the candidate AAA bond is larger than the median value of all

absolute yield spread differences. The candidate AAA bond pool for the AA+ or AA bond i on day t is denoted by $\text{AAA}_{i,t}^{yieldspread}$.

5. AAA bonds that belong to both $\text{AAA}_{i,t}^{haircut}$ and $\text{AAA}_{i,t}^{yieldspread}$ are denoted as matched set of AAA bonds for AA+ or AA bond i on day t, $\text{AAA}_{i,t}^{matched}$.

6. For any AA+ or AA bond i day t observation in the six-month pre-event window, the average yield of AAA bonds belonging to $\text{AAA}_{i,t}^{matched}$ is taken as the benchmark yield.

7. For any AA+ or AA bond i, the union of all its matched bond sets $\text{AAA}_{i,t}^{matched}$ across its non-zero trading days T_i is denoted by $\text{AAA}_{i}^{matched} = \bigcup_{t \in T_i} \text{AAA}_{i,t}^{matched}$.

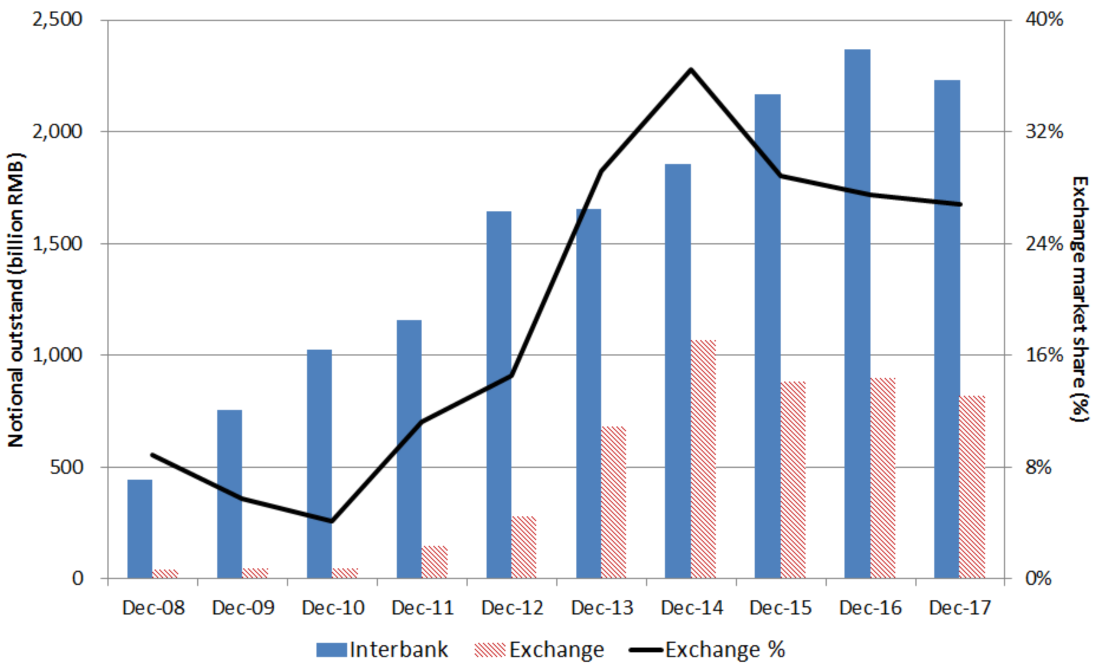
8. For any AA+ or AA bond i day τ observation in the six-month post-event window, the average yield of AAA bonds with non-zero trading on day τ belonging to $\text{AAA}_{i}^{matched}$ is taken as the benchmark yield.

B Additional Results

Figure A1: China's Dual-listed Enterprise Bond Market

This figure plots China's dual-listed enterprise bond market from 2008 to 2017. Panel A plots enterprise bond outstanding in interbank and exchange markets. Panel B plots all enterprise bond issuance and dual-listed enterprise bond issuance.

Panel A: Dual-listed enterprise bond outstanding by depository market (billion RMB)



Panel B: Enterprise bond issuance (billion RMB)

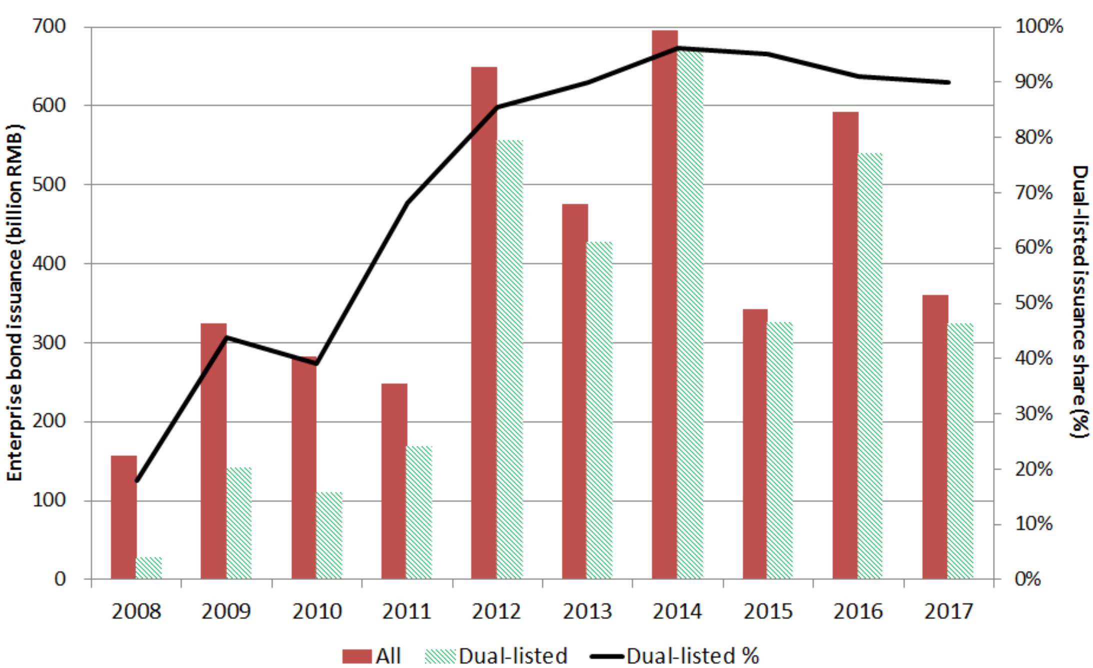
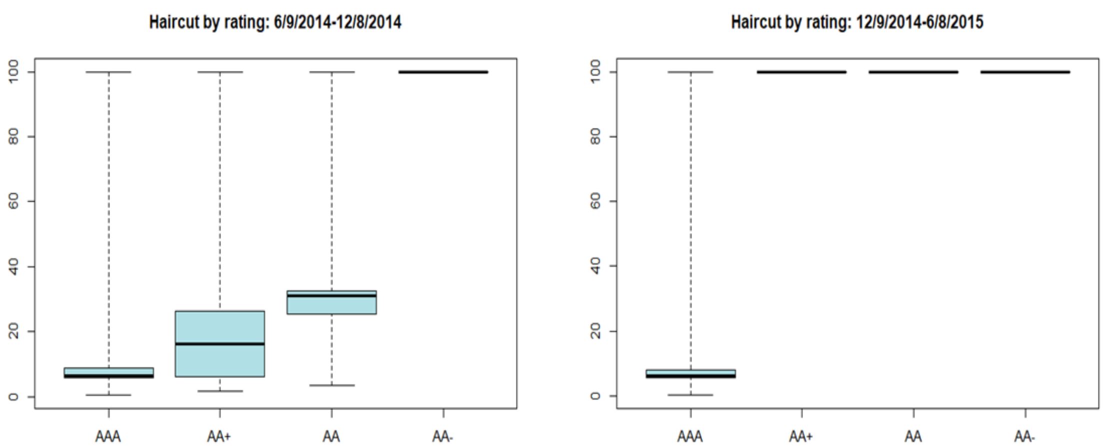


Figure A2: Haircut Distribution

This figure presents box plots of haircut by rating. Panel A presents the box plots using the dual-listed enterprise bond sample with non-zero trading. Panel B presents the box plots using the simultaneous trading sample. The pre-event subsample is 6/9/2014 to 12/8/2014 and the post-event subsample is 12/9/2014 to 6/8/2014.

Panel A: Dual-listed enterprise bond sample



Panel B: Simultaneous trading sample

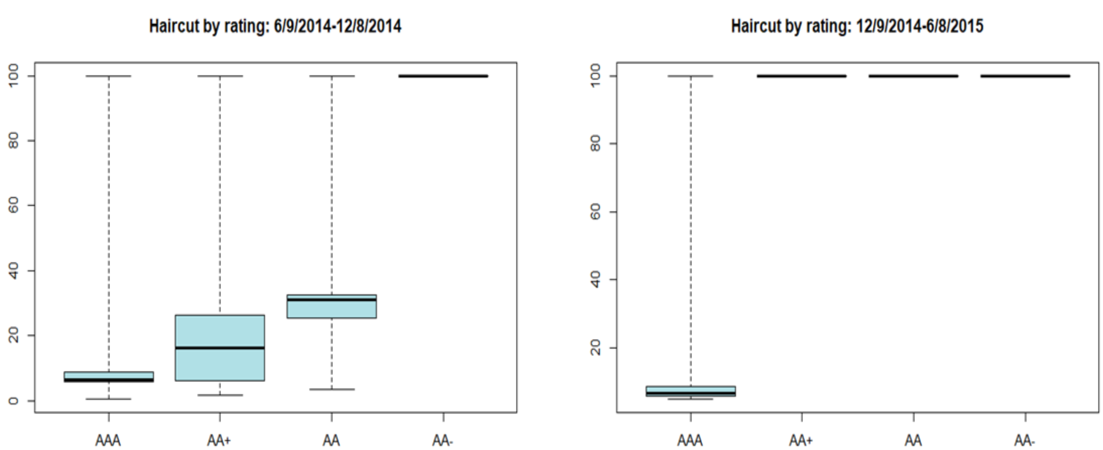


Table A1: China's Bond Market Liquidity

This table reports various measures of China's bond market liquidity. ZDays is the time series average of the fraction of bonds that do not trade on a given day. $\text{ZDays}_{w/trade}$ is the time series average of the fraction of bonds that do not trade on a given day, excluding bonds that do not have any single trade over the sample period. Turnover is the average daily turnover across all bond-day observations where a zero is recorded on days without trade. Amihud is the average Amihud (2002) measure across all bonds, where a bond's Amihud measure is estimated using its all non-zero daily trading observations and multiplied by 10^6. Panel A presents the comparison of liquidity between China's two bond markets and U.S. bond market. Panel B presents the exchange market liquidity measures for all exchange-traded bonds, enterprise bonds, and exchange-traded corporate bonds. Panel C presents the interbank market liquidity measures for all interbank-traded bonds, enterprise bonds, mid-term notes, and commercial papers. In Panel A, the sample period is 1/1/2012 to 12/31/2017 for China's two markets and the sample period is 1/1/2010 to 12/31/2014 for the U.S. market, where the U.S. market liquidity measures are from Anderson and Stulz (2017). In Panels B and C, the sample period is 6/9/2014 to 6/8/2015.

Panel A: China and U.S. comparison

	China: Interbank	China: Exchange	U.S.
ZDays	0.88856	0.81326	0.78820
$\text{ZDays}_{w/trade}$	0.88768	0.79798	0.70940
Turnover	0.01212	0.00099	0.00150
Amihud	0.00016	2.54233	0.48810

Panel B: China's exchange bond market liquidity

	All	Enterprise bond	Exchange-traded corporate bond
ZDays	0.80693	0.83215	0.75485
$\text{ZDays}_{w/trade}$	0.77092	0.80758	0.68604
Turnover	0.00109	0.00050	0.00231
Amihud	2.93788	3.79992	1.06712

Panel C: China's interbank bond market liquidity

	All	Enterprise bond	Mid-term note	Commercial paper
ZDays	0.90284	0.92185	0.92419	0.83746
$\text{ZDays}_{w/trade}$	0.89786	0.91462	0.92160	0.83451
Turnover	0.00984	0.00801	0.00757	0.01647
Amihud	0.00021	0.00040	0.00023	0.00005

Table A2: Sample Coverage

This table reports the sample coverage by rating. Panel A presents the number of bonds for the simultaneous trading sample and the dual-listed enterprise bond sample.[32] Panel B presents the dual-listed enterprise bond sample coverage over all enterprise bonds. Panel C presents the enterprise bond sample coverage over all corporate bonds. Sample coverage measures in Panels B and C include number of bonds, notional RMB value, number of non-zero trading days, and RMB trading volume.

Panel A: Simultaneous-trading sample and dual-listed sample

	All	AAA	AA+	AA	AA-
$N_{simultaneous}$	1072	85	316	553	118
$N_{dual-listed}$	2493	378	755	1058	302
Coverage (%)	43.0%	22.5%	41.9%	52.3%	39.1%

Panel B: Dual-listed sample relative to all enterprise bonds

	All	AAA	AA+	AA	AA-
Number of bonds	82.7%	63.2%	83.8%	86.7%	89.9%
Notional value	79.3%	60.4%	85.5%	87.2%	90.5%
Days with trades	91.7%	83.2%	91.9%	92.8%	95.8%
RMB trading volume	82.6%	55.1%	78.4%	90.7%	92.4%

Panel C: Enterprise bonds relative to all corporate bonds

	All	AAA	AA+	AA	AA-
Number of bonds	28.8%	20.6%	33.6%	38.8%	15.0%
Notional value	27.1%	19.7%	35.7%	50.7%	10.1%
Days with trades	41.6%	24.0%	48.2%	51.4%	28.2%
RMB trading volume	26.7%	13.2%	28.7%	59.6%	6.4%

[32]Since our observations are at bond-rating level, we treat the same bond with different ratings at two points in time as different bonds for the purpose of reporting the summary statistics in this table.

Table A3: Summary Statistics: Same-day Sample

This table reports the summary statistics the same-day trading sample from 6/9/2014 to 6/8/2015. Number of observations, the mean, the standard deviation, the 10th percentile, the median, and the 90th percentile are presented. Panel A presents the summary statistics of key variables. Panel B presents the summary statistics of exchange premium by rating. Panel C presents the summary statistics of haircut by rating.

Panel A: All variables

	N	Mean	STD	P10	Median	P90
EX premium	3411	-0.06	0.44	-0.64	-0.03	0.50
EX $premium_{pre}$	1655	0.06	0.39	-0.39	0.03	0.56
EX $premium_{post}$	1756	-0.17	0.46	-0.76	-0.13	0.40
Haircut	3411	64.70	38.54	14.73	100.00	100.00
$Haircut_{pre}$	1655	32.70	24.47	7.40	30.44	72.08
$Haircut_{post}$	1756	94.85	21.12	100.00	100.00	100.00
Conversion	3411	37.33	40.85	0.00	0.00	90.00
$Conversion_{pre}$	1655	71.18	26.24	28.00	74.00	98.00
$Conversion_{post}$	1756	5.42	22.24	0.00	0.00	0.00
IB spread	3411	2.46	0.80	1.44	2.47	3.47
EX spread	3411	2.51	0.85	1.37	2.58	3.49
Maturity	3411	5.12	1.58	3.06	5.25	6.75
Turnover	3411	0.08	0.09	0.02	0.06	0.18
Market price	3411	104.95	5.61	100.26	105.19	110.70
Volatility	3411	0.01	0.02	0.00	0.01	0.03
CDB_{spot}	3411	4.37	0.52	3.80	4.15	5.19
Term spread	3411	0.55	0.31	0.29	0.46	0.97
GC001-SHIBOR	3411	1.78	3.72	-0.46	0.53	5.46
Ret_{stock}	3411	0.42	1.59	-1.13	0.31	2.44

Panel B: Exchange premium by rating

	N	Mean	STD	P10	Median	P90
AAA	160	0.15	0.43	-0.38	0.07	0.64
AA+	1046	-0.01	0.43	-0.57	0.00	0.54
AA	1783	-0.10	0.44	-0.69	-0.06	0.45
AA-	422	-0.07	0.47	-0.65	-0.05	0.50

Panel C: Haircut by rating

	N	Mean	STD	P10	Median	P90
AAA	160	10.18	7.68	5.07	6.67	25.60
AA+	1046	62.06	40.74	7.01	100.00	100.00
AA	1783	62.78	35.97	18.50	43.65	100.00
AA-	422	100.00	0.00	100.00	100.00	100.00

Table A4: IV Estimation: Standard Errors Clustered by Rating and Week

This table reports the results of IV regressions using the simultaneous trading sample with rating/week two-way clustered standard errors. Panels A and B present the results for the first and second stage regressions. Columns (1) and (2) present the results using full sample. Columns (3) and (4) present the results using a subsample of AA+, AA, and AA- bonds. Columns (5) and (6) present the results using a subsample of AA+, AA, and AAA bonds. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent t-statistics clustered by rating and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Haircut	(1)	(2)	(3)	(4)	(5)	(6)
Shock	72.89***	67.80***	72.12***	64.96***	74.35***	72.31***
	(19.99)	(10.53)	(19.58)	(8.06)	(18.97)	(9.55)
Controls	No	Yes	No	Yes	No	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	9976	9799	9438	9282	8801	8631
R-square	0.93	0.97	0.92	0.96	0.92	0.97

Panel B: Second stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Exchange premia	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Haircut}$	-0.50***	-0.40***	-0.64***	-0.53***	-0.24***	-0.21***
	(-3.04)	(-3.07)	(-8.78)	(-5.98)	(-6.89)	(-4.10)
Maturity		1.97**		2.10***		2.41***
		(2.41)		(3.05)		(2.88)
Turnover		0.07		0.05		0.10
		(1.15)		(0.68)		(1.51)
Market price		0.01***		0.01***		0.01***
		(3.11)		(3.45)		(5.25)
Volatility		0.08		-0.03		0.01
		(0.62)		(-0.10)		(0.08)
CDB_{spot}		-8.47		-4.95		-13.36*
		(-1.53)		(-0.55)		(-1.84)
Term spread		5.48		1.37		10.80***
		(1.60)		(0.18)		(3.04)
GC001-SHIBOR		-0.25*		-0.25**		-0.23
		(-1.88)		(-2.30)		(-1.47)
Ret_{stock}		-0.14		-0.26		0.09
		(-0.66)		(-0.82)		(0.51)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	9976	9799	9438	9282	8801	8631
R-square	0.15	0.50	0.14	0.48	0.17	0.52

Table A5: IV Estimation: [-3,3]-Month Event Window

This table reports the results of IV regressions using the simultaneous trading sample in the [-3,3]-month window around the event day. Panels A and B present the results for the first and second stage regressions. Columns (1) and (2) present the results using full sample. Columns (3) and (4) present the results using a subsample of AA+, AA, and AA- bonds. Columns (5) and (6) present the results using a subsample of AA+, AA, and AAA bonds. The sample period is 9/9/2014 to 3/8/2015. Heteroscedasticity consistent t-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Haircut	(1)	(2)	(3)	(4)	(5)	(6)
Shock	72.10***	71.95***	71.19***	72.03***	73.99***	72.38***
	(52.06)	(37.12)	(55.30)	(37.48)	(41.05)	(37.07)
Controls	No	Yes	No	Yes	No	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	4391	4208	4107	3948	3830	3658
R-square	0.93	0.98	0.92	0.98	0.91	0.97

Panel B: Second stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Exchange premia	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Haircut}$	-0.37***	-0.21***	-0.47***	-0.30***	-0.21**	-0.10
	(-4.03)	(-2.83)	(-4.23)	(-2.97)	(-2.25)	(-1.32)
Maturity		3.46***		3.62***		3.71***
		(2.87)		(2.93)		(2.90)
Turnover		0.01		-0.00		0.08
		(0.12)		(-0.00)		(0.71)
Market price		0.01		0.01		0.01
		(1.42)		(0.90)		(1.60)
Volatility		0.08		-0.01		-0.08
		(0.12)		(-0.02)		(-0.12)
CDB_{spot}		-12.66		-9.76		-14.51
		(-1.07)		(-0.82)		(-1.07)
Term spread		41.10**		34.69*		49.36**
		(2.22)		(1.76)		(2.55)
GC001-SHIBOR		-0.02		0.02		-0.11
		(-0.15)		(0.16)		(-0.85)
Ret_{stock}		-0.40		-0.47		-0.12
		(-0.85)		(-0.80)		(-0.25)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	4391	4208	4107	3948	3830	3658
R-square	0.10	0.49	0.09	0.48	0.10	0.50

Table A6: OLS Estimation

This table reports the results of OLS regressions using the simultaneous trading sample. Columns (1) and (2) present the results using full sample. Columns (3) and (4) present the results using a subsample of AA+, AA, and AA- bonds. Columns (5) and (6) present the results using a subsample of AA+, AA, and AAA bonds. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent *t*-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Exchange premia	(1)	(2)	(3)	(4)	(5)	(6)
Haircut	-0.38***	-0.23***	-0.43***	-0.26***	-0.22***	-0.10
	(-5.91)	(-3.05)	(-6.19)	(-3.01)	(-3.38)	(-1.17)
Maturity		2.19***		2.41***		2.56***
		(3.39)		(3.62)		(3.48)
Turnover		0.07		0.05		0.10
		(0.78)		(0.55)		(0.96)
Market price		0.012***		0.01**		0.02***
		(2.80)		(2.38)		(3.18)
Volatility		0.06		-0.02		-0.01
		(0.22)		(-0.07)		(-0.03)
CDB_{spot}		-12.71		-11.78		-16.38
		(-1.27)		(-1.16)		(-1.36)
Term spread		9.27**		7.39*		13.18**
		(2.07)		(1.76)		(2.29)
GC001-SHIBOR		-0.25**		-0.26**		-0.22*
		(-2.23)		(-2.44)		(-1.84)
Ret_{stock}		-0.04		-0.09		0.18
		(-0.14)		(-0.28)		(0.52)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	9976	9799	9438	9282	8801	8631
R-square	0.15	0.50	0.15	0.49	0.17	0.52

Table A7: IV Estimation: Same-day Sample

This table reports the results of IV regressions using the same-day trading sample. The dummy variable, Shock, serves as the instrument variable for bond haircut, which equals 1 for the treatment group (bonds with rating AA+ and AA) after the regulation change date 12/8/2014 and 0 otherwise. Panels A and B present the results for the first and second stage regressions. Columns (1) and (2) present the results using full sample. Columns (3) and (4) present the results using a subsample of AA+, AA, and AA- bonds. Columns (5) and (6) present the results using a subsample of AA+, AA, and AAA bonds. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent t-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Haircut	(1)	(2)	(3)	(4)	(5)	(6)
Shock	72.84***	67.16***	71.93***	64.02***	74.70***	71.73***
	(60.93)	(21.76)	(64.56)	(14.71)	(41.09)	(48.66)
Controls	No	Yes	No	Yes	No	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	3410	3145	3250	3004	2989	2737
R-square	0.93	0.97	0.92	0.97	0.92	0.97

Panel B: Second stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
EX premia	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Haircut}$	-0.54***	-0.46***	-0.65***	-0.62***	-0.25**	-0.17
	(-5.27)	(-3.79)	(-5.37)	(-4.19)	(-2.57)	(-1.63)
Maturity		-0.15		-0.12		0.41
		(-0.15)		(-0.12)		(0.37)
Turnover		0.09		0.07		0.15
		(0.78)		(0.65)		(1.11)
Market price		0.01		0.00		0.01*
		(1.10)		(0.78)		(1.85)
Volatility		0.24		0.10		0.40
		(0.57)		(0.23)		(0.54)
CDB_{spot}		-18.60		-14.34		-25.88
		(-1.27)		(-0.94)		(-1.53)
Term spread		-3.08		-6.54		1.53
		(-0.34)		(-0.62)		(0.18)
GC001-SHIBOR		-0.23		-0.21		-0.40**
		(-0.89)		(-0.82)		(-2.28)
Ret_{stock}		-0.63		-0.77		-0.52
		(-1.34)		(-1.57)		(-1.06)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	3410	3145	3250	3004	2829	2596
R-square	0.17	0.55	0.16	0.54	0.13	0.53

Table A8: IV Estimation: Robustness with Alternative Controls

This table reports the results of IV regressions using the simultaneous trading sample with alternative control variables. $\text{Turnover}^{ex}/\text{Turnover}^{ib}$ is the bond-day-market level turnover. $\text{Turnover}^{ex}_{rating}/\text{Turnover}^{ib}_{rating}$ is the rating-day-market level turnover. Panels A and B present the results for the first and second stage regressions. Columns (1) and (2) present the results using full sample. Columns (3) and (4) present the results using a subsample of AA+, AA, and AA- bonds. Columns (5) and (6) present the results using a subsample of AA+, AA, and AAA bonds. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent t-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Haircut	(1)	(2)	(3)	(4)	(5)	(6)
Shock	72.89***	68.17***	72.12***	65.41***	74.35***	72.32***
	(66.20)	(26.39)	(71.89)	(16.49)	(47.09)	(53.93)
Controls	No	Yes	No	Yes	No	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	9976	9799	9438	9282	8801	8361
R-square	0.93	0.97	0.92	0.96	0.92	0.97

Panel B: Second stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Exchange premia	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Haircut}$	-0.50***	-0.40***	-0.64***	-0.52***	-0.24**	-0.21**
	(-5.36)	(-4.10)	(-6.25)	(-4.64)	(-2.01)	(-2.03)
Maturity		1.99***		2.13***		2.40***
		(3.12)		(3.14)		(3.35)
Turnover^{ex}		0.52		0.44		0.33
		(1.10)		(0.93)		(0.70)
Turnover^{ib}		0.06		0.05		0.09
		(0.70)		(0.53)		(0.85)
Market price		0.01**		0.01**		0.01***
		(2.59)		(2.12)		(3.05)
Volatility		0.08		-0.03		0.02
		(0.27)		(-0.10)		(0.04)
$\text{Turnover}^{ex}_{rating}$		-2.15		-3.53		-17.36
		(-0.10)		(-0.14)		(-0.86)
$\text{Turnover}^{ib}_{rating}$		-1.77		-1.94		0.62
		(-0.97)		(-1.08)		(0.30)
CDB_{spot}		-8.51		-5.00		-13.12
		(-0.86)		(-0.50)		(-1.12)
Term spread		5.22		1.20		10.83*
		(1.02)		(0.20)		(2.00)
GC001-SHIBOR		-0.25**		-0.26**		-0.24*
		(-2.25)		(-2.41)		(-2.01)
Ret_{stock}		-0.15		-0.27		0.09
		(-0.48)		(-0.70)		(0.25)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	9976	9799	9438	9282	8801	8631
R-square	0.15	0.50	0.14	0.48	0.17	0.52

Table A9: IV Estimation using Matched AAA Bonds as Benchmark: Robustness with Alternative Controls

This table reports the results of IV regressions using the matched AAA bonds as benchmark using alternative control variables. The pledgeability premium is the credit spread between AA+/AA dual-listed enterprise bonds and their matched AAA bonds, where the matching criteria include yield spread and haircut before 12/8/2014. Control variables indicated with "bmk" refer to the average value of matched AAA bonds. $\text{Turnover}^{ex}_{rating}/\text{Turnover}^{ib}_{rating}$ is the rating-day-market level turnover. Panels A and B present the results for the first and second stage. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent t-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent: Haircut	(1)	(2)
Shock	86.89***	85.64***
	(71.00)	(63.85)
Controls	No	Yes
Rating FE	Yes	Yes
Bond FE	No	Yes
N	9961	9916
R-square	0.98	0.99

Table A9 (cont.): IV Estimation using Matched AAA Bonds as Benchmark: Robustness with Alternative Controls

Panel B: Second stage

Dependent: Pledgeability premium	(1)	(2)
$\widehat{Haircut}$	-0.74***	-0.81***
	(-13.57)	(-11.57)
Maturity		-0.07
		(-0.70)
Turnover		1.99**
		(2.33)
Market price		0.02***
		(3.44)
Volatility		0.34
		(0.60)
Maturity_bmk		0.02**
		(2.20)
Turnover_bmk		-5.36**
		(-2.61)
Market price_bmk		0.00
		(1.01)
Volatility_bmk		1.48
		(1.17)
$\text{Turnover}^{ex}_{rating}$		45.85
		(0.97)
$\text{Turnover}^{ib}_{rating}$		1.01
		(0.22)
CDB_{spot}		-2.57
		(-0.60)
Term spread		4.96
		(0.88)
GC001-SHIBOR		-0.14
		(-0.54)
Ret_{stock}		0.35
		(0.77)
Rating FE	Yes	Yes
Bond FE	No	Yes
N	9961	9916
R-square	0.15	0.63

Table A10: IV Estimation using Same-day Sample: Robustness with Alternative Controls

This table reports the results of IV regressions using the same-day trading sample with alternative control variables. $\text{Turnover}^{ex}/\text{Turnover}^{ib}$ is the bond-day-market level turnover. $\text{Turnover}^{ex}_{rating}/\text{Turnover}^{ib}_{rating}$ is the rating-day-market level turnover. Panels A and B present the results for the first and second stage regressions. Columns (1) and (2) present the results using full sample. Columns (3) and (4) present the results using a subsample of AA+, AA, and AA- bonds. Columns (5) and (6) present the results using a subsample of AA+, AA and AAA bonds. The sample period is 6/9/2014 to 6/8/2015. Heteroscedasticity consistent t-statistics clustered by bond and week are reported in parentheses. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Haircut	(1)	(2)	(3)	(4)	(5)	(6)
Shock	72.84***	67.16***	71.93***	64.02***	74.70***	71.76***
	(60.93)	(21.76)	(64.56)	(14.71)	(41.09)	(47.92)
Controls	No	Yes	No	Yes	No	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	3410	3145	3250	3004	2889	2737
R-square	0.93	0.97	0.92	0.97	0.92	0.97

Panel B: Second stage

Dependent:	Full		AA+ & AA & AA-		AA+ & AA & AAA	
Exchange premia	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Haircut}$	-0.54***	-0.46***	-0.65***	-0.61***	-0.25**	-0.20*
	(-5.27)	(-4.14)	(-5.37)	(-4.39)	(-2.57)	(-1.88)
Maturity		-0.11		-0.07		0.39
		(-0.12)		(-0.07)		(0.37)
Turnover^{ex}		0.62		0.63		0.46
		(0.92)		(0.91)		(0.67)
Turnover^{ib}		0.09		0.07		0.15
		(0.76)		(0.61)		(1.07)
Market price		0.01		0.00		0.01*
		(1.11)		(0.80)		(1.87)
Volatility		0.22		0.08		0.38
		(0.52)		(0.19)		(0.51)
$\text{Turnover}^{ex}_{rating}$		-22.01		-21.44		-64.77*
		(-0.72)		(-0.69)		(-1.82)
$\text{Turnover}^{ib}_{rating}$		-6.62**		-6.24**		-4.53
		(-2.65)		(-2.52)		(-1.41)
CDB_{spot}		-17.93		-14.06		-24.50
		(-1.27)		(-0.96)		(-1.49)
Term spread		-4.37		-7.20		0.27
		(-0.47)		(-0.68)		(0.03)
GC001-SHIBOR		-0.27		-0.24		-0.48**
		(-0.99)		(-0.91)		(-2.55)
Ret_{stock}		-0.67		-0.80		-0.57
		(-1.38)		(-1.57)		(-1.16)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Bond FE	No	Yes	No	Yes	No	Yes
N	3410	3145	3250	3004	2989	2737
R-square	0.17	0.55	0.16	0.54	0.20	0.59