DEUTSCHE
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Discussion Paper

Deutsche Bundesbank
No 51/2016

Fire buys of central bank collateral assets

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Internet http://www.bundesbank.de

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ISBN 978–3–95729–332–9 (Printversion)
ISBN 978–3–95729–333–6 (Internetversion)

Non-technical summary

Research Question

In the aftermath of the Lehman Brothers bankruptcy, the European Central Bank (ECB) provided banks with unlimited liquidity. Unlimited central bank liquidity provision increases the demand for eligible collateral assets. The scope of this study is to investigate whether banks pay a premium to purchase these assets, which I call the Fire Buy premium, and to estimate the level of this premium. In the course of the crisis, the ECB lowered the quality threshold of its collateral framework. However, the haircut applied to these securities did not reflect all the risks related to the collateral. A complementary research question is to what extent banks paid a further premium, which I call the Risk-Shifting premium, to explore these haircut advantages.

Contribution

To determine both premia empirically and estimate their magnitude, I match the full fixed-income trading book of 26 German banks with their liabilities against the Eurosystem. Hence, my study links monetary policy to trading behavior and adds to the risk-shifting literature.

Results

I find empirical evidence for both premia and quantify the Fire Buy premium to be 15.6 bps and the the Risk-Shifting premium to be 65.6 bps. The existence of the Fire Buy premium demonstrates that the implementation of unlimited central bank liquidity provision imposes an extra cost on banks when they need liquidity most. The Risk-Shifting premium prices how much banks are willing to pay to access the risk-shifting mechanism in the Eurosystem.

Nichttechnische Zusammenfassung

Fragestellung

Im Gefolge der Insolvenz von Lehman Brothers beschloss die Europäische Zentralbank (EZB), den Banken Liquidität gegen Sicherheiten in unbegrenzter Höhe zur Verfügung zu stellen. Die unbegrenzte Liquiditätsbereitstellung durch die EZB führte zu einer steigenden Nachfrage nach denjenigen Wertpapieren, die die EZB als Sicherheiten akzeptierte. Es wird die Frage untersucht, ob die Banken bei dem Erwerb solcher Wertpapiere einen Aufschlag, in dem Papier Fire-Buy-Prämie genannt, zahlten und wie hoch diese Prämie war. Im Laufe der Krise erweiterte die EZB ihren Sicherheitenrahmen und senkte den Bonitätsschwellenwert für notenbankfähige Wertpapiere, wobei die auf diese Papiere angewandten Bewertungsabschläge manchmal nicht die gesamten mit den Wertpapieren verbundenen Risiken widerspiegelten. Eine weitere Fragestellung ist, ob die Banken beim Erwerb mancher Wertpapiere bereit waren, einen zusätzlichen Aufschlag, in dem Papier Risikoverlagerungsprämie genannt, zu zahlen, um die Abweichungen bei den Bewertungsabschlägen auszunutzen.

Beitrag

Anhand einer Studie des gesamten Bestands an festverzinslichen Wertpapieren im Handelsbuch von 26 deutschen Banken und deren Verbindlichkeiten gegenüber dem Eurosystem wird untersucht, ob die beiden oben genannten Prämien sich empirisch nachweisen lassen, und – falls der Nachweis erbracht wird – soll deren Höhe geschätzt werden. Die vorliegende Studie stellt eine Verbindung zwischen der Geldpolitik und dem Handelsverhalten von Banken her und ergänzt die Literatur, die sich mit dem Thema Risikoverlagerung befasst.

Ergebnisse

Es finden sich empirische Belege für beide Prämien. Die Höhe der Fire-Buy-Prämie wird auf 15,6 Basispunkte geschätzt, die der Risikoverlagerungsprämie auf 65,5 Basispunkte. Die Existenz der Fire-Buy-Prämie deutet an, dass unbegrenzte Liquiditätsbereitstellung den Banken zusätzliche Kosten auferlegt, wenn sie Liquidität am dringendsten benötigen. Die Risikoverlagerungsprämie gibt die Zahlungsbereitschaft der Banken an, den Risikoverlagerungsmechanismus in Anspruch zu nehmen.

Bundesbank Discussion Paper No 51/2016

Fire Buys of Central Bank Collateral Assets*

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Abstract

In times of financial distress, central banks provide unlimited liquidity to avoid fire sales. In response, banks raise their demand for collateral assets, and the short-term scarcity of collateral securities leads to higher prices, the Fire Buy premium. To avoid collateral scarcity, central banks increase the set of eligible collateral assets. However, if the risk-shifting channel is open for these newly eligible securities, banks prefer to pledge them and pay another premium, the Risk-Shifting premium. With the full fixed-income trading book of 26 German banks, I identify each trade of each bank and investigate how unlimited liquidity provision affects collateral prices. Also, I match banks' trades with their balance sheet and show how funding liquidity impacts premia payment. I quantify the Fire Buy premium to be 15.6 bps; and the Risk-Shifting premium on BBB-rated assets to be 65.6 bps.

Keywords: Fire Buy, Risk-Shifting, Haircut Subsidy, ECB, Over-the-Counter Markets

JEL classification: E41, E44, E58, G11, G14, G15, G21

*Contact: calebederoure@gmail.com, https://sites.google.com/site/calebederoure/. I am deeply indebted to Falko Fecht for his advice and continuous willingness to help. Also, I am grateful for comments from Tobias Berg, Ben Craig, Darrell Duffie, Dimitris Georgarakos, Yalin Gündüz, Michael Kötter, Jochen Mankart, Christoph Memmel, Margit Münzer, Martin Oehmke, Loriana Pelizzon, Larissa Schäfer, Sascha Steffens, participants at the Bundesbank Forschertreffen, Bundesbank Spring Conference (2016), 33^{rd} Meeting of the French Financial Association (AFFI) and seminars at the Goethe University Frankfurt and Frankfurt School of Finance & Management.

1 Introduction

In times of financial distress and malfunctioning of the interbank market, central banks often provide banks with unlimited liquidity. In order to access central bank liquidity, banks need to pledge eligible collateral assets. Thus, the possibility to access unlimited liquidity plus the need to have collateral to access this facility lead to an increase in the demand for collateral assets and impacts the secondary market for these securities. Since the unrestricted provision of liquidity takes place precisely in periods of financial distress, adverse effects on this market may challenge financial stability when it matters most. The scope of the present study is to analyze how changes in central bank liquidity provision impact the secondary market for collateral assets, potentially affecting financial stability.

In 2008, after the Lehman Brothers collapse, many banks lost the access to the European interbank market. In order to provide funding liquidity for those banks and avoid fire sales spirals, the ECB decided to provide unlimited liquidity. Therefore, the European Central Bank (ECB) changed its usual form of liquidity provision based on variable-rate auctions to fixed-rate full allotment (FRFA) tenders. In this setup, banks can draw as much funds as they desire as long they have enough collateral to pledge. Hence, the demand for collateral assets increases and banks pay a premium to acquire these securities, the Fire Buy premium.[1] In order to mitigate this effect, the ECB enlarged its collateral framework to accept BBB-rated assets. However, the haircut the ECB applies to these assets does not reflect transactions' risk, i.e. these securities enjoy a haircut subsidy.[2,3] Since banks can exploit this subsidy from the ECB, they are willing to pay a further premium to acquire these assets, the Risk-Shifting premium. The objective of this paper is to present evidence for the existence of both premia and quantify them.

For this end, I match the fixed-income trading book of 26 German banks with their funding liquidity in ECB open market operations. My results show that after the introduction of FRFA tenders banks pay a Fire Buy premium of 15.6 basis points, and the 90^{th} percentile bank pays 65.6 bps more than the median to acquire BBB-rated collateral assets, the Risk-Shifting premium.[4] To the best of my knowledge, I am the first to link changes in the central bank collateral framework with prices of fixed-income instruments. My contribution is twofold. First, the existence of the Fire Buy premium demonstrates that the implementation of unlimited central bank liquidity provision imposes an extra cost on banks when they need liquidity most. Second, the Risk-Shifting premium prices how much banks value the risk-shifting mechanism in the Eurosystem.

My identification strategy offers a rare opportunity to match banks' trading behavior (at the bank-security level) with banks' funding liquidity. Therefore, I use several valuable

[1] Another factor that contributed to the short term scarcity of collateral was liquidity hoarding; see e.g. Heider, Hoerova, and Holthausen (2015).

[2] In 2010, the ECB reviewed its haircut policy and concluded that haircuts applied to BBB-rated assets should be revised upwards. This revision was implemented on 1^{st} January 2011. See Appendix and ECB press release "ECB introduces graduated valuation haircuts for lower-rated assets in its collateral framework as of 1 January 2011" from April 4^{th} 2010.

[3] BBB-rated assets are investment grade and, by definition, good quality collateral. Thus, this study does not address the riskiness level of these assets but rather the haircut applied to them.

[4] As comparison, the 10 years German Bund, the safest assets in the ECB collateral pool, yielded on average ∼400 bps in 2008. In October 2008, the BBB-spread averaged ∼600 bps (measured by the Bank of America US Corporate BBB Option-Adjusted Spread).

data sets. First, I have the full fixed income trading book of 26 German banks. With this data set I can identify for each transaction the security being traded, the buyer, the seller, the size and the price of the trade (among other variables). Second, I am able to look into banks' balance sheet and recognize how much liabilities they have against the Eurosystem. In this way, I am able to identify how dependent a bank is on central bank funding and link it to its respective trading behavior. Third, I have the list of eligible collateral assets at the ECB as published on its website and the rating applied by the ECB to each security.[5] Thus, I can unambiguously identify how a bank's trading behavior changes with the FRFA announcement and conditional on its central bank funding liquidity.

The treatment group of my empirical strategy is banks with a large share of liabilities to the ECB. The inferences are based on the interaction of this group with my treatment, the introduction of FRFA tenders. A possible criticism to this approach is that the results could be driven by a structural break, which changes the behavior of all banks similarly, i.e. the effect could be on the time series and not on the cross-section. In order to underline that my results come from the cross-section, I present a robustness check dividing the banks into two groups (above and below median in each period) and performing a differences-in-differences approach. Furthermore, I perform several other falsification tests. My results are robust to anticipation effects and to possible interaction with Lehman Brothers bankruptcy, and I demonstrate that my results are not driven by the network structure of OTC markets.

My inferences are based on the almost simultaneous implementation of FRFA tenders (October 8^{th}) and the expansion of the ECB collateral framework to accept BBB-rated collateral assets (October 15^{th}). This feature poses no real concern for my identification strategy because both policies act in opposite directions. Whereas the FRFA increases the demand for collateral assets, the expansion of the collateral framework increases the supply of collateral assets. Hence, the inclusion of BBB-rated securities in the collateral framework act against the identification of the Fire Buy premium and allows the identification of two effects in the same period.

My study relates to the literature on unlimited central bank liquidity provision. Bagehot (1873) proposes that, in times of financial distress, monetary authorities should lend in an early and unlimited manner to solvent banks, against appropriate collateral at high interest rates. Rochet and Vives (2004) provide a formal model for Bagehot's doctrine, in which even in modern interbank markets, central bank's liquidity intervention is desired. Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2016) and Fecht, Nyborg, Rocholl, and Woschitz (2015) link unlimited central bank liquidity provision to the risk-shifting channel, when the haircut does not cover the collateral risk, liquidity provision is under-collateralized and the monetary authority bears a part of the risk. Both studies present evidence that relatively weaker banks, in the search for yield, use ECB facilities to access disproportionately high quantity of liquidity using lower-quality collateral.[6] My study expands the literature on unlimited central bank liquidity provision and the risk-shifting

[5] For a given security the binding rating for the ECB is the best one among the accepted agencies. In 2008, the ECB accepted only ratings from the big three agencies: Standard & Poor's, Moody's and Fitch. In 2009, the ECB started accepting ratings from DBRS.

[6] Specifically banks in need of liquidity prefer the ECB funds market to the interbank market because the ECB only applies a haircut based only on the security risk, whereas in the interbank market, haircuts also take into consideration the correlation between pledged collateral risk and counterparty risk.

channel by investigating their effects on the secondary market for collateral assets and pricing how much banks value the risk-shifting channel when liquidity is unlimited.

My study also relates to the literature on OTC markets because price discrimination is a necessary condition for the Risk-Shifting premium. Securities eligible as collateral in central bank operations are debt instruments, which are mainly traded over-the-counter (OTC). In OTC markets, prices are a result of a bargaining process between counterparties, and price differentiation occurs; see e.g., Duffie, Gârleanu, and Pedersen (2005), Duffie, Gârleanu, and Pedersen (2007), and de Roure, Mönch, Pelizzon, and Schneider (2016). In Duffie et al. (2005), an agent's bargaining power is given by the outside option to trade, i.e. how quickly an agent can find another counterparty to liquidate the trade. Therefore, unlimited central bank liquidity provision may reduce banks' bargaining power in two ways. First, banks may want to execute the trade more quickly so they can pledge the asset as collateral. Second, banks needing central bank liquidity tend to hold their collateral assets, reducing the matching probability between buyers and sellers. Hence, my study complements the literature on OTC markets by linking monetary policy to prices of fixed-income instruments through the bargaining power channel.

2 Theoretical Underpinning

2.1 Fire Buy Theory

In all open market operations, the monetary authority requests collateral and imposes a haircut on the collateral value to mitigate credit risk; see e.g., Chailloux, Gray, and McCaughrin (2008), Cheun, von Köppen-Mertes, and Weller (2009). Thus, when providing unlimited liquidity, central banks induce banks to acquire collateral assets.

The *Fire Buy* theory is based on the short-term scarcity of collateral assets. When central banks introduce unlimited liquidity provision, banks' demand for collateral assets increase. In the short term, these assets are in limited supply. Thus, the increased demand leads to higher prices, the Fire Buy premium.

The reason why central banks provide unlimited liquidity is to provide funding liquidity to banks in times of financial distress. The counterfactual of this policy is that some banks would have no other form to refinance themselves potentially starting fire sales spirals. Thus, trying to avoid fire sales the monetary authority creates fire buys of collateral assets, which represents one cost related to the provision of unlimited central bank liquidity. However, the Fire Buy premium cannot be interpreted as an argument against full allotment tenders because its welfare lost is certainly much smaller than the costs of no action. In fact, the Fire Buy premium is an argument in favor of the expansion of the collateral framework when the provision of liquidity is unlimited, as indeed the ECB acted.

Banks prefer central bank liquidity over cash, the most liquid asset, because cash has a negative real return whereas central bank liquidity usually has positive returns, i.e. the yields on the collateral asset stay with the banks. In this sense, central bank liquidity is cheaper than cash. Thus, during financial crisis, when banks hoard liquidity, it is cheaper to hoard central bank collateral assets then cash.

To illustrate how FRFA tenders increase banks' demand for assets eligible as collateral at the ECB, I present Figure 1 as anecdotal evidence. I use the Security Holdings Statistics

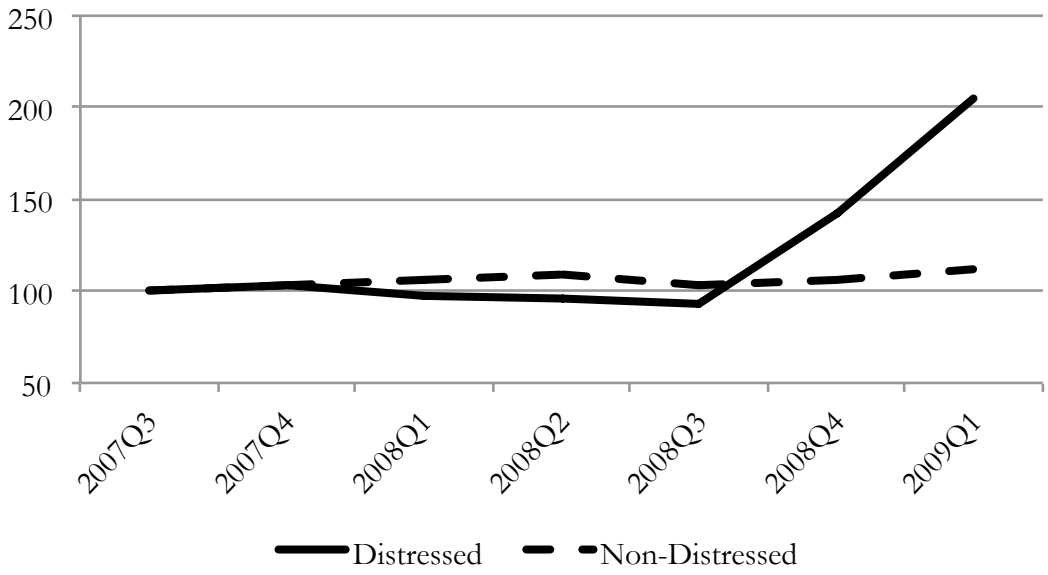

Figure 1: Holdings of Eligible Collateral Assets at the ECB. Asset values adjusted for the respective haircut aggregated across banks in two groups. Values normalized to 100 in third quarter 2007 and correspond to the holdings on the last day of each quarter. Source: Security Holdings Statistics, Deutsche Bundesbank, Bade et al. (2016).

of the Deutsche Bundesbank (Bade et al. (2016)), a quarterly data set that contains all asset holdings (security-by-security) of all 26 banks (bank-by-bank). I sum up the holdings (haircut-adjusted) of all eligible collateral assets at the ECB divided in two groups and normalize to 100 in 2007Q3. The first group, which I call *distressed*, represents ten banks in the sample that were rescued by the German government (central or regional) later in the crisis.[7] The second group I name *non-distressed*; it comprises the remaining 16 banks.

Figure 1 shows that before the implementation of fixed-rate full allotment tenders in 2008Q3 both lines move in parallel. In the following two quarters, distressed banks double their haircut-adjusted holdings of ECB collateral assets. This sharp increase suggests that specifically banks with liquidity needs adjusted their portfolio towards holding more ECB eligible collateral assets. The kink in 2008Q3 illustrates my identification strategy, the introduction of FRFA tenders change banks' demand curve for collateral assets. In the following sections I investigate the price impact of this increased demand.

A shortcoming of the graph is that it presents two simultaneous effects. First, the increased demand for collateral assets. Second, the change in the definition of eligible collateral assets to accept BBB-rated assets, which added more securities to the Single List.[8] Hence, the sharp increase is a mixture of increased demand for collateral assets

[7]The SoFFin, or *Sonderfonds Finanzmarktstabilisierung* and in English *Financial Market Stabilisation Fund*, provided liquidity through guaranteed debt issued by eligible financial institutions, also by direct investment in banks' equity and purchase of securities in open market operations. The program was designed by the German federal government. In addition, Figure 1 also includes banks that were rescued by state governments.

[8]The Single List is a list published every day on the ECB's website containing all securities accepted as collateral in its open market operations.

and the acceptance of new securities potentially already in banks' books.

2.2 The Risk-Shifting Theory

The *risk-shifting* theory says that some banks may use central bank liquidity lines to shift risks from their balance sheet to the monetary authority. This channel is open when the haircut applied by the central bank is below the market. In this case, transactions are undercollateralized, and the central bank bears part of the loss should issuer and counterparty default. In the Eurosystem, this haircut subsidy is higher for lower-rated collateral securities (Drechsler et al. (2016)). Hence, banks can pledge low-rated collateral to the ECB and leave better quality assets for other operations. In this way, banks are able to increase their yields by substituting collateral assets.

The reason why collateral arbitrage benefits banks differently is that in private repos they receive haircuts based on the collateral risk *and* on the correlation risk between collateral and their own counterparty risk, whereas in the ECB funds market haircuts adjust only to security risk. For instance, an Austrian and a Portuguese bank of similar rating might receive different haircuts in private repos when using a Portuguese sovereign bond as collateral. This differentiation happens because, in the scenario where Portugal is bankrupt, Portuguese banks are also likely to be bankrupt, whereas an Austrian bank would be less affected. This correlation risk is not taken into account in the Eurosystem (see Fecht et al. (2015) for further discussion).[9]

The *Risk-Shifting premium* is the premium banks in great need of central bank liquidity pay to acquire lower-rated collateral assets. They are willing to pay this extra premium because they can increase their yields through the risk-shifting channel by at least this amount. The Risk-Shifting premium enhances the *risk-shifting* theory by focusing on the effects of monetary policy design on the secondary market for collateral assets. Its existence demonstrates that the risk-shifting channel is so wide that banks are willing to pay a hefty premium to purchase lower-rated collateral assets.

The empirical identification of the Risk-Shifting premium is based on two components. First, the implementation of fixed-rate full allotment tenders, which increases the demand for collateral assets as described by the kink in Figure 1. Second, the expansion of the ECB collateral framework to accept BBB-rated assets. In this setup, one would expect that banks more dependent on ECB funds would pay more to acquire BBB rated collateral assets.

The use of two contemporaneous policies' implementation to identify the Risk-Shifting premium is possible because both policies act in different directions. On the one hand, the ECB has expanded its collateral framework to accept BBB-rated collateral assets in order to cover the scarcity of collateral assets by increasing the supply of these assets. On the other hand, when acquiring these newly eligible assets banks with lower bargaining

[9]The ECB explains: "*In contrast to commercial banking practice, where haircuts can be set at more stringent levels for counterparties with higher perceived credit risk, the Eurosystem, in line with its mandate to maintain a level playing field among market participants, cannot apply differentiated haircuts in its policy operations, i.e. haircuts that would depend on the creditworthiness of the counterparty. Furthermore, the Eurosystem calculates the haircut on an asset-by-asset basis, not adjusting the haircuts to the diversification or concentration features of the collateral pool. Additionally, the Eurosystem retains the ability to apply additional discretionary haircuts on an asset.*" Source: The Financial Risk Management of the Eurosystem's Monetary Policy Operations, ECB website.

power pay a premium. Hence the expansion of the collateral framework militates against the existence of the Fire Buy premium, whereas the identification of the Risk-Shifting premium is based on both policies simultaneously.[10]

The Risk-Shifting premium arises only because collateral assets are traded OTC, where prices are opaque and discrimination occurs. Duffie et al. (2005) and Duffie et al. (2007) demonstrate that prices in OTC markets are not unique but rather a result of a bargaining process, where the bargaining power is the outside option to trade and price discrimination occurs. The outside option to trade is given by how quickly an agent can find another counterparty to liquidate the trade. In the present context, changes in the collateral framework influence bargaining power in two ways. First, they impose timing pressure on the execution of the trade so that banks can use the asset as collateral. Second, they induce banks to hold more collateral assets, which reduces the number of sellers, increases the number of buyers, and affects the matching probability in OTC markets. Thus, monetary policy affects banks' trading behavior through the bargaining power channel.

If banks are willing to incur a Risk-Shifting premium, it is because they can exploit the risk-shifting channel by at least this amount. Thus, the Risk-shifting premium prices how much a bank values the collateral arbitrage and serves as indicator of how severe the risk-shifting channel is.

3 Data

3.1 Data Sources

The innovation of the present study is to use a novel data set that allows me to identify trading behavior in the security-bank dimension and match it with banks' respective balance sheet. To this end, I merge several data sets. First, banks' fixed income trades provided by the German Federal Financial Supervisory Authority (BaFin). Second, the daily list of assets eligible as collateral at the ECB and their respective ratings made available by the Deutsche Bundesbank. Third, banks' balance sheet statistics, also furnished by the Deutsche Bundesbank (Beier, Krueger, and Schaefer (2016)).

Section 9 of the German Securities Trading Act states that all credit and financial services institutions must report to the German Federal Financial Supervisory Authority (BaFin) any transaction in securities or derivatives which are admitted to trading on a regulated market (including over-the-counter trades). From this data source, I obtained all fixed income transactions by 26 German banks between January 1^{st} and December 31^{st} 2008 including the buyer, seller, security, time, price and quantity.[11] Each trade is reported only once and can be a positive (buy order) or a negative value (sell order). In order to prevent small trades from driving my results I exclude all trades with a volume smaller than €100,000.00 or the equivalent thereof. Trades are treated on a daily basis; in case a bank trades the same security more than once a day, I average prices weighted by their order size. The data set distinguishes between proprietary and client trade. Here

[10] More precisely, for the identification of the Risk-Shifting premium only the expansion of the collateral framework is necessary. However, the unlimited central bank liquidity provision contributes to the identification by increasing the demand for newly eligible collateral assets.

[11] The time period and bank sample are chosen according to data availability.

I focus only on own-account trades. For the purpose of this paper, I am only interested in buy orders and abstract from short positions.[12]

Every day the ECB publishes a list of all assets eligible as collateral, also called the Single List. This document is a list containing all securities (security-by-security) accepted by the ECB including information on their coupon, haircut, issuance and maturity dates, and other characteristics. By comparing the changes in the assets in the list, I am able to identify which assets have been added to and removed from the ECB collateral framework. Moreover, I received from the Bundesbank a list broken down by the asset rating applied by the ECB. From this data set, I am able to identify which securities in banks' trading book belong to the ECB Collateral Framework, and categorize them by ratings and haircut.

To avoid issues regarding the issuance and maturity of assets during the observation period, I focus only on assets that were in the list at the beginning and at the end of the year (except for BBB assets that were only added in October).

The Balance Sheet Statistics of the Deutsche Bundesbank (BISTA) provide a monthly bank-by-bank overview of banks' activities. Among other variables, it contains the size of banks (total assets) and the total central bank funds in their balance sheet. With this information, I create the main explanatory variable central bank funding/TA_{bw}. All variables are provided monthly and interpolated into weekly data.

3.2 Descriptive Statistics

Table 1 describes $CBfunding_{bw}$ and fb_{ibt} in three ways; the full sample, before and after the introduction of FRFA. The first covariate presents banks' reliance on central bank funding as a share of their size, the variable of our primary interest. In the full sample, the ECB provides 3.5% of a median bank's liabilities. This figure increases to 11.7% at the 90^{th} percentile. The second covariate is fb_{ibt}, which is a variable that takes the value of 1 if bank b buys asset i at day t, -1 if it sells and zero otherwise. The mean of fb_{ibt} is negative, meaning that, overall, banks in the sample are selling their fixed income securities.

Comparing before and after the introduction of FRFA, we observe an increase in the mean reliance on central bank funds of about 1.7%. The increase seems to be more robust for banks more reliant on the central bank. Looking into fb_{ibt}, we find that selling pressure is stronger before the FRFA. After the introduction of FRFA banks tend to buy fixed-income instruments more often.

Table 2 presents the mean and standard errors of securities characteristics.[13] Assets are divided into four categories according to Table 11 in the Appendix: (I) central government debt instruments and debt securities issued by central banks; (II) local and regional government debt instruments, Jumbo Pfandbrief, agency and supranational debt instruments; (III) covered bonds, traditional Pfandbrief, credit institution debt instruments, debt instruments issued by corporates; (IV) asset-backed securities (ABSs). In general terms, prices tend to be around 100 and with a standard deviation of around 3. This feature is common in fixed-income assets, where a par value is paid at maturity. Thus,

[12] As a falsification test I run the same regressions with sell orders; see Section 6.

[13] For the purpose of this study, I aggregate assets rated AAA and AAA- into AAA, securities rated AA+, AA, and AA- into AA and similarly for rates A and BBB.

the use of security fixed effects accounts for most of the variation in prices. Furthermore, the average haircut ranges mostly between 3% and 4% for assets rated AAA, AA, and A; and 7% to 10% for BBB assets. Although theoretically haircuts could go up to 20%, the mean is far lower. Lastly, assets of type (III) are the most populated.

	Mean	Std Error	10^{th} pcl	25^{th} pcl	50^{th} pcl	75^{th} pcl	90^{th} pcl
Full Sample							
C.B. Funding/TA	0.049	0.046	0.002	0.017	0.035	0.064	0.117
fb_{ibt}	-0.001	0.214	0	0	0	0	0
Before FRFA							
C.B. Funding/TA	0.042	0.040	0.000	0.013	0.032	0.056	0.101
fb_{ibt}	-0.002	0.212	0	0	0	0	0
After FRFA							
C.B. Funding/TA	0.058	0.063	0.005	0.015	0.041	0.078	0.132
fb_{ibt}	0.003	0.221	0	0	0	0	0

Table 1: Distribution of C.B. Funding/TA and fb_{ibt}. C.B. Funding/TA is banks' liabilities to the ECB over total assets, fb_{ibt} takes the value of 1 if bank b buys security i at day t, -1 if it sells, and zero otherwise. Source: BaFin and Balance Sheet Statistics of the Deutsche Bundesbank, Beier et al. (2016).

	Category I				Category II				Category III				Category IV			
	AAA	AA	A	BBB	AAA	AA	A	BBB	AAA	AA	A	BBB	AAA	AA	A	BBB
Price	100.67	99.72	98.3	101.30	98.28	97.31	-	100.97	96.57	96.14	96.23	95.96	95.30	-	-	-
	(4.54)	(3.29)	(4.82)	(3.30)	(2.88)	(2.24)	-	(2.01)	(3.95)	(4.53)	(4.25)	(4.38)	(4.18)	-	-	-
Mean Coupon (%)	4.00	4.12	4.51	3.67	3.69	3.62	5.40	3.97	3.09	3.39	4.27	4.28	4.30	-	4.88	-
	(0.83)	(0.86)	(1.00)	(0.82)	(0.91)	(0.61)	(0.52)	(0.55)	(1.07)	(1.16)	(0.92)	(0.96)	(0.74)	-	(0.00)	-
Mean Haircut (%)	3.22	1.63	2.96	9.77	3.58	3.43	5.73	10.75	3.94	3.87	4.17	7.93	5.10	-	2.00	-
	(1.35)	(2.39)	(2.30)	(209)	(1.21)	(1.08)	(3.04)	(0.66)	(1.51)	(1.69)	(1.42)	(1.64)	(3.45)	-	(0.00)	-
Mean Days-to-Maturity	2,470	1,985	2,927	1,693	1,334	1,311	5,579	1,154	1,126	1,163	1,255	1,017	5,616	-	585	-
	(2,409)	(2,396)	(3,362)	(209)	(980)	(721)	(3,209)	(501)	(834)	(821)	(761)	(781)	(5,097)	-	(17)	-
Monthly # Trades	13,064	3,335	679	78	12,521	303	4	202	8,600	12,782	9,002	2,797	205	-	4	-
	(4,199)	(1,541)	(276)	(35)	(3,731)	(104)	(4)	(154)	(2,068)	(2,063)	(2,451)	(1,526)	(106)	-	(2)	-
Monthly Turnover	7,060	1,520	224	1.7	2,080	66.2	11.6	2.9	19,900	389	254	91.1	155	-	2.2	-
(in € billion)	(3,680)	(931)	(171)	(2)	(1,020)	(49.8)	(12.1)	(3.3)	(65,200)	(135)	(84.4)	(74.4)	(79.3)	-	(2.8)	-
# Assets	272	146	40	7	599	48	4	30	2,235	1,346	856	310	348	0	1	0

Table 2: Mean and standard errors of securities characteristics by rating and ECB categories. Monthly number of trades, mean over months. Maturity of perpetual bonds treated as 100 years. Category I: central government debt instruments, debt instruments issued by central banks; Category II: local and regional government debt instruments, Jumbo Pfandbrief, agency and supranational debt instruments; Category III: covered bonds, traditional Pfandbrief, credit institution debt instruments, debt instruments issued by corporates; Category IV: asset-backed securities. Note: with the expansion of the collateral framework, the ECB created a further category (uncovered debt) which is excluded from the analysis since I do not observe any trade with these assets. Missing prices omitted for confidentiality reasons. Source: BaFin and ECB.

4 The Fire Buy Premium

4.1 Empirical Strategy

First, I investigate whether banks pay more to buy ECB collateral assets after the introduction of fixed-rate full allotment tenders. In my data set, for every transaction I have a bank identifier for buyer and seller. Given that I am interested in a purchase premium, I focus only on buy orders. In Section 6, I present results using sell orders as a falsification test. My estimation strategy is a differences-in-differences model (before/after FRFA, eligible/non-eligible as collateral assets) using time-varying fixed effects, as:[14]

$$p_{ibt} = \beta_1 FRFA_t * eligible_{iw} + \beta_2 FRFA_t + \theta p_{it-1} + \Delta_{iw} + \Delta_{bw} + u_{ibt} \quad (1)$$

where p_{ibt} is the price bank b pays for security i at day t,[15] $FRFA_t$ is a dummy variable that takes the value of 1 after the ECB announces fixed-rate full allotment tenders on October 8^{th} 2008, $eligible_{iw}$ is a dummy that takes the value of 1 if the ECB accepts security i in week w as collateral and zero otherwise, Δ_{iw}, and Δ_{bw} are security-week and bank-week fixed effects, respectively, and u_{ibt} is the error term. Further, in order to avoid autocorrelation I include the AR(1) process. The lagged price variable, p_{it-1}, is a constructed variable based on the interpolation of prices within the sample and does not necessarily mean that the asset was traded at this price on the previous day. Note that the standalone variable, $eligible_{iw}$, is captured by the time-varying fixed effects. The use of time-varying fixed effects accounts for all variation in the bank-week and security-week dimensions (observable and unobservable) and dismisses the need for control variables.

In summary, for the estimation of Equation (1), I use all buy positions of the fixed income trading book and compare whether assets eligible as collateral were purchased at a premium. Formally I test,

Hypothesis 1*: Given the scarcity of ECB collateral assets, banks pay a Fire Buy premium after the introduction of FRFA tenders by the ECB,* $\beta_1 > 0$.

In order to match weekly with daily variables, I repeat the week value in all days of the week. I opted for this method because balance sheet statistics are reported on a monthly basis and interpolated into weekly data. Interpolating the data further into daily statistics would add no economic meaning.

To identify the Fire Buy and the Risk-Shifting premia I use one side of the trade: buy positions. I focus only on this side of the market because it is the side where the restrictions on bargaining power are binding. In other words, banks reliant on ECB funds have fewer outside options to trade when buying collateral assets, which is probably not the case when banks sell these assets.

Second, I investigate whether FRFA tenders encourage banks to buy more ECB collateral assets. In so doing, I estimate a linear probability model (OLS) using a differences-in-differences approach (before/after FRFA, eligible/non-eligible as collateral assets) and

[14] In Equations (1) and (2) $FRFA_t$ is not suppressed because the fixed-effects are defined weekly whereas $FRFA_t$ daily.

[15] I use prices instead of yields because the majority of the trades are widespread.

time-varying fixed effects.

$$fb_{ibt} = \alpha_1 FRFA_t * eligible_{iw} + \alpha_2 FRFA_t + \Delta_{iw} + \Delta_{bw} + e_{ibt} \quad (2)$$

where fb_{ibt} equals 1 if bank b buys security i at day t, -1 if bank b sells, and zero otherwise. The sample for estimation of Equation (2) includes all trades in fixed income assets (buy/sell) and I expand the data sample with zeros for all combinations of bank-security-time, where no trade takes place.

In Equation (2), the diff-in-diff interaction term tests whether the introduction of FRFA increases the probability that banks buy collateral assets in the secondary market. If the coefficients α_1 is significant and positive, banks are more likely to buy collateral assets. Formally,

Hypothesis 2*: After the introduction of FRFA, banks are likelier to buy ECB collateral assets,* $\alpha_1 > 0$

4.2 Results

Before I introduce the formal estimation of the Fire Buy premium, I present Figure 2 to illustrate it. In so doing, I subtract the price of each security from its monthly mean. Further, I group the securities in two groups – eligible and non-eligible – taking their monthly average. Figure 2 clearly shows a jump in demeaned prices of eligible assets in October 2008 and a drop in non-eligible assets in the same month. This opposite movement is not due to a mechanical reaction because all prices refer to buy orders and for a mechanical reaction the inclusion of sell orders would be necessary. Also, Figure 2 illustrates that before and after the treatment demeaned prices move in parallel, suggesting that the Fire Buy premium emerges with the FRFA tenders' implementation and vanishes over time.

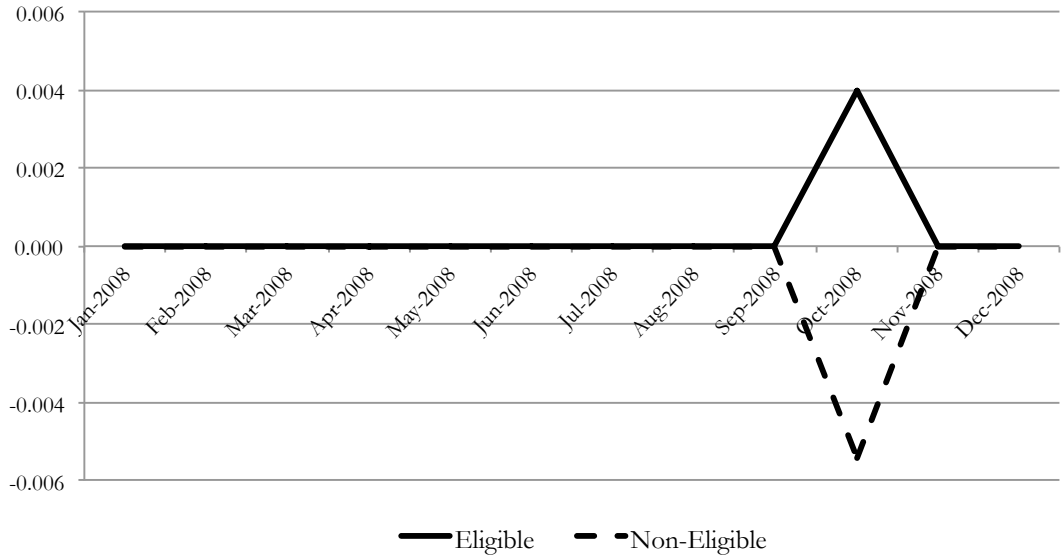

Figure 2: Demeaned prices of securities buy orders with their monthly mean aggregated by eligible and non-eligible securities at the ECB. Sources: own calculation, BaFin, ECB.

Table 3 regressions (I) and (III) present the estimations of Equations (1) and (2), the Fire Buy premium.

Regression (I) shows that after the introduction of FRFA banks pay a Fire Buy premium of 15.6 bps. The result is significant at the 5% level and is in line with Hypothesis 1: banks pay a Fire Buy premium to buy ECB collateral assets after the introduction of FRFA tenders.

The significance of $FRFA_t$ shows that all assets in the sample became cheaper after the introduction of FRFA; this effect is identified by the day variation within the week. The economic meaning of this variable is difficult to interpret since most of the effects from fixed-rate full allotment is captured by the fixed effects. However, statistically, if the variable were left out, it could bias the significance of other variables. Thus, I decided to keep it in the estimation.

Regression (III) shows that after the introduction of FRFA tenders banks became less likely to buy eligible collateral assets (negative and significant interaction term). This result is the opposite of our Hypothesis 2. At first glance, the rise in prices encourages banks in my sample to buy fewer collateral assets.

In order to understand how my results are influenced by banks' dependence on ECB funds I expand previous estimations with a third dimension, the dependence on central bank funding. Regressions (II) and (IV) in Table 3 present the results.

In Regression (II), I investigate whether the Fire Buy premium changes depending on banks' dependence on ECB funds. The intuition is that some banks might have restricted access to the interbank market and be willing to pay higher Fire Buy premiums then others to acquire ECB collateral assets. However, the results point that all interaction terms with the variable CBfunding/TA_{bw} are not significant. Thus, I find no evidence that the Fire Buy premium is a cross-section issue but that, rather, all banks are affected. In this regression, the interaction term $FRFA_t * Eligible_{iw}$ is significant at the 5% level and somewhat higher, about 22.8 basis points.

In regression (IV), all interaction terms are significant, suggesting that indeed the probability to buy collateral assets changes dependent on banks' reliance on ECB funds. For any given level of CBfunding/TA_{bw} the interaction terms $FRFA_t$*$CBfunding/TA_{bw}$ and $FRFA_t$*$CBfunding/TA_{bw}$*$Eligible_{iw}$ almost cancel each other out. Hence, we find that banks more dependent on ECB funds buy more eligible collateral assets not only after the introduction of FRFA but during the full observation window ($CBfunding/TA_{bw}$*$Eligible_{iw}$ positive and significant).

This result is testimony to Hypothesis 2: *banks in greater need of ECB funds are likelier to buy ECB collateral assets.* More specifically, the median bank buys 2.870 (0.035*0.082*1000) ECB collateral assets for every 1,000 trade decisions, while the 90^{th} percentile bank buys 9.594 (0.117*0.082*1000) ECB collateral assets. This difference illustrates the tested hypothesis.

In summary, this section concludes that collateral became more expensive after the introduction of FRFA tenders. The Fire Buy premium affected all banks, not only those more reliant on ECB funding. Further, we find that FRFA tenders do not drive banks to buy more collateral assets, yet banks that are more reliant on ECB funding buy more collateral assets regardless of the form of liquidity provision.

	(I) p_{ibt}	(II) p_{ibt}	(III) fb_{ibt}	(VI) fb_{ibt}
FRFA$_t$	-0.329***	-0.351***	0.006***	0.005***
	(0.086)	(0.117)	(0.001)	(0.001)
FRFA$_t$*Eligible$_{iw}$	0.156**	0.228**	-0.008***	-0.007***
	(0.080)	(0.108)	(0.001)	(0.002)
FRFA$_t$*CBfunding/TA$_{bw}$		0.370		0.036***
		(1.541)		(0.006)
CBfunding/TA$_{bw}$*Eligible$_{iw}$		-0.178		0.078***
		(0.397)		(0.007)
FRFA$_t$*CBfunding/TA$_{bw}$*Eligible$_{iw}$		-1.514		-0.030***
		(1.115)		(0.008)
p_{it-1}	0.659***	0.659***		
	(0.040)	(0.040)		
Bank-Week FE	Yes	Yes	Yes	Yes
Security-Week FE	Yes	Yes	Yes	Yes
adj. R^2	0.998	0.998	0.009	0.009
adj. within R^2	0.289	0.289	0.000	0.000
# Obs	303,601	303,476	23,964,109	23,964,109
# Securities*Week	92,563	92,563	506,998	506,998
# Bank*Week	1,102	1,102	1,254	1,254
Autocorrelation	0.000	0.000	0.000	0.000

Table 3: **Fire Buy premium**: (I) Estimation of Fire Buy premium, as: $p_{ibt} = \beta_1 FRFA_t * eligible_{iw} + \beta_2 FRFA_t + \theta p_{it-1} + \Delta_{iw} + \Delta_{bw} + u_{ibt}$; (II) Estimation of Fire Buy premium, as: $p_{ibt} = \beta_1 FRFA_t * CBfunding/TA_{bw} * eligible_{iw} + \beta_2 CBfunding/TA_{bw} * eligible_{iw} + \beta_3 FRFA_t * CBfunding/TA_{bw} + \beta_4 FRFA_t * eligible_{iw} + \beta_5 FRFA_t + \theta p_{it-1} + \Delta_{iw} + \Delta_{bw} + u_{ibt}$. fb_{ibt}; (III) Fire Buy likelihood estimation using OLS and time-varying fixed effects, as: $fb_{ibt} = \alpha_1 FRFA_t * eligible_{it} + \alpha_2 FRFA_t + \Delta_{iw} + \Delta_{bw} + e_{ibt}$; (IV) Fire Buy likelihood estimation using OLS and time-varying fixed effects, as: $fb_{ibt} = \alpha_1 FRFA_t * CBfunding/TA_{bw} * eligible_{it} + \alpha_2 FRFA_t * CBfunding/TA_{bw} + \alpha_3 FRFA_t * eligible_{it} + \alpha_4 CBfunding/TA_{bw} * eligible_{it} + \alpha_5 FRFA_t + \Delta_{iw} + \Delta_{bw} + e_{ibt}$. fb_{ibt} takes the value of 1 if bank b buys security i on day t, -1 if it sells, and zero otherwise; p_{ibt} is the nominal price paid by bank b for security i on day t; FRFA$_t$ takes the value of 1 after its announcement on October 8^{th}, 2008 and zero otherwise; $CBfunding/TA_{bw}$ is the ratio of ECB funds to total assets; $Eligible_{iw}$ takes the value of 1 if asset i is eligible at week w; lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Autocorrelation gives the p-value for the Wooldridge (2010) test for autocorrelation in panel data, where H_0 is autocorrelation.

4.3 Anticipation Effect

The difference-in-differences empirical strategy is based on the idea that the causality is due to the treatment, the implementation of FRFA tenders. If agents anticipate the actions of the ECB before its introduction, they may react before the announcement and the coefficient of my estimations could be underestimated. The period analyzed in this study is very peculiar because just before the introduction of FRFA a major event occurred: the bankruptcy of Lehman Brothers. Thus, to test for anticipation effects I choose a date before the Lehman event. In Section 6, I formally test for possible spillovers from the Lehman event.

To test whether banks pay a Fire Buy premium before the announcement of the fixed-rate full allotment, I restrict the sample such that it finishes before the FRFA announcement (October 8^{th}), choose a placebo date for the treatment (August 1^{st}) and estimate Equations (1) and (2) as before. The results are presented on Table 4.

	(V) p_{ibt}	(VI) fb_{ibt}
FRFA$_t$*Eligible$_{iw}$	0.021	0.186***
	(0.040)	(0.009)
FRFA$_t$	0.096***	-0.007
	(0.010)	(0.005)
p_{it-1}	0.656***	
	(0.060)	
Bank-Week FE	Yes	Yes
Security-Week FE	Yes	Yes
adj. R^2	0.998	0.016
adj. within R^2	0.328	0.000
# Obs	230,811	20,509,762
# Securities*Week	71,228	408,654
# Bank*Week	878	1,066

Table 4: **Anticipation Effect – Fire Buy premium**: (V) Differences-in-differences estimation using placebo treatment on August 1^{st}, 2008; (VI) Likelihood estimation estimation using placebo treatment on August 1^{st}, 2008. p_{ibt} is the nominal price paid by bank b for security i on day t; fb_{ibt} takes the value of 1 if bank b buys security i on day t, -1 if it sells, and zero otherwise; FRFA$_t$ takes the value of 1 after its announcement on August 1^{st}, 2008 and zero otherwise; $Eligible_{iw}$ takes the value of 1 if asset i is eligible at week w; lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Regression (V) shows no evidence that the Fire Buy premium is paid in anticipation of the introduction of FRFA tenders, i.e. the interaction term is non-significant. Regression (VI) presents evidence for an anticipation effect: banks are likelier to buy collateral assets in the months preceding the implementation of FRFA tenders. Thus, the picture we

have so far is that banks start buying collateral assets before the provision of unlimited liquidity provision but the price impact kicks in after the policy introduction.

4.4 Technical Remarks

Estimating a model using security-week and bank-week fixed effects is a statistically tight approach. Another form of estimating fixed effects that yields similar results in a linear estimation is the use of dummy variables. In this case, I would have included 93,665 dummies as explanatory variables in the first estimation and 508,252 in the second. These very large numbers illustrate the tightness of the estimation. Moreover, it accounts for all observable and non-observable effects on the security-week and bank-week dimensions and dismisses the use of control variables.

Estimations (I) and (II) present a very high overall R^2, around 0.99. This number means that almost all data variation is explained by the model. However, the within R^2 shows that this value is mostly driven by the fixed-effects and not by the regressors of interest. Nevertheless, the model fits the data fairly good with R^2 of 0.289.

A common concern regarding estimations with high R^2 is the serial correlation of the error term. I address this issue with the Wooldridge (2010) test for autocorrelation in panel data. In the last line of Table 5, the p-value of the test is presented. There, we find that the inclusion of the AR(1) process excludes the possibility of autocorrelation at the 5% confidence level.

5 The Risk-Shifting Premium

5.1 Empirical Strategy

In this section, I approach the question whether banks in great need of central bank money pay a premium for lower-rated collateral, the Risk-Shifting premium. Therefore, I look into the subset of eligible assets divided by rating category (AAA, AA, A, and BBB) and estimate a two-way interaction model using $CBfunding_{bw}$ and $FRFA_t$, as:

$$p_{ibt} = \lambda_1 FRFA_t * CBfunding/TA_{bw} + \lambda_2 FRFA_t + \eta p_{it-1} + \Delta_{iw} + \Delta_{bw} + \epsilon_{ibt} \quad (3)$$

$CBfunding/TA_{bw}$ is the ratio of central bank liabilities to total liabilities of bank b in week w. In the present context, the reliance on central bank liquidity is an indicator that banks have poor access to interbank markets and need to obtain funding from the central bank. Thus, central bank funding is an indicator of how distressed a bank is.

In Equation (3) the coefficient of the interaction term, λ_1, represents how reliance on ECB funds influences the premium payment after the introduction of FRFA tenders. In this context, I test:

Hypothesis 3: *Banks in greater need of ECB funds pay a premium for lower-rated collateral assets,* $\lambda_1^{BBB} > 0$.

5.2 Results

In order to illustrate the Risk-Shifting premium, I present Figure 3. It presents the demeaned prices of BBB-rated collateral with their respective monthly average. In a second step, I aggregate this value in two groups. The first group is comprised of banks for which, in a given month, reliance on ECB funds is above the median, called *reliant*. The second group consists of the remaining banks, which I call *non-reliant*.

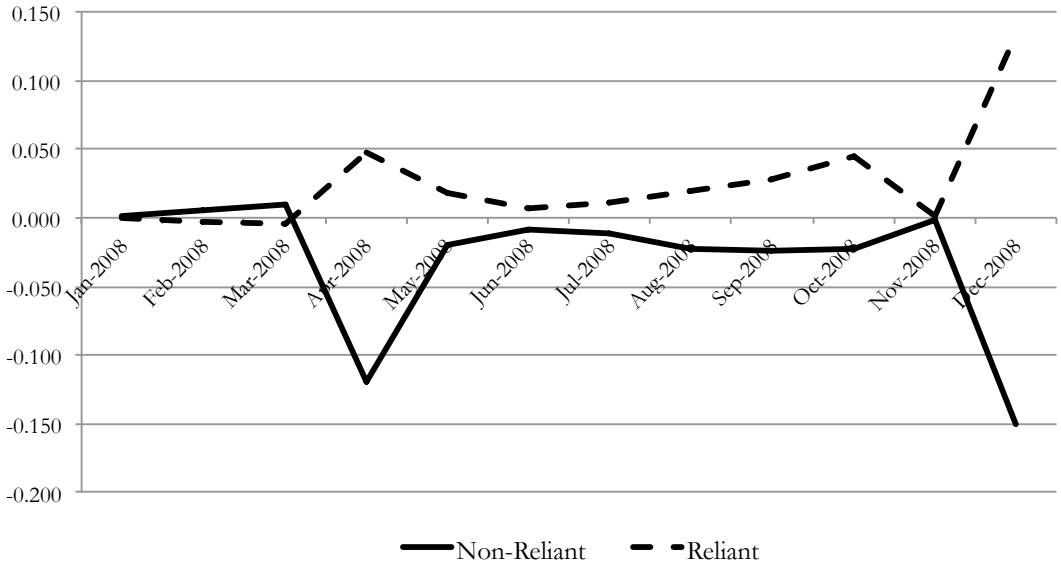

Figure 3: Demeaned prices of buy transactions with BBB-rated ECB collateral assets by *Reliant* and *Non-Reliant*. Reliant comprises banks whose dependence on ECB funds is above the median in a given month; Non-Reliant covers all other banks. Sources: own calculation, BaFin, ECB.

Figure 3 shows that since April 2008 banks more reliant on ECB funds pay more to acquire collateral assets. The price difference is persistent over the course of the year and peaks in December. Interestingly, the effect on banks less reliant on ECB liquidity is opposite.

In order to understand how severe the risk-shifting channel is, I estimate Equation (3) for 4 subsamples of collateral assets (AAA, AA, A, and BBB) using only the buy side of the market. Table 5 presents the estimation.

The variable of our primary interest is the interaction between the ratio of central bank funds to total liabilities ($CBfunding/TA_{bw}$) and the dummy representing the introduction of fixed-rate full allotment tenders ($FRFA_t$). The coefficient of the interaction term is positive and significant only for BBB assets. The median bank pays 28 basis points (=0.035*8.001) to buy BBB-rated collateral assets, whereas banks in the 90^{th} percentile pays 93.6 bps (=0.117*8.001). The difference between these banks illustrates the Risk-Shifting premium, 65.6 basis points. In other words, banks more reliant on ECB funds are willing to pay on average 65.6 basis points to acquire BBB-rated collateral assets.

Moreover, in order to avoid criticism that my results are being driven by the time series and not the cross-section, i.e. there was a structural break that led all banks to pay a premium and not only those dependent on ECB funds, I estimate a differences-

in-differences approach. I define a variable $ECBreliant_{bw}$ that takes the value of one if bank b reliance on ECB funds is above the median in the week w and zero otherwise. The diff-in-diff approach is comprised of $ECBreliant_{bw}$ and FRFA; the results are presented in Table 6.

	(VII) p^{AAA}_{ibt}	(VIII) p^{AA}_{ibt}	(IX) p^{A}_{ibt}	(X) p^{BBB}_{ibt}
$FRFA_t$*CBfunding/TA_{bw}	-0.358	0.884	-3.518	8.001***
	(1.422)	(2.936)	(2.341)	(2.806)
$FRFA_t$	0.063	-0.216*	-0.644***	-0.629**
	(0.093)	(0.126)	(0.170)	(0.232)
p_{it-1}	0.685***	0.582***	0.615***	0.462***
	(0.043)	(0.069)	(0.057)	(0.114)
Bank-Week	Yes	Yes	Yes	Yes
Security-Week	Yes	Yes	Yes	Yes
adj. R^2	0.994	0.995	0.988	0.993
adj. within R^2	0.270	0.256	0.236	0.162
# Obs	47,192	20,908	15,833	8,669
# Securities*Week	11,121	6,826	4,149	3,785
# Bank*Week	815	757	794	733
Autocorrelation	0.023	0.000	0.000	0.000

Table 5: **Risk-Shifting premium – Interaction Model:** estimation by rating category with time-varying fixed effects, as: $p_{ibt} = \lambda_1 FRFA_t + \lambda_2 FRFA_t * CBfunding_{bt} + \eta p_{it-1} + \Delta_{iw} + \Delta_{bw} + \epsilon_{ibt}$. p_{ibt} is the nominal price paid by bank b for security i on day t; $FRFA_t$ takes the value of 1 after its announcement on October 8^{th}, 2008 and zero otherwise; $CBfunding/TA_{bw}$ is the ratio of ECB funds to total assets; and lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Autocorrelation gives the p-value for the Wooldridge (2010) test for autocorrelation in panel data, where H_0 is autocorrelation.

The results are economically very similar to the previous estimation; banks more reliant on ECB funds pay more for lower-rated collateral assets. The upper half (above median) pays 25.2 bps more than the lower half. This result complements the previous one by showing that it is not the level of ECB funds that drives the results but rather the cross-section of banks. The results of this section confirm Hypothesis 3.

The existence of the Fire Buy and the Risk-Shifting premia, shown proving Hypotheses 1 and 3, suggest two confounding effects. The possibility of raising unlimited amounts of funds from the central bank and the scarce provision of collateral assets lead banks to pay a premium to acquire these securities. In order to avoid a shortage of collateral assets and mitigate the Fire Buy premium, the ECB enlarged its collateral framework to accept BBB-rated assets. However, the haircut applied to these assets does not cover

	(XI) p^{AAA}_{ibt}	(XII) p^{AA}_{ibt}	(XIII) p^{A}_{ibt}	(XIV) p^{BBB}_{ibt}
FRFA$_t$*ECBreliant$_{bw}$	-0.075	0.121	0.093	0.252**
	(0.097)	(0.127)	(0.233)	(0.109)
FRFA$_t$	0.072	-0.206***	-0.835***	-0.304**
	(0.074)	(0.064)	(0.151)	(0.127)
p_{it-1}	0.685***	0.582***	0.614***	0.462***
	(0.044)	(0.070)	(0.058)	(0.114)
Bank-Week	Yes	Yes	Yes	Yes
Security-Week	Yes	Yes	Yes	Yes
adj. R^2	0.994	0.992	0.988	0.990
adj. within R^2	0.270	0.256	0.236	0.162
# Obs	47,192	20,908	15,833	8,669
# Securities*Week	11,127	6,826	4151	1,668
# Bank*Week	821	758	797	503
Autocorrelation	0.021	0.000	0.000	0.000

Table 6: **Risk-Shifting premium – Differences-in-Differences model:** estimation by rating category with time-varying fixed effects, as: $p_{ibt} = \lambda_1 FRFA_t + \lambda_2 FRFA_t * ECBreliant_{bw} + \eta p_{it-1} + \Delta_{iw} + \Delta_{bw} + \epsilon_{ibt}$. p_{ibt} is the nominal price paid by bank b for security i on day t; FRFA$_t$ takes the value of 1 after its announcement on October 8^{th}, 2008 and zero otherwise; $ECBreliant_{bw}$ takes the value 1 if bank b's dependence on ECB funds is above the median in week w; and lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Autocorrelation gives the p-value for the Wooldridge (2010) test for autocorrelation in panel data, where H_0 is autocorrelation.

	(XV) p_{ibt}^{AAA}	(XVI) p_{ibt}^{AA}	(XVII) p_{ibt}^{A}	(XVIII) p_{ibt}^{BBB}
FRFA$_t$*CBfunding/TA$_{bw}$	3.760	-1.892	-0.888	-1.253
	(2.762)	(1.218)	(0.657)	(1.168)
FRFA$_t$	0.083**	0.077**	0.097**	0.158*
	(0.041)	(0.035)	(0.041)	(0.087)
p_{it-1}	0.686***	0.669***	0.566***	0.591***
	(0.059)	(0.117)	(0.054)	(0.065)
Bank-Week	Yes	Yes	Yes	Yes
Security-Week	Yes	Yes	Yes	Yes
adj. R^2	0.995	0.994	0.991	0.992
adj. within R^2	0.265	0.347	0.203	0.200
# Obs	40,003	14,717	11,667	4,526
# Securities*Week	9,485	4,851	3,116	1,220
# Bank*Week	669	516	634	398

Table 7: **Anticipation Effect – Risk-Shifting premium** estimation by rating category with time-varying fixed effects and placebo treatment on August 1^{st}, 2008. p_{ibt} is the nominal price paid by bank b for security i on day t; FRFA$_t$ takes the value of 1 after its announcement on August 1^{st}, 2008 and zero otherwise; $CBfunding/TA_{bw}$ is the ratio of ECB funds to total assets; and lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

all risks related to the transaction. Banks exploiting the haircut subsidy pay a further premium to acquire BBB-rated collateral assets. If the haircut reflected all risks related to the operation, the risk-shifting channel would be closed, andyield seeking banks would not pay the Risk-Shifting premium. At the limit, we can interpret the Risk-Shifting premium as how much a bank can increase its yield by pledging the particular asset and shifting the extra risk to the ECB. Hence, the Risk-shifting premium prices gains from the risk-shifting mechanism.

All technical remarks applied to the Fire Buy premium also hold for the Risk-Shifting premium.

5.3 Anticipation Effect

In this section, I test whether banks could anticipate the Risk-Shifting premium and potentially start incurring it before the policy implementation. Therefore, I set a placebo treatment on August 1^{st} and restrict the sample until the actual treatment on October 8^{th}. The results are presented in Table 7.

None of the coefficients of the interaction term FRFA_t*CBfunding/TA_{bw} is significant. This result suggests no anticipation effect.

6 Falsification Tests

In this section, I present supporting evidence for the causal effect of the treatment, $FRFA_t$. I address three issues using falsification tests. First, is the network structure of OTC markets (dealers vs non-dealers) influencing my results? Second, are the results driven by the fact that I am looking only into buy orders? Third, are the results driven by the Lehman Brothers bankruptcy about a month before the ECB's actions?

6.1 Dealer-Non-Dealer Structure of OTC Markets

In over-the-counter markets price differentiation occurs according to the network structure of the market. Periphery participants (non-dealers) pay a premium to trade with the core (dealers); see e.g. Li and Schürhoff (2014). In order to disentangle a premium payment attributed to the network structure from the proposed premia I identify trades in which dealers are the counterparty. For each trade I am able to identify both counterparties. Thus, I determine for each security the trader that has been the most frequent counterparty in my sample. I create a dummy variable called $Dealer_{i-b}$ that takes the value of 1 whenever the counterparty of the trade is the largest counterparty of the specific asset.[16] Further, I interact the variable $Dealer_{i-b}$ with the variables in Equation (1) and (3).

Table 8 presents the results. Regression (IXX) shows the general case using the full fixed-income trading book of the banks in the sample, whereas Regressions (XX)-(XXIV) focus on the subsamples of collateral assets. In general terms, we find that trading with a dealer leads to a premium payment, significant and positive coefficient of the variable $Dealer_{i-b}$ in Regression (IXX). This premium increases after the introduction of FRFA tenders, significant and positive coefficient of the interaction variable $Dealer_{i-b}$*FRFA_t

[16]The subscript $-b$ represents the counterparty of bank b in a given trade.

in Regression (IXX). However, I find no evidence that dealers impose price discrimination on banks that are more reliant on ECB funds, with an insignificant coefficient of three way interaction terms in Equations (IXX) – (XXIV) with the exception of (XXII). In this case, the three-way interaction term is negative and significant for AA-rated assets. Moreover, the coefficient is negative, the opposite direction of my concern. In summary, I find no evidence that the dealer-non-dealer structure of OTC markets is responsible for the effects described in this study.

6.2 Sell Side of the Market

My identification strategy is based on the buy side of each trade with collateral assets. However, in decentralized markets participants may be willing to purchase a security at a premium if they can sell it at an even higher premium. For instance, dealers may buy a security from another dealer and sell it to customers at a markup. Hence, I estimate Equations (1) and (3) using only sell orders. If the coefficients are positive and significant, it indicates that participants sell assets at even higher prices. Table 9 presents the results.

In Regression (XXV), the coefficient of the interaction term $FRFA_t * Eligible_{iw}$ is negative and significant. This result suggests that banks in the sample sell ECB collateral assets at a discount after the implementation of FRFA. Also, in Regression (IXXX), the coefficient of the interaction term is negative and significant. These results suggest that, if anything, banks are reselling assets at lower prices, which is not evidence of strategic behavior. A possible explanation of why banks pay a premium when buying collateral assets and sell them at discount is that they are adjusting their portfolio within each category, keeping higher-yielding assets and selling lower-yielding ones.

6.3 Lehman Brothers Bankruptcy

To avoid confusion, the anticipation test was intentionally carried out before the Lehman Brothers bankruptcy. However, it was such an important event during the observation window that I test the possibility that some of my results may have been driven by this event. Hence, I propose an estimation including the bankruptcy as a further treatment in the interaction models described by Equations (1) to (3). Therefore, I define a dummy called $Lehman_t$ that takes the value of 1 after September 14^{th} and interact it with the previous variables. The estimations are presented in Table 10.

In Estimations (XXX) and (XXXII)-(XXXV) the coefficients of the interaction terms $Lehman_t * Eligible_{iw}$ and $Lehman_t * CBfunding/TA_{bw}$ are not significant.[17] This result suggests that the channel though which the Lehman Brothers bankruptcy affects prices is captured in this framework. Estimation (XXXI) suggests that both $Lehman_t$ and $FRFA_t$ increase the probability of banks buying eligible assets but that, when interacted with $Eligible_{iw}$, these coefficients become negative, i.e. after Lehman and FRFA banks reduce their purchase of collateral assets.

[17] Note that $FRFA_t * Lehman_t = FRFA_t$

	(IXX) p_{ibt}	(XX) p^{AAA}_{ibt}	(XXII) p^{AA}_{ibt}	(XXIII) p^{A}_{ibt}	(XXIV) p^{BBB}_{ibt}
$FRFA_t$*$Eligible_{iw}$*$Dealer_{i-b}$	-0.027				
	(0.057)				
$Dealer_{i-b}$*$Eligible_{iw}$	-0.009				
	(0.018)				
$FRFA_t$*$Eligible_{iw}$	0.178**				
	(0.090)				
$Dealer_{i-b}$*$FRFA_t$*$CBfunding/TA_{bw}$		-0.283	-4.836**	-1.131	1.543
		(1.453)	(2.417)	(1.918)	(2.763)
$Dealer_{ib}$*$CBfunding/TA_{bw}$		1.210	-0.251	-1.181	-1.378
		(0.846)	(0.866)	(0.751)	(1.422)
$FRFA_t$*$CBfunding/TA_{bw}$		-0.365	1.575	-3.212	7.659**
		(1.418)	(2.889)	(2.363)	(3.018)
$Dealer_{i-b}$*$FRFA_t$	0.122***	-0.027	0.206*	0.253	-0.072
	(0.045)	(0.069)	(0.118)	(0.185)	(0.207)
$FRFA_t$	-0.366***	0.069	-0.218	-0.684***	-0.615**
	(0.088)	(0.092)	(0.126)	(0.250)	(0.277)
$Dealer_{i-b}$	0.035***	-0.046	0.075*	0.086**	0.073
	(0.012)	(0.036)	(0.044)	(0.034)	(0.060)
p_{it-1}	0.659***	0.685***	0.581***	0.614***	0.461***
	(0.040)	(0.043)	(0.069)	(0.057)	(0.114)
Bank-Week	Yes	Yes	Yes	Yes	Yes
Security-Week	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.999	0.994	0.992	0.989	0.990
adj. within R^2	0.290	0.270	0.258	0.239	0.163
# Obs	303,601	47,191	20,908	15,833	6,416
# Securities*Week	92,590	11,121	6,826	4,149	1,688
# Bank*Week	1,110	815	757	794	503

Table 8: **Falsification Test – Dealer-Non-Dealer Structure of OTC Markets:** (IXX) Estimation of Fire Buy premium with identification of dealers, (XX-XXIV) Risk-Shifting premium with identification of dealers by rating category with time-varying fixed effects. $Dealer_{i-b}$ takes the value of 1 when counterparty $-b$ is the largest counterparty of asset i in the sample; p_{ibt} is the nominal price paid by bank b for security i on day t; $FRFA_t$ takes the value of 1 after its announcement on October 8^{th}, 2008 and zero otherwise; $CBfunding/TA_{bw}$ is the ratio of ECB funds to total assets; $Eligible_{iw}$ takes the value of 1 if asset i is eligible at week w; and lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(XXV) p_{ibt}	(XXVI) p^{AAA}_{ibt}	(XXVII) p^{AA}_{ibt}	(XXVIII) p^{A}_{ibt}	(IXXX) p^{BBB}_{ibt}
FRFA$_t$*Eligible$_i$	-0.448***				
	(0.150)				
FRFA$_t$*CBfunding/TA$_{bw}$		0.045	6.640	-1.580	-2.248***
		(1.611)	(4.490)	(6.267)	(0.837)
FRFA$_t$	-0.049	0.157	-0.210	-0.606*	-0.607
	(0.141)	(0.098)	(0.147)	(0.326)	(0.429)
p_{it-1}	-0.000***	0.620***	0.695***	0.554***	0.397***
	(0.000)	(0.035)	(0.123)	(0.045)	(0.114)
Bank-Week	Yes	Yes	Yes	Yes	Yes
Security-Week	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.998	0.995	0.994	0.985	0.993
adj. within R^2	0.001	0.237	0.282	0.144	0.095
# Obs	380,019	62,425	35,238	24,295	6,008
# Securities*Week	104,616	13,274	9,454	5,095	1,428
# Bank*Week	903	750	618	634	553

Table 9: **Falsification Test – Sell Positions:** (XXV) Estimation of Fire Buy premium using sell positions, (XXVI-IXXX) Risk-Shifting premium using sell positions by rating category with time-varying fixed effects. p_{ibt} is the nominal price paid by bank b for security i on day t; FRFA$_t$ takes the value of 1 after its announcement on October 8^{th}, 2008 and zero otherwise; $CBfunding/TA_{bw}$ is the ratio of ECB funds to total assets; $Eligible_{iw}$ takes the value of 1 if asset i is eligible at week w; and lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(XXX) p_{ibt}	(XXXI) fb_{ibt}	(XXXII) p^{AAA}_{ibt}	(XXXIII) p^{AA}_{ibt}	(XXXIV) p^{A}_{ibt}	(XXXV) p^{BBB}_{ibt}
Lehman$_t$*Eligible$_{iw}$	-0.010	-0.004**				
	(0.136)	(0.002)				
FRFA$_t$*Eligible$_{iw}$	0.157*	-0.008***				
	(0.081)	(0.001)				
Lehman$_t$*CBfunding/TA$_{bw}$			2.129	-0.279	-4.762	2.223
			(2.341)	(2.306)	(3.633)	(3.881)
FRFA$_t$*CBfunding/TA$_{bw}$			-0.358	0.884	-3.521	8.001***
			(1.422)	(2.936)	(2.341)	(2.806)
Lehman$_t$	-0.041	0.008***	-0.120	-0.035	-0.290	-0.116
	(0.110)	(0.001)	(0.130)	(0.126)	(0.213)	(0.304)
FRFA$_t$	-0.330***	0.006***	0.063	-0.218*	-0.643***	-0.629**
	(0.087)	(0.001)	(0.093)	(0.126)	(0.172)	(0.232)
p_{it-1}	0.659***		0.685***	0.582***	0.615***	0.461***
	(0.040)		(0.043)	(0.069)	(0.057)	(0.114)
Bank-Week FE	Yes	Yes	Yes	Yes	Yes	Yes
Security-Week FE	Yes	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.998	0.010	0.994	0.995	0.988	0.993
adj. within R^2	0.289	0.000	0.270	0.256	0.236	0.161
# Obs	303,601	23,964,109	47,192	20,908	15,833	8,669
# Securities*Week	104,616	506,998	11,121	6,826	4,149	3,785
# Bank*Week	903	1254	815	757	794	733

Table 10: **Falsification Test – Lehman Brothers Bankruptcy:** (XXX) Fire Buy premium estimation with Lehman treatment; (XXXI) likelihood estimation using OLS; time-varying fixed effects and Lehman treatment; (XXXII-XXXV) Risk-Shifting premium estimation by rating category with time-varying fixed effects and Lehman treatment. $Lehman_t$ takes the value of 1 after its bankruptcy on September 14^{th} and zero otherwise; fb_{ibt} takes the value of 1 if bank b buys security i on day t, -1 if it sells, and zero otherwise; p_{ibt} is the nominal price paid by bank b for security i on day t; $CBfunding/TA_{bw}$ is the ratio of ECB funds to total assets; FRFA$_t$ takes the value of 1 after its announcement on October 8^{th}, 2008 and zero otherwise; $Eligible_{iw}$ takes the value of 1 if asset i is eligible at week w; and lagged prices are based on the interpolation of transaction prices from all banks. Variables with subscript t are defined daily and w weekly. Standard errors in parentheses and clustered in the bank-security dimension. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7 Conclusion

In the present study, I describe the impact of unlimited central bank liquidity provision on the secondary market for collateral assets. In order to avoid fire sales the ECB provided unlimited liquidity leading to a scarcity of collateral assets and banks paid the Fire Buy premium. It demonstrates that banks pay more for collateral assets in times when central bank liquidity is most needed and underlines the necessity of an expansion of the collateral framework. In order to avoid a shortage of collateral securities, the ECB lowered the quality threshold to accept BBB-rated collateral. However, the haircut applied to these assets did not totally reflect the risk of the operation, encouraging banks to shift risks to the ECB balance sheet. This risk-shifting feature leads banks to pay the Risk-Shifting premium and represents how much banks can increase their yields using haircut subsidies. Hence, my study links monetary policy to trading behavior and adds to the risk-shifting literature.

If eligible collateral assets were abundant, the Fire Buy premium would not arise. The ECB has sought to mitigate the problem by enlarging its collateral framework to accept BBB-rated collateral assets. Also, other forms of enlargement have been implemented, such as the inclusion of foreign currency-denominated bonds, and unsecured bank bonds. The analysis of these policies goes beyond the scope of this study.

When haircuts perfectly reflect securities' risk and the correlation risk between collateral and counterparty, banks are indifferent about which asset to pledge. In this way, an enlargement of the collateral framework merely means an enhancement of liquidity provision, and no Risk-Shifting premium would exist. Hence, a haircut policy that takes into account the correlation risk between collateral and counterparties could be able to avoid the Risk-Shifting premium. However, a haircut policy that takes discretionary decisions on a transaction-by-transaction basis is not feasible because the estimation of the correlation risk between counterparties and collateral is non-trivial since there are over 30.000 eligible collateral assets and over 1.000 counterparties in the Eurozone. Nevertheless, this study takes the view that more differentiation rules among counterparties could help avoid the risk-shifting channel.

My results are drawn from a sample of 26 German banks and thus relate only to a small subsample of European banks. However, the ECB Collateral Framework applies to all banks in the Eurosystem, and the risk-shifting channel is open to all of them. Hence, the phenomenon described in this study may occur with other banks as well. I leave this issue to be determined by future research.

I make use of one specific identifying shock, the implementation of full allotment tenders. However, scarcity of collateral assets and a disputable haircut setting could occur in other situations. For instance, the asset purchase program in early 2011 may have induced banks to acquire collateral assets because they knew the ECB would buy them. I leave the investigation of this period to further research as well.

Appendix

The ECB Collateral Framework

The *ECB Collateral Framework* is a guideline for the implementation of monetary policy in the euro zone. The framework is relatively broad in all its dimensions; see Eberl and Weber (2014), Nyborg (2015), ECB (2003), ECB (2005), ECB (2006), ECB (2008a), ECB (2008b). First, it permits several categories of debt instruments: corporate bonds, government bonds, covered bonds, uncovered bank bonds and ABSs. Second, the quality threshold is relatively loose; until October 2008 bonds had to be rated A- or better, and thereafter BBB- or better. Third, the number of counterparties is relatively large; as of January 2011, 3,211 financial institutions had access to the ECB funds market.

To mitigate security risks, the ECB applies a haircut to the asset value according to Table 11. Haircuts increase with maturity, non-coupon payment, and category. In contrast to the private markets, the ECB does not take into account the correlation between collateral risk and counterparty. For instance, an Austrian and a Portuguese bank of similar rating might receive different haircuts in private repos when using a Portuguese sovereign bond as collateral. This differentiation happens because, in the scenario where Portugal is bankrupt, Portuguese banks are also likely to be bankrupt, whereas an Austrian bank would be less affected.

The ECB conducts open market operations predominantly via repos (repurchase agreements), but banks can also access central bank funds through the marginal lending facility. In both cases, banks need to pledge high-quality collateral. Unlike the Fed, where the primary dealer system is used, in the Eurosystem, a large number of banks can engage in transactions with the ECB.

Also in contrast to the US, where only Treasuries are accepted as collateral, the ECB allows a wider range of assets as collateral in four categories as described above. The definition of which securities are accepted as collateral depends on many factors including asset quality, type of asset, credit standard, place of issue, type of issuer, currency, asset marketability etc. The most notable characteristic is asset quality, which until October 2008 had to be a rating of A- or better, and BBB- or better thereafter.

Until October 2008, the ECB conducted variable-rate auctions, where participants had to submit bids for loan quantities at different interest rates. According to the aggregated demand for credit, the ECB determined the interest rate given the amount of liquidity it was prepared to supply. All bids above the clearing interest rate would be satisfied. Since October 2008, the ECB moved to a fixed-rate full allotment procedure in all its refinancing operations (Main Refinancing Operations or MROs; and Longer-Term Refinancing Operations or LTROs). This policy meant that banks can borrow any amount as long they have eligible collateral assets. In practical terms, the ECB became the lender of last resort.

AAA to A-

	Category I		Category II		Category III		Category IV	
Maturity	Fixed	Zero	Fixed	Zero	Fixed	Zero	Fixed	Zero
0-1	0.5	0.5	1	1	1.5	1.5	2	2
1-3	1.5	1.5	2.5	2.5	3	3	3.5	3.5
3-5	2.5	3	3.5	4	4.5	5	5.5	6
5-7	3	3.5	4.5	5	5.5	6	6.5	7
7-10	4	4.5	5.5	6.5	6.5	8	8	10
> 10	5.5	8.5	7.5	12	9	15	12	18

BBB+ to BBB-

	Category I		Category II		Category III		Category IV	
Maturity	Fixed	Zero	Fixed	Zero	Fixed	Zero	Fixed	Zero
0-1	5.5	5.5	6	6	6.5	6.5		
1-3	6.5	6.5	7.5	7.5	8	8		
3-5	7.5	8	8.5	9	9.5	10	Not	
5-7	8	8.5	9.5	10	10.5	11	Accepted	
7-10	9	9.5	10.5	11.5	11.5	13		
> 10	10.5	13.5	12.5	17	14	20		

Table 11: **Eurosystem haircuts** (in %) by liquidity category, residual maturity, and coupon (zero or fixed) in 2008. Category I: central government debt instruments, debt instruments issued by central banks; Category II: local and regional government debt instruments, Jumbo Pfandbrief, agency and supranational debt instruments; Category III: covered bonds, traditional Pfandbrief, credit institution debt instruments, debt instruments issued by corporates; Category IV: asset-backed securities. Note: with the expansion of the collateral framework, the ECB created a further category (uncovered debt) which is excluded from the analysis since I do not observe any trade with these assets. Source: Fecht et al. (2015).

ECB Haircut Adjustment of 2011

In 2008, when the ECB expanded its Collateral Framework to accept BBB rated assets, it imposed a flat 5% haircut add-on compared to assets with similar maturity and category, see Table 11. However, as my study shows, this flat haircut add-on does not cover all risks related to this type of collateral. In its press release of 8^{th} of April 2010, the ECB reviews its haircut policy and announces the introduction of a graduated haircut schedule. Table 12 presents the haircut increase in % points compared to Table 11.

In this adjustment, all revisions were related to BBB-rated collateral assets, and upwards (up to 19%), which evidences that previous haircuts were downwards biased.

AAA to A-

	Category I		Category II		Category III		Category IV	
Maturity	Fixed	Zero	Fixed	Zero	Fixed	Zero	Fixed	Zero
0-1	0	0	0	0	0	0	0	0
1-3	0	0	0	0	0	0	0	0
3-5	0	0	0	0	0	0	0	0
5-7	0	0	0	0	0	0	0	0
7-10	0	0	0	0	0	0	0	0
> 10	0	0	0	0	0	0	0	0

BBB+ to BBB-

	Category I		Category II		Category III		Category IV	
Maturity	Fixed	Zero	Fixed	Zero	Fixed	Zero	Fixed	Zero
0-1	0	0	0	0	+1.5	+1.5		
1-3	0	0	+3	+4	+10	+11.5		
3-5	0	0	+7	+8	+15.5	+17.5	Not	
5-7	0	0	+8.5	+10.5	+16.5	+19	Accepted	
7-10	0	0	+9	+11	+15.5	+19		
> 10	0	0	+7.5	+12	+13.5	+16.5		

Table 12: **Haircut Change of 1^{st} 2011 (in %).** Category I: central government debt instruments, debt instruments issued by central banks; Category II: local and regional government debt instruments, Jumbo Pfandbrief, agency and Supranational debt instruments; Category III: covered Bonds, traditional Pfandbrief, credit institution debt instruments, debt instruments issued by corporates; Category IV: asset-backed securities. Note: with the expansion of the collateral framework, the ECB created a further category (uncovered debt) which is excluded from this table for simplicity. Source: ECB

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