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Banks' Trading After the Lehman Crisis – The Role of Unconventional Monetary Policy

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Banks' Trading after the Lehman Crisis - The Role of Unconventional Monetary Policy*

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Abstract

Based on a unique trade-level dataset, we analyze the proprietary trading reaction of German banks to the Lehman collapse and the subsequent unconventional monetary policy measures in 2008. After the Lehman collapse, we observe that market liquidity tightened. However, there is no evidence of broad-based fire sales in the German banking sector. Instead, we observe a flight to liquidity. The European Central Bank's unconventional measures had a strong impact on banks' trading behavior by inducing shifts towards eligible securities and reducing pressure on market liquidity. This suggests that the unconventional measures helped stabilizing the financial system after the Lehman collapse.

Keywords: Proprietary trading, fire sales, flight to liquidity, Lehman crisis, market liquidity, unconventional monetary policy

JEL Classification: E44, E50, G01, G11, G21

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1 Introduction

Contagion effects through fire sale externalities were at the heart of the global financial crisis. Market participants' trading behavior and the resulting contagion effects are said to have amplified the rather modest losses in the US subprime sector and contributed to the spread of the crisis on a global scale (Brunnermeier, 2009; Hellwig, 2009). In response to these disturbances, many central banks resorted to unconventional measures in order to contain the crisis. The effectiveness of these measures in reducing fire sales has, however, hardly been assessed.

Therefore, this paper looks at German banks' proprietary trading to analyze how the unconventional monetary policy measures by the European Central Bank (ECB) affected banks' trading behavior after the Lehman collapse. The default of Lehman Brothers can be seen as a shock to the German banking system that was both unexpected and exogenous, which makes this setting ideal for studying banks' trading reactions. The shock reduced banks' liquidity due to the drying-up of interbank markets (see, e. g., Abbassi, Bräuning, Fecht, and Peydró (2014); Abbassi, Fecht, and Tischer (2017)) and the drawing of credit lines by special purpose vehicles. It also affected banks' solvency due to direct losses from interbank exposures and negative returns on securities holdings. Both would be expected to have raised the pressure for banks to conduct fire sales. However, unconventional monetary policy measures by the ECB – in particular, the full allotment policy and the extension of the collateral framework – may have reduced the need for banks to conduct fire sales and may have relaxed the pressure on funding and market liquidity. With increased liquidity provision by the central bank, funding from private sources is replaced by central bank funding, making liquidity shocks much less harmful.

Our analysis is based on a unique trade-level dataset for the German banking sector. The paper answers two main research questions: First, is there any evidence of fire sales of German banks after the Lehman collapse? And second, did banks' trading behavior change after the ECB implemented unconventional monetary policy measures? The employed dataset covers all trades by all German banks in all assets that are eligible for trade on a regulated market in the European Economic Area (EEA). Thus, it contains a wide range of asset classes (such as stocks, bonds, derivatives and futures), including the over-the-counter (OTC) transactions in these assets. This makes it possible to not only distinguish between different asset classes but also between banks' securities trading behavior in exchanges and OTC markets.

In order to assess the impact of unconventional monetary policy measures, we match the data with the daily list of ECB-eligible assets and divide them up into narrow basket assets, extended

basket assets, never eligible bonds, and never eligible stocks.[1] We also group banks according to the significance of fire sale constraints, as predicted by economic theory. Specifically, banks with a weak liquidity position and a low regulatory capital ratio are more likely to conduct fire sales. We then study the investment behavior of banks or bank groups in different eligibility classes around the Lehman crisis and the ECB's unconventional monetary policy measures. In addition, we analyze price reactions at the security level, depending on the securities' eligibility status and banks' trading behavior.

Our results suggest that the Lehman crisis did not trigger broad-based fire sales in the German banking system. Instead, banks increasingly invested in narrow basket assets, which points towards a flight to liquidity. In line with this interpretation, banks sold never eligible bonds in response to the introduction of full allotment whereas the extension of the collateral basket induced large purchases of newly eligible assets. Hence, the results indicate that the monetary policy measures were an important driver of banks' trading decisions. Trades reflected a portfolio rebalancing in response to the crisis and to monetary policy measures rather than distressed selling. The eligibility of securities had a strong impact on banks' trading behavior. Interestingly, with the support of central bank liquidity, German banks on the whole acted as market liquidity providers during the 2008 crisis.[2]

However, looking at the prices of selling transactions, we find evidence of tight market liquidity, especially directly after the collapse of Lehman. Interestingly, this seems to have been driven mainly by trades in OTC markets. As expected, tight market liquidity does not affect eligible assets to the same extent. Hence, through their effect on the eligibility of securities, unconventional monetary policy measures mitigated the pressure on market liquidity. These results support the view that the ECB's policy measures contributed to stabilizing the financial system after the Lehman collapse.

We also find that there is a heterogeneity across bank groups. Relatively illiquid banks invest in narrow basket assets and sell ineligible bonds, trying to improve their liquidity positions. By contrast, relatively liquid banks invest in extended basket assets and stocks, allowing them to collect higher returns. Weakly capitalized banks move into riskier bonds, which may be evidence of risk-shifting. In line with economic theory, the tightening of market liquidity after the Lehman

[1] Narrow basket assets are eligible for central bank transactions in normal times, including many sovereign bonds. Extended basket assets became eligible with the extension of the ECB's Collateral Basket on 22 October 2008. The other two groups never became eligible.

[2] See De Roure (2016) for an analysis of the purchase prices of ECB-eligible securities, which shows that banks' trading behavior induced a price premium in eligible assets.

collapse appears to have been largely driven by banks constrained by liquidity or capital. Hence, it seems that price reactions driven by constrained banks did, indeed, exist after the Lehman collapse. However, they were muted by monetary policy responses.

Despite of the importance attached to fire sale externalities in the recent crisis, empirical evidence is scarce. There are a number of papers analyzing low frequency balance sheet data, such as De Haan and Van den Ende (2013) and Boyson, Helwege, and Jindra (2014). De Haan and Van den Ende (2013) employ monthly balance sheet data for seventeen large Dutch banks and find evidence of fire sales, triggered by liquidity constraints. Boyson et al. (2014) use quarterly balance sheet data for US banks, investment banks, and hedge funds and do not find any evidence of liquidity-driven fire sales. Other papers have used data on mutual funds. For example, Coval and Stafford (2007) show that even in the pre-crisis period outflows from investment funds could create price pressure in securities held in common by distressed funds. Manconi, Massa, and Yasuda (2012) find that the trading behavior of institutional investors facing liquidity constraints may lead to a propagation of distress to other asset classes, in this case from securitized bonds to corporate bonds. Finally, Ellul, Jotikasthira, and Lundblad (2011) provide evidence of fire sales in the insurance sector in response to regulatory constraints becoming binding after a shock to the companies' capital. Even less is known about the effects of unconventional monetary policy on banks' trading behavior.[3] Our paper contributes to this literature by providing evidence on German banks' securities trading after the Lehman shock and by explicitly focusing on how monetary policy measures affect banks' trading behavior.

The paper proceeds as follows. Section 2 describes the theoretical background and the data. Section 3 presents the empirical specifications as well as the aggregate results for all banks, analyzing trading volumes first and then transaction prices. In Section 4, we allow for heterogeneous bank reactions and distinguish between different bank groups according to their liquidity and capital positions, again considering trading volumes and transaction prices. Section 5 contains the conclusion.

[3] Acharya and Steffen (2015) analyze the impact of the unconventional longer-term refinancing operations in 2011 and 2012 on bank exposures, but they do not focus on the immediate central bank measures in the aftermath of the crisis. Hildebrand, Rocholl, and Schulz (2012) analyze bank investments after the financial crisis but are not able to disentangle the effects of the Lehman default and the subsequent central bank policy measures due to the quarterly frequency of their data.

2 Theoretical Background and Data

2.1 The Fire Sale Mechanism

In theory, contagion through fire sale externalities works as follows. In response to a shock to the value of assets or a sudden withdrawal of liabilities, banks may be forced to sell assets if a liquidity or leverage constraint becomes binding. Given the forced nature of the sales, prices might deviate from fundamental values in the presence of financial frictions. Therefore, distress sales of assets may depress market prices, which may then feed back into the banking sector through common exposures. If banks holding the same assets have to recognize distressed prices on their balance sheets, they might have to sell assets as well, leading to an expansion of the crisis (see, e. g., Allen and Gale (2004); Cifuentes, Ferrucci, and Shin (2005); Brunnermeier and Pedersen (2009)).[4]

Hence, the occurrence and intensity of fire sales in response to a shock hinge on banks being constrained. The first is a liquidity constraint. If banks are unable to refinance a part of their balance sheet, they are forced to sell assets to generate the liquidity needed to repay the debt (the classical Diamond and Dybvig (1983) case, see also Allen and Gale (2000) and Allen and Gale (2004)). Margin calls could have a similar effect. The less liquidity a bank has beforehand, the stronger the reaction is expected to be. The second is a leverage constraint. If banks experience losses, e. g. due to failing counterparties after Lehman's bankruptcy, this could result in a lack of regulatory capital, inducing asset sales to "free up" regulatory capital (Cifuentes et al. (2005)). As long as the assets sold have regulatory risk weights above zero, this relaxes the pressure on capital. Sales are most likely to occur at banks that already had low regulatory capital ratios to begin with. These banks will also find it harder to absorb higher costs for refinancing liabilities (e. g., increasing haircuts) during a period of stress.[5] Given these theories about bank behavior, we expect that banks with less liquidity and less capital are more prone to sell assets following the shock from Lehman's bankruptcy.

[4] Hellwig (2009) argues that price effects were reinforced by mark-to-market accounting. However, the role of mark-to-market pricing has been questioned by Laux and Leuz (2010) who note that fire sale prices do not necessarily have to be recognized on the balance sheet. According to Gorton and Metrick (2012), fire sales can also occur in the shadow banking sector and spill over to the regulated sector.

[5] Adrian and Shin (2010, 2014) show that financial institutions may target a specific ratio of value-at-risk to equity, making leverage procyclical. This could also give rise to fire sales. However, as they show, such behavior can be found empirically for US broker dealers, in particular.

2.2 The Role of Eligibility

Trading behavior is expected to differ across different types of securities. When it comes to liquidity, the most important characteristic of an asset is its employability in repo transactions. By "repoing" an asset, a bank can obtain funds without having to sell the asset on the market. Therefore, we classify our assets according to their eligibility for ECB refinancing operations. Assets that were not eligible at any point in 2008 (mostly stocks, investment funds, certificates, options, bonds) are labeled "never eligible assets". Assets that were eligible before the ECB's collateral extension on 22 October 2008 or after 14 November 2008 are the "narrow basket assets," and those that became eligible in the meantime are the "extended basket assets."[6] The never eligible assets are rather heterogeneous. Therefore, we further split the never eligible assets into "never eligible bonds" that were never eligible in 2008 and "never eligible stocks", covering stocks, certificates, options and the like. Note that the narrow and the extended basket also consist predominantly of bonds, which makes it easy to compare them with the group of "never eligible bonds," whereas the "never eligible stocks" are very heterogeneous.

The assets most prone to being sold in response to a shock are the ineligible ones. Unlike eligible assets, they cannot be used for repo transactions with the central bank or in interbank markets. In order to improve the regulatory capital position, selling ineligible assets seems also appropriate because their average risk weight is higher.[7] The models cited in the previous subsection do not introduce a central bank acting as a lender of last resort. In a crisis, the lender of last resort should – provided there is sufficient collateral – lend freely to solvent banks to keep the financial system liquid. After the Lehman collapse in 2008, the European Central Bank (ECB) accomplished this task mainly by introducing two unconventional monetary policy measures. First, it converted the normal refinancing operations with banks to a fixed tender procedure on 8 October (announcement) and 15 October (implementation). This implied that, given sufficient collateral, banks could obtain as much liquidity as they wanted. Under this regime, the only reason for short-term liquidity problems is a lack of eligible collateral. In order to avoid a potential lack of collateral, the ECB extended the range of eligible collateral on 15 October (announcement) and 22 October (implementation) by reducing the rating threshold to BBB-. Between 22 October and 14 November the ECB added assets to this extended collateral

[6] We end the extended basket period on 14 November, as the number of eligible assets stops increasing after this date (see the lower right-hand graph of Figure 1). It seems that the ECB's collateral policy returned to normal after this point. Defining all newly eligible assets after 14 November until the end of the sample period as "extended basket assets" does not change our results.

[7] For example, stocks and derivatives are typically subject to a 100% risk weight, while government bonds, which are an important part of eligible assets, are often subject to a 0% risk weight.

basket, increasing the number of eligible assets from around 26,000 to more than 50,000 (see the lower right-hand graph of Figure 1). Consequently, the outstanding volume of eligible collateral increased from around 9 trillion in 2007 to nearly 13 trillion in 2009 (European Central Bank (2013)). The extended basket assets were of lower quality than the assets that had already been eligible before (the narrow basket assets) and were consequently subject to a higher haircut. Still, after the extension of the collateral basket, banks holding such assets could easily generate liquidity by using them in a repo transaction with the central bank without having to sell them, or any other assets, to generate liquidity.

Full allotment should generally lead to an improvement in banks' liquidity positions, which would, in turn, help to prevent liquidity-induced sales. As a result, investing in narrow basket assets became more attractive as they could be employed in repo transactions to an unlimited extent from that point onwards. It could even generate an incentive to create riskier narrow basket assets to be used in central bank transactions.[8] In this way, banks were able to increase their return on assets without affecting their liquidity positions. By contrast, extended basket assets were not yet attractive at this point in time. Yet, when these assets became eligible, they were suddenly a great deal more attractive because they then provided better liquidity services while yielding higher returns than narrow basket assets at the same time. Given the higher haircut that extended basket assets were subject to, liquidity-constrained banks may nevertheless have found narrow basket assets more attractive. In contrast, ineligible assets became relatively unattractive at this point, regardless of their relatively high returns. Therefore, one would expect that banks sell ineligible assets in order to invest the proceeds in eligible assets. Especially extended basket assets, which have a higher coupon than the narrow basket assets on average, would offer a relatively attractive return while providing better liquidity services than stocks or ineligible bonds.

2.3 Data

The analysis is based on several data sources. The main source is from the German Federal Financial Supervisory Authority (BaFin). This unique data set is based on reporting requirements laid out in §9 of the German Securities Trading Act (Wertpapierhandelsgesetz) under which all credit institutions and financial services institutions are required to report to the BaFin all transactions of all securities and derivatives that are admitted to being traded on

[8] In fact, this is what happened in the ABS market where some ABS were only created to be used as central bank collateral ("originate to repo", see European Central Bank (2013)).

an organized market in the EEA. The main objective of reporting is to prevent insider trading. Therefore, the dataset contains detailed trade information, i. e., the names of the trading bank and its counterparty, a dummy variable indicating whether the bank's book was affected by the trade, the security identification number ISIN, time and date of the trade as well as the transaction price, volume and currency and the exchange at which the trade took place.[9] In total, roughly 1.2 million securities are potentially subject to reporting requirements. In our observation period from July to November 2008, 149,900 different securities were traded by 1,527 banks, amounting to around 24 million trades. In order to test for the representativeness of our data set, we matched it with the Deutsche Bundesbank's Securities Holdings Statistics, which contain detailed quarterly information on the securities holdings of all German banks in terms of volume (i. e., in euro), excluding derivatives ((Amann, Baltzer, and Schrape, 2012)). The securities trading data set captures 64% to 97%[10] of the trading volume calculated on the basis of the Securities Holdings Statistics from 2008. Note that our dataset also contains around 80,000 securities that do not appear in the Securities Holdings Statistics, which means they were traded and affected the banks' accounts but did not appear on the banks' books at the end of the quarter.

We select our data sample in the following way. To begin with, we disregard all trades with a price of zero and those where the trading bank is also the counterparty. To control for bond issuance, we exclude all trades that take place before the issuance date of the security and all trades by banks in their own bonds with a trade volume of over 1 billion. In addition, we only look at trades that have an impact on a bank's own account. Customer trades are, therefore, not included in the analysis. We do not include any savings and cooperative banks, except for the ten largest ones of each bank group. The small savings and cooperative banks delegate trading to their central institutions. Thus, the informative value of the few trades contained in the data set is low. Banks that already received state support before the Lehman crisis were not included in the data sample either. Finally, we disregarded all banks that traded on fewer than 21 days in 2008. This procedure leaves us with 120 German banks (including foreign branches and subsidiaries), which covers 95% of all trades included in the initial data set. These 120 banks represent 64% of total assets of the entire banking system in Germany. Further information

[9] If a transaction is conducted in OTC form, but the underlying security is permitted for trading in an organized market in the EEA, it still has to be reported to BaFin. Only derivatives such as CDS and interest rate swaps, which are exclusively traded in OTC form, are not subject to reporting requirements under this reporting framework.

[10] The exact number depends on the interpretation of assets that are not held by any bank in one quarter in the Securities Holdings Statistics but by at least one bank in the following or preceding quarter. The share captured is 64% if they are counted as traded and 97% if they are counted as newly issued or matured.

on banks regarding their liquidity and solvency positions is collected from the Bundesbank's Monthly Balance Sheet Statistics.

The information on asset classes (stocks, government bonds, corporate bonds, covered bonds, CDOs, etc.) is obtained from the Centralised Securities Database (CSDB), while daily data on the eligibility of securities for the European System of Central Banks (ESCB) is obtained from the Eligible Assets Database (EADB). We restrict the sample to the period from 1 July 2008 until 30 November 2008, which includes ten weeks before and ten weeks after the bankruptcy of Lehman Brothers on 15 September 2008. While the period before Lehman's demise was relatively calm, the financial crisis reached its peak in the aftermath of the bankruptcy. Several European banks were on the brink of failure and had to be rescued, while interbank markets around the world dried up. Since banks were no longer able to refinance themselves, they were at risk of becoming illiquid (see, e. g., Abbassi et al. (2014); Gabrieli and Georg (2014); Bräuning and Fecht (2012)). For Germany, the demise of Lehman can be seen as an exogenous shock, since it was not a result of the actions of German banks (see Brunnermeier (2009); Valukas (2010)), but affected German banks' funding quite substantially (e. g., Hypo Real Estate lost its funding and finally had to be nationalized). Therefore, the Lehman default provides an ideal setting to study the reaction of banks to a large shock and to see whether such shocks give rise to fire sales.

Figure 1 shows some descriptive characteristics of the dataset and illustrates how trading behavior was affected by both the crisis and monetary policy measures. In all of the following figures, the three vertical red lines represent the following three events analyzed here: first, the default of Lehman Brothers (15 September), second, the announcement of full allotment (8 October), and, third, the introduction of the extended collateral basket (22 October). In the upper left- and right-hand panels, we see the gross (buy plus sell) trading volume per day across all banks in the four eligibility classes. The narrow basket assets have the highest daily gross trading volume across the period under review. The maximum value of 30 billion was reached on 8 October, i. e., the day that full allotment was introduced and the interest rate cut was announced. The trade volume of shares and other non-eligible assets is slightly lower, with an average daily value of around 10 billion. Note that trading in both asset classes intensified around the Lehman collapse and the policy interventions that followed. A different picture emerges for extended basket assets and never eligible bonds, which are only rarely traded in quantities larger than 2 billion. We observe an increase in trading activity in extended basket assets towards the end of our sample period, starting in the week following the announcement

to expand the collateral framework on 15 October. While never eligible bonds were traded only in small quantities prior to this expansion, values beyond 2 billion became more common after the event. These aggregate trading patterns suggest that trading behavior changed due to the events that took place in September and October 2008. A similar conclusion can be drawn from the chart in the lower left-hand panel, which shows the number of banks trading in an eligibility class on a given day. There are around 60 banks trading each day with narrow basket assets and never eligible stocks. The number increased slightly after the Lehman collapse and dropped again after the policy measures were launched in October. Never eligible bonds are traded on a permanent basis by more than 30 banks per day. For the extended basket assets, this number increased from 20 to nearly 30 after the collateral extension. It thus seems that the collateral extension led to an increase in trading activity regarding these assets. Finally, the chart on the lower right-hand side shows the daily number of ESCB eligible assets. The narrow basket

Figure 1: Descriptive graphs

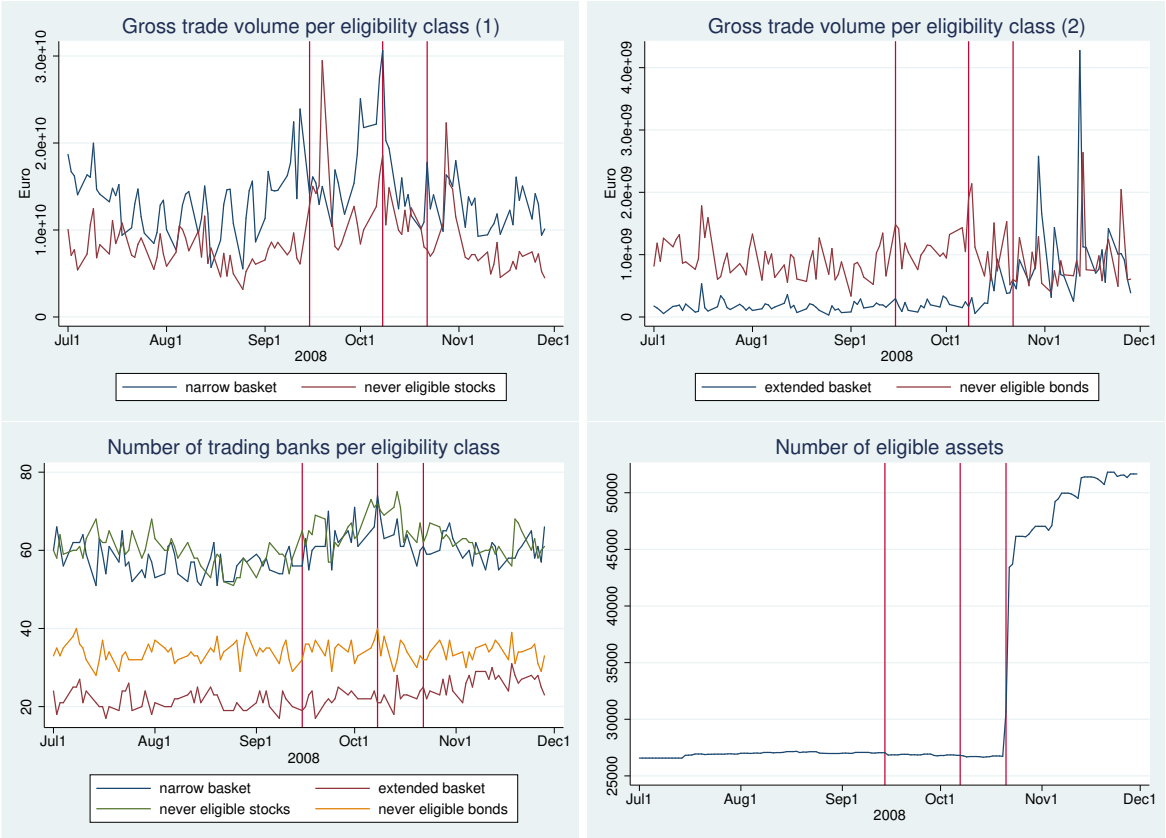


Figure 1 shows some descriptive timelines. The two upper graphs illustrate the daily gross traded volume in euro per eligibility class. The lower left-hand graph depicts the daily number of trading banks per eligibility class. The red bars indicate from left to right: the default of Lehman Brothers (15 Sep), the announcement of full allotment (8 Oct) and the introduction of the extended basket (22 Oct). The lower right-hand graph shows the daily number of eligible assets. Sources: Microdatabase Securities Holdings Statistics, 1 July 2008 - 30 November 2008, own calculations, ECB.

contained around 26,000 assets at the beginning of our sample. Then, with the introduction of the extended basket, the number doubled; this meant that, towards the end of our sample period, the ESCB accepted 52,000 assets as collateral.

3 Empirical Analysis – Aggregate Results

We now discuss the econometric model and our results, focusing on the German banking system as a whole without distinguishing between different bank groups. Any net purchases or sales of assets must, in the aggregate, be absorbed by market participants that are not included in our sample, such as hedge funds, insurance companies or non-German institutions. In Section 4, we will proceed to analyze trading behavior of different bank groups to allow for a situation where distressed banks trade within the banking sector. We will start by taking a look at trading volumes before considering transaction prices.

3.1 Empirical specification for trading volumes

In order to analyze the trading behavior of banks and their reactions to the Lehman shock as well as the two policy measures, we construct a measure of net trading volumes, capturing the daily net purchasing volume for each eligibility class at the bank level. We focus on net trading volumes in order to measure the liquidity generated or absorbed by the banks' trades. Let $n^j_{i,t}$ count all trades of bank i on day t in eligibility class j. We calculate the total volume of each trade $n^j_{i,t}$, $trade^j_{n^j_{i,t},i,t}$, as the product of the price (converted to euro using the end of day exchange rate from Bloomberg and divided by 100 in case of a bond) and the nominal value (for bonds) or the quantity (for stocks and the like), counting purchases as positive and sales as negative. We then sum these trade volumes over $n^j_{ti,}$ and divide by the initial total assets of the bank as at June 2008, TA_i, which gives us the weighted net purchasing volume of bank i in eligibility class j on day t, $net\_buy^j_{i,t}$:

$$net\_buy^j_{i,t} = \sum_{n^j_t=1}^{N^j_t} \frac{trade^j_{n^j_{i,t},i,t}}{TA_i} * 100 \tag{1}$$

The weighting by the initial total assets reduces the dominance of large banks and allows us to depict the banking system as a whole.[11] The weighted daily purchasing amount is multiplied by 100 to get a percentage value. Further, note that we attribute the value zero when a bank did

[11] We also show results for the unweighted variable in Figure A2 in the appendix.

not trade an asset class on a given day.

In the econometric analysis, we examine how banks' trading behavior changed in response to the Lehman collapse as well as to unconventional monetary policy measures. In the basic regression, the variable $net\_buy^j_{i,t}$ is regressed on three event dummies. The first is the default of Lehman Brothers on 15 September 2008, represented by the dummy $Lehman_t$, which equals one from 15 September to 7 October. The second is the announcement of the full allotment policy on 8 October 2008, represented by the dummy FA_t, which equals one from 8 October until 21 October. Note that we use the announcement of full allotment rather than the implementation one week later as it was clear that the full allotment policy would affect only narrow basket securities, which were the only eligible securities at the time. So in order to take advantage of the full allotment policy, one would need narrow basket securities. The third event is on 22 October, when the implementation of the extended collateral basket started. The corresponding dummy variable $extended_t$ equals one from 22 October until the end of the sample period. Here, we use the implementation date instead of the announcement date, the reason being that the announcement itself did not specify which securities would become eligible. Consequently, banks could not react in a targeted fashion until they saw which securities became eligible following the implementation. Moreover, note that the new securities were added to the eligibility list over several days so that the impact of the implementation could be expected to happen gradually. In an unreported robustness check, we also use the announcement date as the relevant event. This does not affect our results qualitatively. All regressions include bank fixed effects. The basic regression model then looks as follows:

$$net\_buy^j_{i,t} = \alpha_i + \beta_1 Lehman_t + \beta_2 FA_t + \beta_3 Extended_t + u^j_{i,t}, \tag{2}$$

where j = narrow basket, extended basket, never eligible stocks, never eligible bonds

We will illustrate the regression results by constructing graphs of average trading behavior. To this end, we cumulate the weighted amount over time so that $net\_buy^{cum,j}_{i,t}$ depicts the amount a bank has bought or sold in net terms in a certain eligibility class between t_0 (July 1, 2008) and time t, weighted by initial total assets:

$$net\_buy^{cum,j}_{i,t} = \sum_{t_n=t_0}^{t} net\_buy^j_{i,t_n} \tag{3}$$

For the aggregate graphs, which show the German banking system's holdings (and thus its net trade with the rest of the world), we take daily averages over all banks.

3.2 Results on trading volumes

Below, we discuss the regression results along with the graphical illustration. The main results for the aggregate German banking system are given in Table 1 and depicted in Figure 2, which shows the aggregate cumulated net purchasing volume weighted by total assets (Equation (3) averaged across all banks) for the period from 1 July until 30 November 2008.[12]

In turn, we discuss the results for the four eligibility classes. The trading behavior in narrow basket assets is depicted in the upper left-hand panel of Figure 2. On average, German banks made net purchases of narrow basket assets during the sample period. Between July and November 2008, German banks bought narrow basket assets worth 4% of their balance sheet on average, with purchases accelerating sharply after the default of Lehman Brothers. Between 15 September and 8 October, the average net balance increased by nearly 2 percentage points (relative to total assets), implying that the daily net purchasing volume in this period was far higher than before the Lehman collapse or after the full allotment announcement. In the regressions (Table 1), this is reflected in a highly significant and large coefficient of the Lehman dummy (see column 1). In contrast, the coefficients of the two other dummy variables are not significantly different from zero, meaning that net purchases returned to the pre-crisis trend. We do not observe aggregate sales of narrow basket assets during the sample period. Hence, there is no evidence of fire sales of narrow basket assets, especially not in the post-Lehman period when money markets were most tense. Given that such assets could be used in central bank transactions, it is not surprising that rather than selling assets into a distressed market, they were reserved for repo transactions with the central bank.

Instead, the opposite occurred, namely that banks *bought* narrow basket assets on a broad scale in this period. There are several potential reasons why banks would buy a greater volume of narrow basket assets. First, supply-side factors may have been at play. Since narrow basket assets are often government bonds, a higher issuance of government debt securities – for which banks are usually important buyers – might be responsible for the substantial increase in narrow basket holdings after Lehman. However, the issuance of German government debt securities increased only slightly from 51 billion to 57 billion from the second to the third quarter of 2008. (Note also that the issuance volume is planned one year in advance and finally determined one quarter before the actual issuance date.) Furthermore, an increased supply could stem from non-German financial institutions or German non-banks. In this case, the massive increase after

[12] Note that the graphs depict cumulated series so that the regressions refer to the first difference of the graphs shown.

Lehman could be interpreted as German banks acting as the provider of market liquidity for institutions not included in our sample, which are conducting fire sales. Some evidence for this interpretation can be found in Abbassi, Iyer, Peydró, and Tous (2016) who show that German banks invested mainly in assets of which the price had previously fallen. Second, demand-side factors may have played a role. As narrow basket securities provide access to central bank and interbank repo funding, they represent a valuable investment in the context of a liquidity crisis.[13] This is especially true as collateralized interbank markets became increasingly popular in the crisis period (see, e. g., Mancini, Ranaldo, and Wrampelmeyer (2016)), which have even stricter collateral requirements compared with the ECB (see also European Central Bank (2013) for the use of collateral of European banks with the ECB). [14]

In the upper right-hand panel of Figure 2, we see the average net purchases of extended basket assets. Until after the announcement of full allotment, banks tended to be net sellers of these securities on average. The numbers are small compared with narrow basket assets as extended basket assets are traded infrequently. However, we see a small selling tendency after the collapse of Lehman Brothers, which intuitively makes sense as these assets are, on average, less liquid and riskier. Most importantly, they did not provide access to central bank liquidity until the collateral extension took effect. What is more, banks started buying these assets on a large scale exactly on the date the collateral extension was announced (15 September 2008). The regression results confirm the graphical impression (see column 2 of Table 1). Net purchases are smaller in the post-Lehman period than before but the difference is not statistically significant. However, we see a positive and significant coefficient after the extension of the collateral basket, the coefficient being much smaller than that for narrow basket assets, as expected.

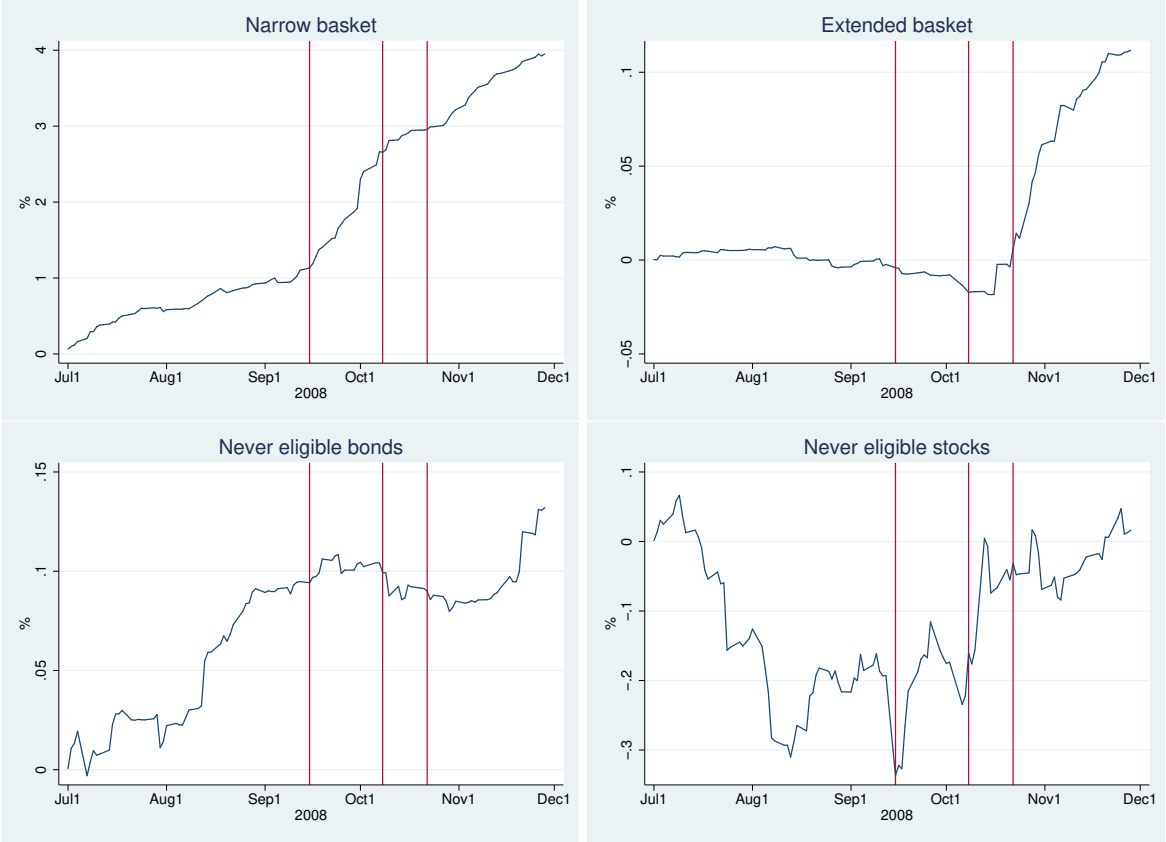
It seems that the ESCB eligibility status made extended basket assets significantly more attractive for banks. The reason is straightforward: From this point on, they could be repoed for liquidity with the ECB so that buying these assets did not impair the liquidity position of the bank. Furthermore, they had on average a higher coupon and thus were more rewarding for

[13] Assuming that the Lehman shock reduced the liquidity of many financial assets and claims, another underlying reason for the net purchase of narrow basket assets could be that banks tried to reestablish a given liquidity level on the asset side of their balance sheet by buying more liquid assets as in Froot and Stein (1998).

[14] Instead of using cash, which would not directly increase the banks' liquidity, banks could tap the following funding sources to finance the purchase of narrow basket assets: central bank liquidity via repoed credit claims or asset-backed securities (some banks engaged in so-called "originate to repo" activities, i. e., they originated ABS in the crisis with the sole purpose of using them as central bank collateral, see European Central Bank (2013)) or sales of ineligible assets. In fact, Podlich (2016) shows that distressed German banks sold roughly 60 billion worth ineligible assets in the fourth quarter of 2008, using quarterly data from the Securities Holdings Statistics. Distressed banks are defined as banks which received government support between 2007 and 2011. Not all those banks are in our sample, because we exclude banks that received government support before our sample period begins.

banks to hold than, e. g., narrow basket securities. It thus appears that banks were engaging in risk-shifting by collecting the coupon on riskier assets but offloading part of the risk at the ECB. This complements the "carry trade" finding of Acharya and Steffen (2015) who argue that banks borrowed from the ECB to generate exposure to high-yield euro-peripheral countries (which, however, would be part of the narrow basket). These results also help us interpret the findings on the narrow basket assets. Given that eligibility appears to make an asset very attractive, it seems plausible that banks were buying narrow basket assets to prop up their liquidity pool. This trading behavior also changed banks' portfolio composition. Using the Securities Holdings Statistics, which includes a quarterly snapshot of all securities held by German banks, we see that relative to their total assets as at the end of June 2008, banks in our sample increased their holdings of narrow basket assets by 2.7% between the second and third quarter of 2008,

Figure 2: Aggregate cumulated net purchasing volumes by eligibility class



The figure shows the net (purchases – sales) euro trading volume of all 120 banks, weighted by each bank's total assets as at June 2008, averaged per day and cumulated over days, for all assets grouped by their ECB eligibility. Increases reflect an expansion in asset holdings while decreases represent net sales. The graphs show the evolution of the trade balance of the German banking system with the rest of the world. The red bars indicate from left to right: the default of Lehman Brothers (15 Sep), the announcement of full allotment (8 Oct) and the introduction of the extended basket (22 Oct). Sources: Microdatabase Securities Holdings Statistics, 1 July 2008 - 30 November 2008, own calculations, ECB, Deutsche Bundesbank.

Table 1: Results without bank heterogeneity

LHS:	narrow basket	extended basket	nev. elig. bonds	nev. elig. stocks
	(1)	(2)	(3)	(4)
Lehman	0.0773***	-0.000813	-0.00117	0.0131
	(0.000)	(0.546)	(0.384)	(0.305)
Full allotment	0.00789	0.00117	-0.00304*	0.0370**
	(0.565)	(0.474)	(0.063)	(0.017)
Extended basket	0.0142	0.00521***	-0.000300	0.00385
	(0.126)	(0.000)	(0.786)	(0.713)
Bank FE	yes	yes	yes	yes
N	12420	12420	12420	12420
R-sq	0.051	0.022	0.025	0.009
adj. R-sq	0.041	0.013	0.016	-0.001

Regressions for eligibility classes at the bank level without bank heterogeneity. The variable on the left-hand side is the net purchasing volume of each bank, weighted by its total assets as at end of June 2008. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB, Deutsche Bundesbank.

and their holdings of extended basket assets by 341% between the third and fourth quarter of 2008.[15]

The lower left-hand panel of Figure 2 illustrates the aggregate holdings of never eligible bonds. As can be seen, banks invested in these bonds before the Lehman crisis but largely ceased to do so once Lehman crashed. Banks became net sellers of never eligible bonds after the FA announcement and also briefly after the extended basket implementation, before purchases rise again towards the end of our sample. In the regressions this shows up in a mildly significant negative coefficient in the full allotment period (column 3 of Table 1). The results for never eligible stocks are less clear (lower right-hand graph of Figure 2). This is not entirely surprising as this asset class consists mostly of stocks and derivatives; these are often used by banks in the context of market making and hedging activities, potentially making it hard to detect a particular trading strategy. Generally speaking, banks sold these assets before the Lehman crisis and a remarkable downward jump occurs at the time of the Lehman collapse, with banks

[15]The initial holdings of extended basket assets are very low, which makes the increase in absolute terms relatively small. Further note that the numbers are not directly comparable between the two databases since maturing assets change total holdings in the Securities Holdings Statistics, but not in our trading-based dataset.

selling 0.1% of their average balance sheet total on average. This development resembles fire sale behavior, but is reversed immediately and the same amount is repurchased between the Lehman event and the full allotment period. The reactions to both policy measures were positive. Purchases increased after full allotment was announced and the extended basket implemented. In the regressions, only the coefficient of the full allotment dummy is statistically significant and very large (column 3 of Table 1). The sharp increase in holdings immediately after the FA announcement might indicate that banks were either increasingly willing to hold riskier securities after being assured that they would have access to the central bank liquidity (a demand effect) or that they purchased a large amount of assets because they were supplied by other market participants.

These results are interesting as we see that trading reactions for bonds differ markedly depending on the bonds' eligibility status. While banks buy bonds that can be used to generate central bank liquidity, they tend to sell bonds that do not. From a liquidity perspective, this seems reasonable as the only way to generate liquidity with ineligible assets is to sell the assets. This complements the finding by Beber, Brandt, and Kavajecz (2009), who study transactions in the European bond market and find that, compared with normal times, the market liquidity of bonds becomes more important for the investment decision – relative to credit quality – during periods of distress. Note also that never eligible bonds being sold off supports the hypothesis that the increased build-up of never eligible stocks is supply-driven. As never eligible bonds can be regarded as the riskiest of our bond classes, they are most similar to stocks or derivatives regarding risk characteristics. If the increased holdings of these assets had been incited by a rise in demand by banks for risky assets, we should have been able to observe an increase in holdings of riskier bonds as well.

There are two potential factors that could bias our analysis. First, banks might sell large quantities of assets at decreasing prices. This could mask large-scale sales in our analysis as we are multiplying quantities and prices. In Figure A1 in the appendix, we therefore show results using only the quantities without multiplying the prices. With the exception of stocks, where banks, indeed, seem to have sold cheaper assets (or purchased more expensive assets), the results are comparable to Figure 2. Note, however, that the "never eligible stocks" also consist of all types of options and other derivatives, which means that price differences between securities in sales and purchases can quickly arise (for instance, a bank can sell options at low prices and hedge this by buying the underlying securities, which are usually more costly). Moreover, by weighting the net purchases with banks' total assets large-volume sales by big banks could

potentially go unnoticed. We therefore also show the results for unweighted net purchases (again, multiplying quantities and prices) in Figure A2. Here too, the results for narrow and extended basket assets are very similar to the results presented in Figure 2. For never eligible stocks, we find that the size of banks has an impact, which is intuitive given that large and small banks engage in derivative trading to different degrees. The results for never eligible bonds also differ. In unweighted terms, banks sold never eligible bonds in substantial quantities on balance, suggesting that these sales are attributable to large banks, in particular.

Table 2: Results for regressions at ISIN level

LHS:	narrow basket	extended basket	nev. elig. bonds	nev. elig. stocks
	(1)	(2)	(3)	(4)
Lehman	166001.1***	-12128.1	-3923.7	6553.5**
	(0.000)	(0.210)	(0.520)	(0.029)
Full allotment	125693.0***	12017.5	-17504.4**	5146.8**
	(0.004)	(0.691)	(0.014)	(0.013)
Extended basket	53975.7*	142046.0*	459.7	1243.3
	(0.065)	(0.067)	(0.934)	(0.162)
ISIN FE	yes	yes	yes	yes
N	848783	127203	812050	14467788
R-sq	0.023	0.010	0.014	0.023
adj. R-sq	0.014	0.001	0.005	0.014

Regressions for eligibility classes at ISIN level. The variable on the left-hand side variable is the net purchasing volume for each asset across all banks. Standard errors are clustered at the ISIN level. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB.

The regressions in Table 1 are conducted at bank level to identify the liquidity generated by banks' trading behavior at the individual bank level. It is also instructive to consider the trading behavior at the individual security level and to check whether divergent reactions can also be found with respect to an asset's eligibility status at that disaggregated level. The regressions at the ISIN level confirm the results from the preceding analysis (see Table 2). Once again, we see a shift towards narrow basket assets (starting after the Lehman collapse) and extended basket assets (after the introduction of the extended basket). Moreover, never eligible bonds are sold, in particular after the introduction of full allotment. Finally, we observe an overall shift into

never eligible stocks as before.

Summing up, we observe that banks were, on the whole, net buyers of assets during the Lehman crisis. The eligibility of assets was a key determinant of the trading decisions of banks, which tended to buy eligible assets and sell ineligible assets. This can be seen as a reaction by banks to the tense liquidity situation following the Lehman bankruptcy when interbank markets dried up and banks started hoarding liquidity (Acharya and Merrouche (2013)). However, no evidence of large-scale aggregate fire sales by banks can be found in any of the asset classes considered in the trading data. Therefore, we now turn to the analysis of transaction prices.

3.3 Empirical specification for transaction prices

Even though the analysis of trading volumes provides no evidence of fire sale behavior, there may nevertheless have been pressure on market liquidity after the Lehman collapse. In a next step, we therefore take a look at the evolution of prices. More specifically, we want to know whether banks' trading activity had an impact on security prices in the time period under review. Our focus shifts from a bank-level to a security-level analysis.

In order to capture banks' aggregate trading behavior, we compute the daily net purchasing volume across *all* banks for each ISIN k:[16]

$$net\_buy_{k,t} = \sum_{n_{k,t}=1}^{N_{k,t}} trade_{n_{k,t},k,t} \tag{4}$$

This variable represents the net volume of a particular asset traded with investors outside of the German banking system. Insofar as these can be viewed as outside investors in the spirit of Shleifer and Vishny (1992), price effects are most likely to be found in such trades. The higher the selling volume to outside investors, the greater the effect on prices should be. A similar approach can be found in Nyborg and Östberg (2014) who correlate gross trading volumes with price changes. As fire sale prices are associated with selling, we focus exclusively on selling prices. Net trading volumes can vary considerably across individual assets, and the ultimate price impact depends on an individual asset's liquidity features. Consequently, a bias towards zero can arise if assets traded with outside investors in large quantities are relatively liquid. We take logs of our explanatory variables for this reason. As *net_buy* can have positive and negative

[16] In this section, we focus only on bonds as this is the largest and most important asset class. Further, the analysis uses a relatively homogeneous pool of assets with comparable prices.

values, we use the log-modulus transformation to preserve the sign and the zeros:

$$log(net\_buy_{k,t}) = sign(net\_buy_{k,t}) * log(1 + |net\_buy_{k,t}|) \tag{5}$$

In addition, the selling price may be influenced by the size of the trade, $quantity_{n_{k,t},k,t}$. In liquid markets, the quantity of a trade may not be of great significance. In times of crisis, however, selling prices are likely to decrease with the size of the trade.

Hence, the basic regression establishes a link between selling prices and the quantity of a trade, as well as the overall net purchasing volume for all banks, as defined above:

$$sell\_price_{n_{k,t},i,k,t} = \alpha_i + \alpha_t + \alpha_{kp} + \gamma log(quantity_{n_{k,t},k,t}) + \beta log(net\_buy_{k,t}) + u_{n_{k,t},i,k,t} \tag{6}$$

We control for bank fixed effects α_i, time fixed effects α_t, and ISIN×period fixed effects for the pre-Lehman, post-Lehman, full allotment and extended basket periods. This allows us to control for any bank-specific and time-specific heterogeneity in prices. Furthermore, the ISIN×period fixed effects estimate a base price for each asset in each period. This is important as the underlying bonds are still relatively diverse so that the time fixed effects cannot fully capture the exogenous shifts in asset prices for all assets jointly. The main coefficient of interest is β, relating to the overall net purchasing volume of a given asset. If β is positive, the correlation between banks' net purchasing volume with outside investors and the prices that banks face in asset sales is positive. This would mean that a higher selling volume to outside investors (i. e., a negative net purchasing volume) is associated with lower selling prices, which suggests price pressure or fire sale price behavior.

A favorable aspect of our dataset is that we can distinguish OTC transactions from trades at exchanges. To obtain a better understanding of the often mentioned yet rarely studied OTC markets, we carry out separate calculations of net trading volumes for OTC transactions and exchange transactions and compare the results of the two types of trades. Given that exchanges and OTC markets are fundamentally different regarding market participation, price setting mechanisms and regulation, effects may vary.

3.4 Results on transaction prices

Table 3 contains the results for the regressions of all trades (OTC and exchange). Column 1 of the table shows that there is, indeed, an immediate price impact stemming from the trade's volume: Selling prices tend to be lower, the higher the volume a bank attempts to trade. This

suggests a lack of market liquidity in bond markets. More importantly, prices also appear to be lower when the banking sector as a whole records a high volume of net sales to outside investors. In the regressions in column 2, we allow for different price impacts in different subperiods. The results show that the effect of aggregate net sales is driven by the post-Lehman period, whereas net purchase volumes are not related to prices in the other periods. Hence, although the volume regressions did not find any evidence of fire sale behavior, there seems to have been tight market liquidity in the post-Lehman period, reflected in strong reactions by prices to trading volumes. This result is plausible since market conditions can be expected to be worst immediately after the Lehman collapse as there was only a small number of traders willing to provide market liquidity at that time.

Finally, in column 3, we explore how the price impact differs between eligible and ineligible assets. To that aim, we use the time-varying variable $eligible_{j,t}$, which equals one whenever an individual asset is eligible, and interact it with the net purchasing volume to outside investors. The coefficient of the interaction term is negative and significant. Adding the coefficients on net_buy and $net\_buy \cdot eligible$ shows that the price impact for eligible assets is close to zero in the pre-Lehman period. So, for this period, we find a price impact only for ineligible assets, indicating that outside investors were willing to buy eligible assets without a discount. This is plausible given that eligible assets are often government bonds, which are generally seen as the most liquid bonds. Moreover, banks are not forced to sell such assets into a falling market. Instead of selling such assets, they could be used as collateral in central bank transactions, which would help avoid negative price effects while also providing liquidity. In the period surrounding the collapse of Lehman Brothers, the overall effect is also significant for eligible assets, but the overall effect is more muted than for ineligible assets.

Table 4 shows separate regressions for OTC trades and trades at exchanges. Columns 1 to 3 show that the results for OTC trades are very similar to the previous ones. Most importantly, the coefficient of $log(net\_buy_{j,t})$ is positive and highly significant, which is again largely driven by the post-Lehman period and is stronger for ineligible assets. However, there is also a significant effect for the extended basket period in columns 2 and 3. This could stem from upward price pressure due to the high volume of purchases of extended basket assets by banks in this period. In columns 4 to 6, we see the same regressions as in columns 1 to 3 for exchange trades only. Interestingly, we do not find any significant positive correlation of selling activity with prices. The coefficient of the net trade volume is even significantly negative in the post-Lehman period, which indicates that banks acted as market liquidity providers on exchanges following the Lehman collapse. It

is possible that they were buying assets which had previously diminished in value, inducing a negative correlation between trade volume and prices. The results suggest that market liquidity for banks mainly deteriorated in OTC markets, especially after the Lehman collapse, and mostly for ineligible assets. In the meantime, banks were market liquidity providers on exchange markets after the Lehman event and made use of favorable trading opportunities by buying securities at comparatively low prices.

Table 3: Results for price regressions at the transaction level without bank heterogeneity

LHS:	sell price	sell price	sell price
	(1)	(2)	(3)
log(quantity)	-0.0267***	-0.0267***	-0.0267***
	(0.000)	(0.000)	(0.000)
log(net buy)	0.00240***	0.000799	0.00415**
	(0.000)	(0.126)	(0.037)
log(net buy)*Lehman		0.00509**	0.00541**
		(0.013)	(0.010)
log(net buy)*Full allotment		0.000119	0.000591
		(0.937)	(0.701)
log(net buy)*Extended basket		0.00245	0.00286*
		(0.128)	(0.094)
eligible			0.0522
			(0.673)
log(net buy)*eligible			-0.00435*
			(0.072)
Daily FE	yes	yes	yes
Bank FE	yes	yes	yes
ISIN*Period FE	yes	yes	yes
N	574918	574918	574918
R-sq	0.968	0.968	0.968
adj. R-sq	0.966	0.966	0.966

Here, we estimate regression Equation (6) using the prices of all bond sales as left-hand-side variable. The following four periods are covered: pre-Lehman, Lehman, full allotment and extended basket. Standard errors are clustered at the ISIN level. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB.

Table 4: Results for price regressions at the transaction level without bank heterogeneity

LHS:	sell price	sell price	sell price	sell price	sell price	sell price
Market:	OTC	OTC	OTC	Exchange	Exchange	Exchange
	(1)	(2)	(3)	(4)	(5)	(6)
log(quantity)	-0.0344***	-0.0345***	-0.0345***	0.0198	0.0199	0.0205
	(0.000)	(0.000)	(0.000)	(0.225)	(0.222)	(0.210)
log(net buy)	0.00284***	0.000684	0.00496***	-0.000941	0.00174	0.00157
	(0.000)	(0.220)	(0.004)	(0.648)	(0.463)	(0.862)
log(net buy)*Lehman		0.00809***	0.00838***		-0.00971**	-0.00990**
		(0.000)	(0.000)		(0.022)	(0.020)
log(net buy)*Full allotm.		-0.000483	-0.0000239		0.00230	0.00212
		(0.773)	(0.989)		(0.623)	(0.652)
log(net buy)*Ext. basket		0.00260**	0.00296**		-0.00335	-0.00370
		(0.032)	(0.015)		(0.716)	(0.688)
eligible			-0.0335			0.797
			(0.726)			(0.185)
log(net buy)*eligible			-0.00541***			0.000421
			(0.007)			(0.966)
Daily FE	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
ISIN*Period FE	yes	yes	yes	yes	yes	yes
N	434732	434732	434732	140186	140186	140186
R-sq	0.967	0.967	0.967	0.975	0.975	0.975
adj. R-sq	0.965	0.965	0.965	0.974	0.974	0.974

Here, we estimate regression Equation (6) using the prices of all over-the-counter (OTC) bond sales in columns 1-3 and of all exchange-based bond sales in columns 4-6 as left-hand-side variable. The following four periods are covered: pre-Lehman, Lehman, full allotment and extended basket. Standard errors are clustered at the ISIN level. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB.

4 Empirical Analysis – Heterogeneity across Bank Groups

So far, we have studied the aggregate balances of the German banking system to see how, in the aggregate, German banks reacted to the Lehman crisis and the monetary policy responses that followed. However, this approach does not take into account the potential heterogeneity within the German banking sector. For example, it could be the case that banks facing a liquidity shortfall after Lehman's demise had to engage in a fire sale to generate liquidity while banks with ample liquidity purchased these assets, rendering the aggregate effect zero. The same could be true for banks with high or low regulatory capital ratios: While some might want to sell assets with a comparatively high regulatory risk weight to relax the regulatory capital constraint, banks with more regulatory capital might have had more risk-bearing capacities and purchased the assets that the stressed banks sold.

In order to capture such effects, we divide the banks into groups according to their liquidity buffers and regulatory capital ratios, and study the evolution of asset holdings for the respective groups. More specifically, we use bank balance sheets as at the end of June 2008, before our investigation period began, in order to avoid endogeneity problems. As before, we start by analyzing trading volumes before considering the effects on prices.

4.1 Empirical specification for trading volumes

Equation (2) looks at the German banking system's trading balance with respect to the rest of the world, and thus the extent to which the German banking system as a whole provided or absorbed market liquidity. However, as we argued above, the events are likely to have a stronger impact on banks with fewer liquid assets and weaker capital positions. In addition, it may be the case that, for example, banks with a higher level of liquidity provide liquidity to less liquid banks, which would not be reflected in the aggregate, as the sales and purchases offset each other.[17] Consequently, important differences in the reactions of specific bank groups may be missed by Equation (2). Therefore, in line with the important differences between banks cited above, we compare bank groups based on two balance sheet characteristics, which are computed using the Deutsche Bundesbank's Monthly Balance Sheet Statistics. First, we use the ratio of liquid assets to short-term liabilities, which indicates a bank's liquidity position, given the liabilities it has to repay in the weeks ahead. If the ratio is above one, a bank has enough liquidity to

[17] Given that weighting was carried out based on an individual bank's total assets, the numbers might not add up to zero if the selling banks and the purchasing banks differ in size. Using unweighted holdings yields similar results, compare Figures A1 and A2 in the appendix.

repay short-term debt and is thus relatively independent of the money market. A ratio below one indicates that a bank either has to rely on the money market to roll over maturing debt or take on new debt to repay maturing contracts. If a bank is unable to do so, it has to sell off illiquid assets to service its obligations, which can potentially result in a fire sale. In other words, the ratio is an indicator of the resilience of a bank to a stressed money market and unfavorable refinancing conditions.

Furthermore, we use a measure regarding the capital position of a bank, namely the ratio of tier-1 capital to risk weighted assets, which measures regulatory capital adequacy. The lower the capital ratio, the worse the capital position of a bank. Consequently, these banks are more vulnerable to price shocks as falling prices might translate into lower valuations of assets on the balance sheet and may further reduce a bank's capital. Banks closer to the minimum regulatory capital ratio should then be more eager to sell assets. To build up regulatory capital, banks ought to sell assets with a higher risk weight. In order to obtain a clean measure of a bank's position that is not distorted by the events studied here, we use the balance sheets as at 30 June 2008. To facilitate interpretation, we split the banks at the median of each ratio to form two bank groups for each characteristic. The banks with less liquid assets or a lower capital ratio should have been hit harder by the Lehman default and should be the ones benefitting more from the unconventional monetary policy measures.

Against this backdrop, the regressions that take bank heterogeneity into account look as follows:

$$\begin{aligned} net\_buy^{j}_{i,t} =& \alpha_i + \beta_1 Lehman_t + \beta_2 FA_t + \beta_3 Extended_t + \gamma_1 Lehman_t * risk\ group_i + \\ & \gamma_2 FA_t * risk\ group_i + \gamma_3 Extended_t * risk\ group_i + u^{j}_{i,t}, \\ & \text{for } j = \text{narrow basket, extended basket, never eligible stocks, never eligible bonds} \end{aligned} \tag{7}$$

We interact the events with a dummy variable indicating riskier banks in terms of their liquidity or capital to check whether we can detect fire sales for certain bank groups. Here, $risk\ group_i$ stands for the dummies that indicate the riskier banks according to one of the two characteristics. With respect to liquid assets to short-term liabilities, the dummy variable equals one for the banks with a liquid assets to short-term liabilities ratio below the median; for the tier-1 capital ratio it equals one for the banks with a tier-1 capital ratio below the median.

4.2 Results on trading volumes

We start by looking at banks with different levels of liquidity relative to their short-term obligations as at the onset of the Lehman crisis. We split banks at the median of the distribution of liquid assets to short-term liabilities at the end of June 2008. Banks above the median have more liquid assets compared with their possible short-term payment obligations; we therefore name them "liquid banks." By extension, banks below the median are the "less liquid banks." Results for the liquidity groups can be seen in Figure 3 and Table 5. In the upper left-hand graph of Figure 3 we see the holdings of narrow basket assets of the two bank groups. As illustrated, both groups started to invest more in narrow basket assets after the default of Lehman Brothers, with the increase being a great deal more pronounced for the less liquid banks (denoted by the red graph). A general trend towards assets eligible to obtain central bank liquidity could be observed, although this demand was more strongly driven by less liquid banks. This seems reasonable as banks with less liquidity should increase their holdings of assets giving access to central bank liquidity, especially when (unsecured) interbank funding becomes scarce. Again, the graphical results can be confirmed by the regression analysis in Table 5. We see that both bank groups, and less liquid banks in particular, shift into narrow basket assets after the Lehman collapse (column 1).

When looking at the results for extended basket assets in the upper right-hand graph of Figure 3, it is evident that we can attribute the sales of assets found in the aggregate to the less liquid banks, which suggests that those banks tried to dispose of assets that could not be used to generate central bank liquidity. However, the difference is not statistically significant (see column 2 of Table 5). Both types of banks shift into extended basket assets after the collateral extension, but the effect is much stronger for liquid banks, which is reflected in a highly significant, negative and large coefficient of the respective interaction term. This could be explained by the fact that extended basket assets provide lower liquidity services than narrow basket assets due to their higher haircut, while yielding a higher return at the same time. Since haircuts are less of a concern for liquid banks, it seems plausible that banks with a stronger liquidity buffer were more prone to move into newly eligible and more profitable assets.

The lower left-hand graph shows the results for never eligible bonds. It becomes apparent here that less liquid banks did not want to hold ineligible assets once full allotment had been introduced. At this point, they rapidly disposed of these bonds, while liquid banks gradually moved into never eligible bonds. These results are also reflected in the highly significant and

Figure 3: Aggregate cumulated net purchasing volumes by bank liquidity groups

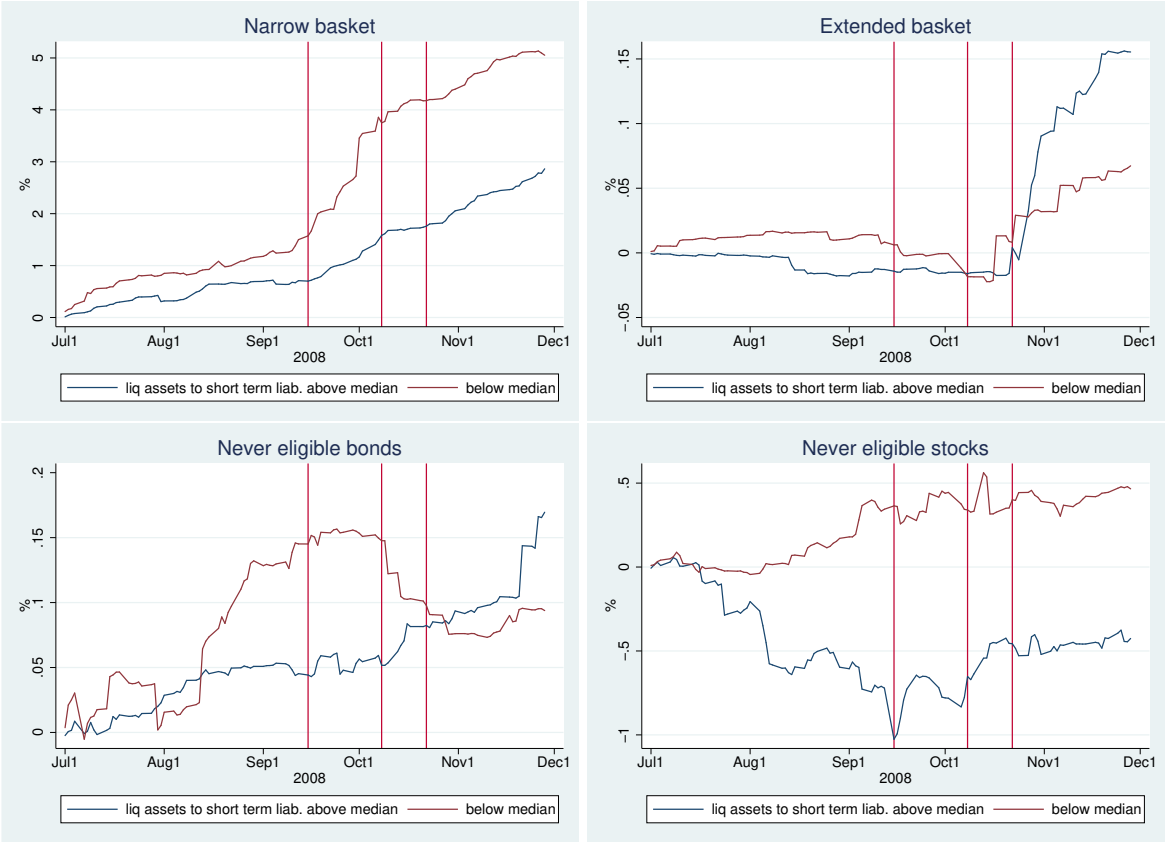


Figure 3 divides banks in two groups according to the median of their liquid assets to short-term liabilities as at June 2008. The graphs show for both groups the net (purchases – sales) euro trading volume of the group's banks, weighted by each bank's total assets as at June 2008, cumulated over days and averaged per day within each group, for all assets grouped by their ECB eligibility. For further information refer to Figure 2. Sources: Microdatabase Securities Holdings Statistics, 1 July 2008 - 30 November 2008, own calculations, ECB, Deutsche Bundesbank.

negative coefficients of the interactions terms for the full-allotment and extended-basket periods (see column 3 of Table 5). Yet even this sharp decrease in the net purchasing volume can hardly be described as fire sales because the same bank group was shifting into other assets at the same time. Hence, not even at the disaggregated level is there any evidence of fire sales.

Another interesting observation concerns the never eligible stocks in the lower right-hand panel. As was shown in Section 3, banks turned into net buyers of stocks and derivatives after the Lehman incident, which remained the case after the introduction of policy measures. Here we see that the liquid banks in particular changed their behavior after the demise of Lehman, shifting towards higher holdings of never eligible stocks. This development is reflected in significantly positive and large coefficients for liquid banks in the regressions for the post-Lehman and full-allotment periods, whereas the effect for less liquid banks (being the sum of the base effect and the coefficient of the interaction term) is close to zero (column 4 of Table 5).

Table 5: Results with bank heterogeneity: liquid assets to short-term liabilities

Risk group:	liquid assets to short-term liabilities			
LHS:	narrow basket	extended basket	nev. elig. bonds	nev. elig. stocks
	(1)	(2)	(3)	(4)
Lehman	0.0358**	-0.0000382	0.0000367	0.0324*
	(0.025)	(0.984)	(0.985)	(0.072)
Full allotment	0.0117	0.000138	0.00138	0.0789***
	(0.543)	(0.952)	(0.548)	(0.000)
Extended basket	0.0255*	0.00754***	0.00231	0.00989
	(0.050)	(0.000)	(0.138)	(0.502)
Risk group*Lehman	0.0837***	-0.00156	-0.00244	-0.0388
	(0.000)	(0.562)	(0.365)	(0.129)
Risk group*Full allotment	-0.00774	0.00208	-0.00892***	-0.0844***
	(0.777)	(0.524)	(0.006)	(0.006)
Risk group*Extended basket	-0.0229	-0.00470**	-0.00526**	-0.0122
	(0.217)	(0.033)	(0.017)	(0.560)
Bank FE	yes	yes	yes	yes
N	12420	12420	12420	12420
R-sq	0.052	0.023	0.026	0.009
adj. R-sq	0.043	0.013	0.016	-0.000

Regressions for eligibility classes at the bank level with bank heterogeneity. The variable on the left-hand side is the net purchasing volume of each bank, weighted by its total assets as at end of June 2008. "Risk group" represents banks with a below-median liquid assets to short-term liabilities ratio as at end of June 2008. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB, Deutsche Bundesbank.

Since the increase started directly after the Lehman event, it seems unlikely that banks were unconditionally seeking exposure to never eligible assets. The more plausible reason is that this increase is attributable to a higher supply of these assets, which was taken up by the banks with the highest liquidity.

Next, we study the effects of different levels of bank capital, measured in terms of the regulatory tier-1 capital ratio (see Table 6 and Figure 4). In general, highly capitalized banks behave similarly to the aggregate: We observe a flight to liquidity, especially to narrow basket assets, and a shift towards stocks. By contrast, less capitalized banks shift less into narrow basket assets and more into riskier extended basket assets. This could be indicative of risk-shifting or "search for yield" behavior as extended basket assets are riskier on balance but also offer a higher coupon. This, too, is consistent with Acharya and Steffen (2015), who show that poorly

Figure 4: Aggregate cumulated net purchasing volumes by bank capital groups

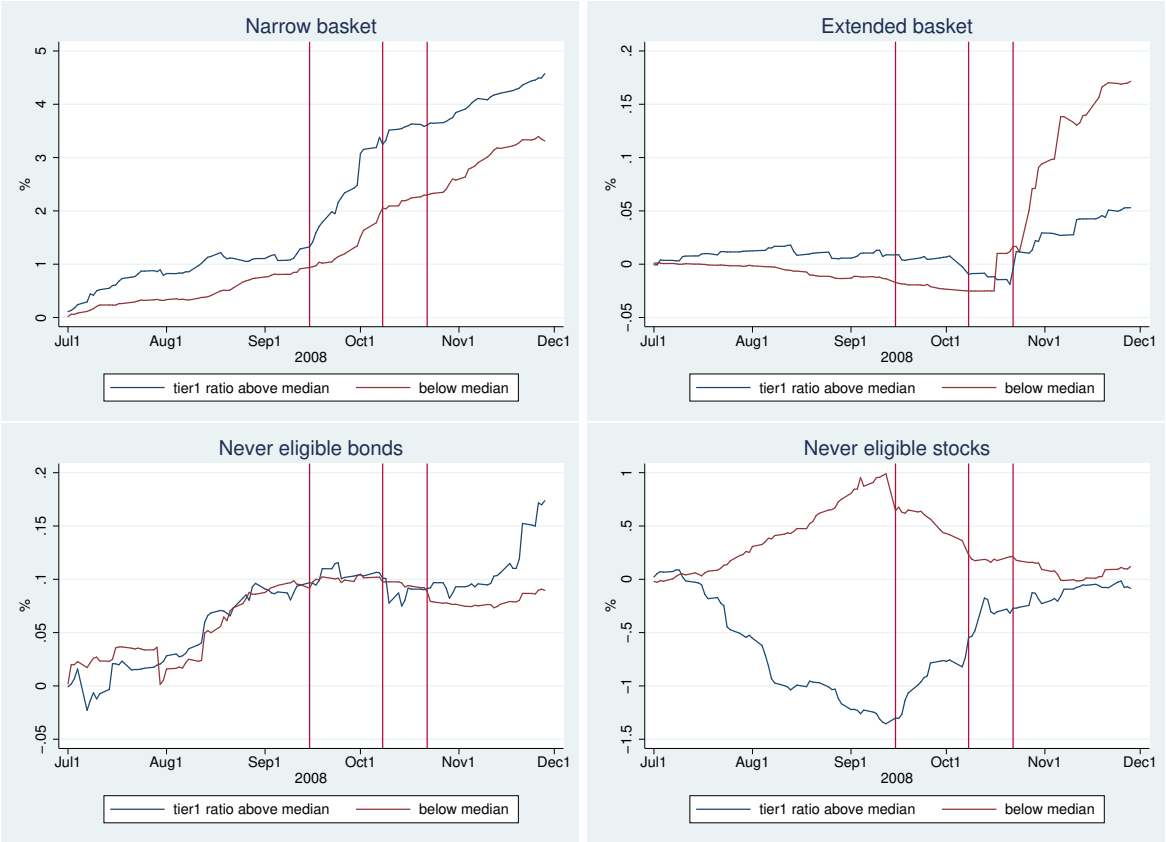


Figure 4 divides banks in two groups according to the median of their tier-1 capital ratio ($\frac{\text{tier-1}}{\text{RWA}}$) as at June 2008. The graphs show for both groups the net (purchases – sales) euro trading volume of the group's banks, weighted by each bank's total assets as at June 2008, cumulated over days and averaged per day within each group, for all assets grouped by their ECB eligibility. For further information refer to Figure 2. Sources: Microdatabase Securities Holdings Statistics, 1 July 2008 - 30 November 2008, own calculations, ECB, Deutsche Bundesbank.

capitalized banks exhibited a higher exposure to high-yield peripheral country bonds. Lastly, we see that less capitalized banks move out of never eligible stocks, whereas better capitalized banks record high net purchases. This suggests that banks with a higher risk-bearing capacity bought these assets in response to an increased supply, partly due to less capitalized banks, which disposed of these assets as they had become too risky or too capital-intensive.

Again, the regression results are consistent with the graphical analysis (Table 6). Both types of banks shift into narrow basket assets, the effect being much stronger for well-capitalized banks. Both bank groups also shift into extended basket assets after the extension of the collateral basket, the effect being much stronger for less capitalized banks. For well-capitalized banks, we observed high net purchases of never eligible stocks, while less capitalized banks shift away from those assets.

Table 6: Results with bank heterogeneity: tier-1 ratio

Risk group:	tier-1 ratio			
LHS:	narrow basket	extended basket	nev. elig. bonds	nev. elig. stocks
	(1)	(2)	(3)	(4)
Lehman	0.107***	-0.00110	-0.00102	0.0866***
	(0.000)	(0.562)	(0.591)	(0.000)
Full allotment	-0.00328	-0.00149	-0.00334	0.0996***
	(0.865)	(0.516)	(0.147)	(0.000)
Extended basket	0.00948	0.00310**	0.00123	0.0334**
	(0.467)	(0.046)	(0.429)	(0.023)
Risk group*Lehman	-0.0603***	0.000580	-0.000309	-0.148***
	(0.008)	(0.830)	(0.909)	(0.000)
Risk group*Full allotment	0.0225	0.00536	0.000599	-0.126***
	(0.411)	(0.100)	(0.854)	(0.000)
Risk group*Extended basket	0.00948	0.00426*	-0.00309	-0.0596***
	(0.609)	(0.053)	(0.162)	(0.004)
Bank FE	yes	yes	yes	yes
N	12420	12420	12420	12420
R-sq	0.051	0.023	0.025	0.012
adj. R-sq	0.042	0.013	0.016	0.003

Regressions for eligibility classes at the bank level with bank heterogeneity. The variable on the left-hand side is the net purchasing volume of each bank, weighted by its total assets as at end of June 2008. "Risk group" represents the banks with a below-median tier-1 ratio as at end of June 2008. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB, Deutsche Bundesbank.

4.3 Empirical specification for transaction prices

In this final section, we again consider the effect of banks' trading behavior on transaction prices. We are particularly interested in testing whether the aggregate results on prices from the previous section are, indeed, driven by constrained banks having to accept less favorable prices. Previous research on fire sales has focused on distressed entities and has found that the selling prices of distressed firms are lower and their price impact larger than for firms that are in good condition (Pulvino (1998), Coval and Stafford (2007), Ellul et al. (2011), Chu (2016)). Consequently, we would expect that the price impact of trades by liquidity- or capital-constrained banks is higher than that of other banks. To study this, we calculate the net purchasing volume per asset of constrained banks only and use this as a further explanatory variable. The coefficient of this variable then shows the additional effect of sales by constrained banks. The estimation

equation looks as follows:

$$sell\_price_{n_{k,t},i,k,t} = \alpha_i + \alpha_t + \alpha_{kp} + \gamma * log(quantity_{n_{k,t},k,t}) + \beta_1 * log(net\_buy_{k,t}) \quad (8)$$
$$+\beta_2 * log(net\_buy_{k,t}^{risk\ group}) + u_{n_{k,t},k,t}$$

4.4 Results on transaction prices

Column 1 of Table 7 shows the regression where we split the price impact between the four subperiods and distinguish between banks that are constrained and those that are not constrained in terms of their liquidity. While there is still a significant price impact of trading by all banks, the net trading volume of liquidity-constrained banks has a significant additional impact on selling prices in the post-Lehman period. This indicates that liquidity-constrained banks were, indeed, forced to accept lower prices. As we showed in Section 4, liquidity-constrained banks continued to act as net buyers of eligible assets; this development is therefore probably attributable to sales of ineligible assets. In column 2, we see that the price impact of constrained banks for ineligible assets is, in fact, higher although the difference is not significant here. Results are similar for capital-constrained banks (see columns 3 and 4).

We now distinguish again between OTC and exchange transactions. The results can be seen in Table A1 for liquidity-constrained banks and in Table A2 for capital-constrained bank (see the appendix for these tables). For OTC transactions, the results for liquidity-constrained banks mirror the previous results (see columns 1 and 2 of Table A1). In addition, the interaction with the eligibility status becomes significant in these regressions. By contrast, columns 3 and 4 show no significant additional impact of the trading of liquidity-constrained banks for exchange transactions, except for the marginally significant coefficient for the full allotment period. So while there is clear evidence that the sales carried out by liquidity-constrained banks in OTC markets contributed to OTC price declines, this does not seem to have been the case for trading prices on exchanges.

In Table A2 we see the results for capital-constrained banks. The results for OTC markets are now even stronger than in the regressions considering liquidity-constrained banks. There is a significant relation between the selling volume of capital-constrained banks and selling prices, especially in the post-Lehman period. And again, when we look at the results for exchange trades, there is no such relation, which suggests that only OTC markets were vulnerable to distressed selling by constrained banks.

Table 7: Results for price regressions at the transaction level with bank heterogeneity

Risk group:	liquid assets	liquid assets	tier-1 ratio	tier-1 ratio
LHS:	sell price	sell price	sell price	sell price
	(1)	(2)	(3)	(4)
log(quantity)	-0.0270***	-0.0269***	-0.0268***	-0.0266***
	(0.000)	(0.000)	(0.000)	(0.000)
log(net buy)	0.000862*	0.00226	0.000953**	-0.000455
	(0.083)	(0.206)	(0.039)	(0.851)
log(net buy)*Lehman	0.00455**	0.00460**	0.00389**	0.00362*
	(0.031)	(0.035)	(0.034)	(0.051)
log(net buy)*Full allotment	-0.000139	0.0000201	-0.000479	-0.000557
	(0.929)	(0.990)	(0.762)	(0.734)
log(net buy)*Extended basket	0.00111	0.00122	-0.000314	-0.000387
	(0.485)	(0.463)	(0.855)	(0.833)
eligible		0.0844		0.0323
		(0.530)		(0.795)
log(net buy)*eligible		-0.00175		0.00149
		(0.418)		(0.610)
log(net buy risk group)	-0.000900	0.0500	-0.000340	0.0135
	(0.666)	(0.107)	(0.684)	(0.155)
log(net buy risk group)*Lehman	0.00838*	0.0142**	0.00397	0.00517*
	(0.078)	(0.039)	(0.141)	(0.064)
log(net buy risk group)*Full allotment	0.00488	0.0131	0.00170	0.00323
	(0.303)	(0.100)	(0.473)	(0.243)
log(net buy risk group)*Extended basket	0.0219	0.0251	0.00829	0.00953
	(0.401)	(0.355)	(0.141)	(0.126)
log(net buy risk group)*eligible		-0.0621		-0.0167
		(0.116)		(0.141)
Daily FE	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes
ISIN*Period FE	yes	yes	yes	yes
N	574918	574918	574918	574918
R-sq	0.968	0.968	0.968	0.968
adj. R-sq	0.966	0.967	0.966	0.966

Here, we estimate regression Equation (8), using the transaction level prices of all bond sales as left-hand-side variable. The risk group banks are below the median of the liquid assets to total liabilities ratio as at end of June 2008 in columns 1-2 and of the tier-1 capital ratio as at end of June 2008 in columns 3-4. The ISIN*Period fixed effects refer to the following four periods: pre-Lehman, Lehman, full allotment and extended basket. Standard errors are clustered at the ISIN level. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB, Deutsche Bundesbank.

Summing up, we see that banks' selling prices depend on the amount of sales to outside investors, with selling prices being lower if the selling volume is higher. This relationship became more pronounced after the Lehman collapse and applied to liquidity- or capital-constrained banks, in particular. However, these relationships hold only for OTC markets, while banks' trading volume has no impact on prices in the context of exchange markets, suggesting that OTC markets are particularly vulnerable to adverse market conditions and to selling pressure from constrained banks.

5 Conclusion

Using a detailed, trade-level dataset on the trading behavior of German banks around the time of the Lehman collapse, we have shown that this disrupting event did not result in widespread fire sales in the German banking sector, either in the aggregate or within certain bank groups. Instead, we observe a general flight to liquidity as all bank groups shift into the most liquid asset class, i. e., narrow basket assets, which can easily be transformed into liquidity at the central bank. Moreover, trading behavior was influenced strongly by unconventional monetary policy measures. In particular, the introduction of the extended basket led to a shift towards newly eligible assets. Hence, the observed trades seem to have occurred largely as a result of portfolio rebalancing in response to monetary policy measures rather than distress. Transactions prices show some evidence of tight market liquidity after the Lehman collapse. However, price pressures subsided once full allotment was introduced. Overall, German banks acted both as market liquidity providers and central bank liquidity seekers during the 2008 crisis.

Distinguishing between different bank groups we find that illiquid banks invested in narrow basket assets and sold ineligible bonds at the same time, presumably to improve their liquidity position. In contrast, liquid banks invested in extended basket assets and stocks, which may have been driven by profitability considerations. Interestingly, liquid banks appear to have played an important role in absorbing the increased supply of never eligible stocks, which may have helped to stabilize prices. Finally, we find that less capitalized banks invest more heavily in riskier bonds, which could be an indication of risk-shifting or search for yield. The observed price effects of trading after the Lehman collapse were driven mostly by banks constrained by their liquidity or capital and by trades in the OTC market, which appears to be most vulnerable to adverse market conditions.

The deep concern about fire sale externalities could not be confirmed for the German banking

sector during this particular period. The absence of broad-based fire sales in our sample does not imply that fire sales did not take place in other financial markets, by non-banks or with assets not captured by our dataset. However, given the scope of our dataset it is unlikely that such fire sales strongly affected the German financial system. There is, however, some evidence of tight market liquidity in the post-Lehman period, which was mitigated by the European Central Bank's unconventional monetary policy. This suggests that these policy measures contributed to stabilizing the financial system after the Lehman collapse.

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A Appendix

Graphs

Figure A.1: Aggregate cumulated net purchasing quantities

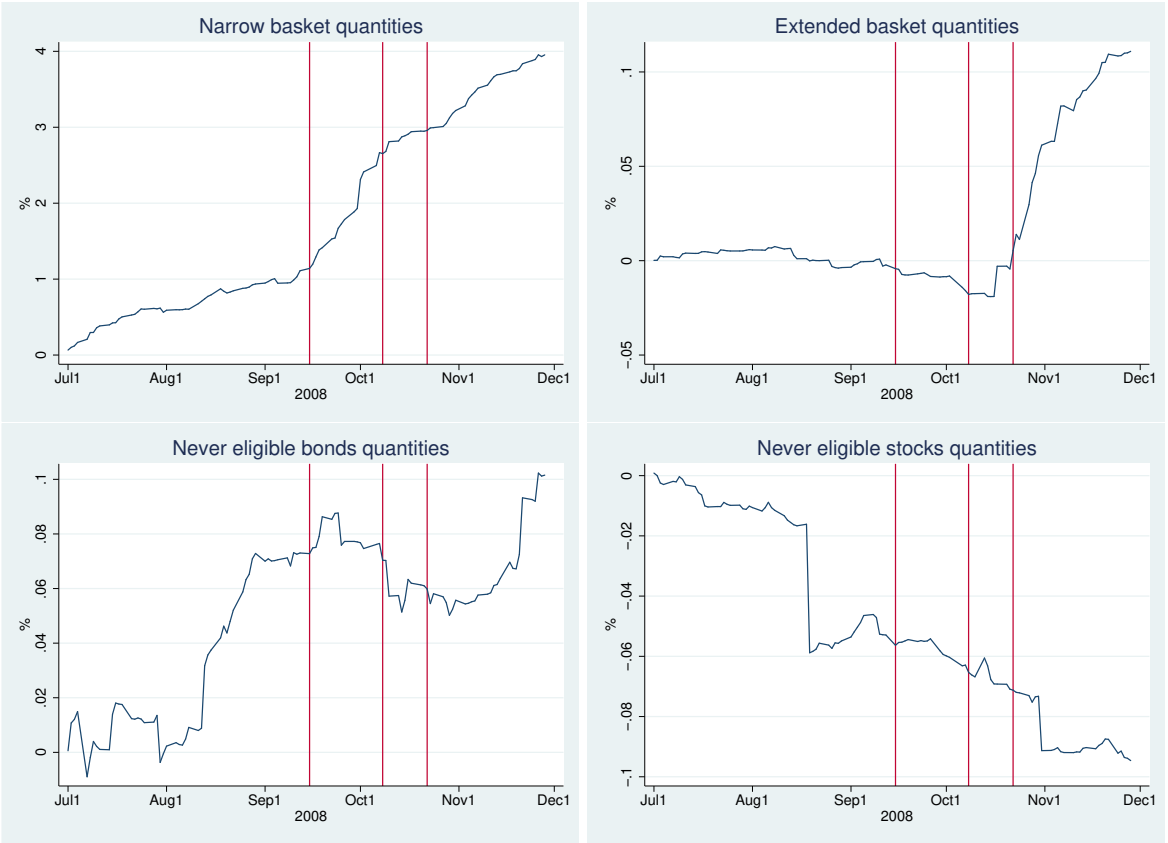

Figure A.1 shows the net (purchases – sales) trading volume (using only euro quantities without prices) of all 120 banks, weighted by each bank's total assets as at June 2008, averaged per day and cumulated over days, for all assets grouped by their ECB eligibility. Increases reflect an expansion in asset holdings while decreases represent net sales. Note that the series for never eligible stocks differs from the price-weighted series in Figure 2 as it only adds up the number of assets involved in each trade while prices are very heterogeneous. For further information refer to Figure 2. Sources: Microdatabase Securities Holdings Statistics, 1 July 2008 - 30 November 2008, own calculations, ECB, Deutsche Bundesbank.

Figure A.2: Unweighted aggregate cumulated net purchasing volumes

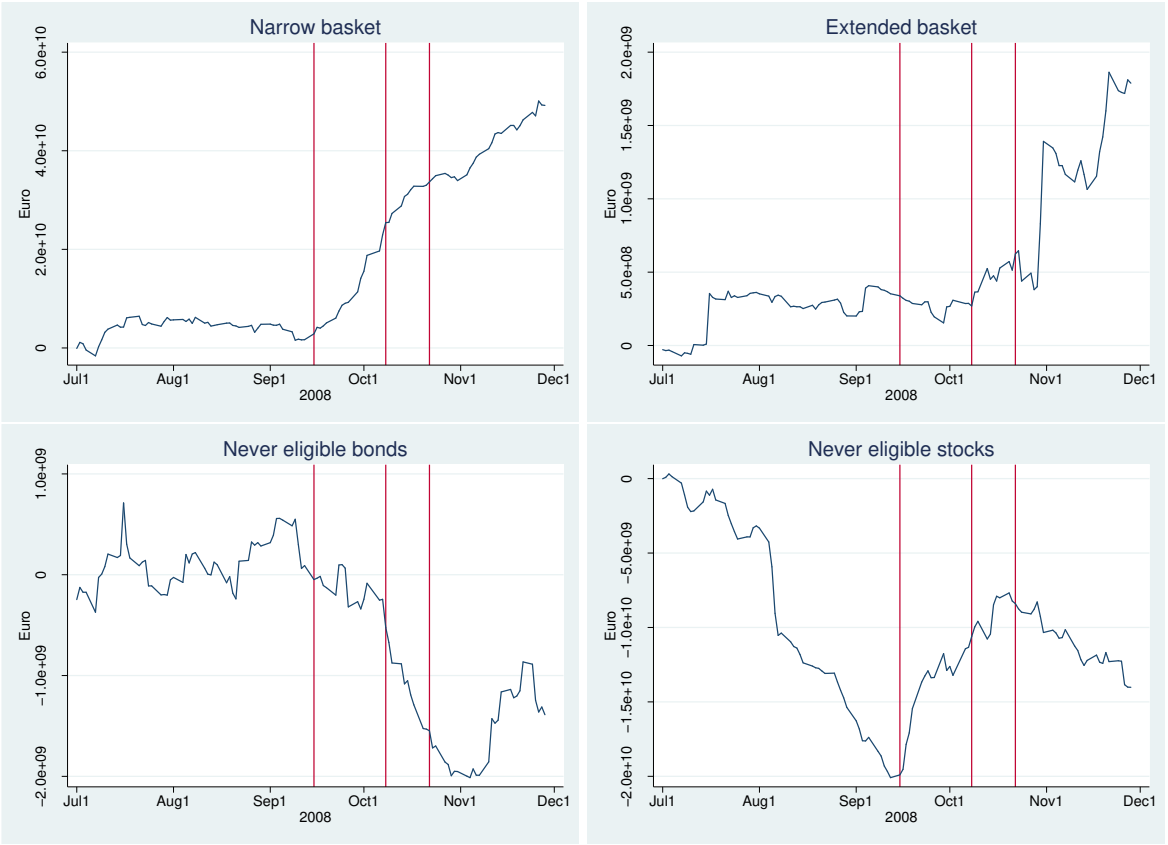

Figure A.2 shows the net (purchases – sales) euro trading volume of all 120 banks, aggregated per day and cumulated over days, for all assets grouped by their ECB eligibility. Increases reflect an expansion in asset holdings while decreases represent net sales. For further information refer to Figure 2. Sources: Microdatabase Securities Holdings Statistics, 1 July 2008 - 30 November 2008, own calculations, ECB.

Tables

Table A.1: Results for price regressions at the transaction level with bank heterogeneity: liquid assets to short-term liabilities

Risk group:	liquid assets to short term liabilities			
LHS:	sell price	sell price	sell price	sell price
Market:	OTC	OTC	Exchange	Exchange
	(1)	(2)	(3)	(4)
log(quantity)	-0.0345***	-0.0345***	0.0200	0.0206
	(0.000)	(0.000)	(0.218)	(0.204)
log(net buy)	0.000720	0.00432***	0.00180	0.00177
	(0.173)	(0.009)	(0.445)	(0.845)
log(net buy)*Lehman	0.00746***	0.00767***	-0.00978**	-0.0100**
	(0.001)	(0.001)	(0.022)	(0.020)
log(net buy)*Full allotment	-0.000823	-0.000408	0.00158	0.00141
	(0.632)	(0.811)	(0.739)	(0.768)
log(net buy)*Extended basket	0.00264**	0.00293**	-0.00361	-0.00395
	(0.026)	(0.013)	(0.697)	(0.670)
eligible		-0.0196		0.797
		(0.841)		(0.185)
log(net buy)*eligible		-0.00458**		0.000305
		(0.017)		(0.975)
log(net buy risk group)	-0.000643	0.0214	-0.00320	-0.00119
	(0.788)	(0.143)	(0.349)	(0.828)
log(net buy risk group)*Lehman	0.00986**	0.0111**	0.00359	0.00537
	(0.039)	(0.024)	(0.741)	(0.620)
log(net buy risk group)*Full allotment	0.00635	0.00829	0.0191*	0.0208
	(0.249)	(0.138)	(0.093)	(0.137)
log(net buy risk group)*Extended basket	-0.000454	0.000482	0.00879	0.0106
	(0.954)	(0.953)	(0.419)	(0.325)
log(net buy risk group)*eligible		-0.0246		-0.00453
		(0.130)		(0.707)
Daily FE	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes
ISIN*Period FE	yes	yes	yes	yes
N	434732	434732	140186	140186
R-sq	0.967	0.967	0.975	0.975
adj. R-sq	0.965	0.965	0.974	0.974

In this table, we estimate the regression Equation (8) using the transaction level prices of all OTC bond sales in columns 1-2 and of all exchange based bond sales in columns 3-4 as left-hand-side variable. The risk group banks are below the median of the liquid assets to short-term liabilities ratio as at end of June 2008. The following four periods are covered: pre-Lehman, Lehman, full allotment and extended basket. Standard errors are clustered at the ISIN level. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB, Deutsche Bundesbank.

Table A.2: Results for price regressions at the transaction level with bank heterogeneity: tier-1 ratio

Risk group:	tier-1 ratio			
LHS:	sell price	sell price	sell price	sell price
Market:	OTC	OTC	Exchange	Exchange
	(1)	(2)	(3)	(4)
log(quantity)	-0.0343***	-0.0343***	0.0195	0.0199
	(0.000)	(0.000)	(0.215)	(0.197)
log(net buy)	0.000562	0.00338**	0.00403	-0.00936
	(0.312)	(0.037)	(0.198)	(0.515)
log(net buy)*Lehman	0.00467**	0.00489**	-0.00826	-0.0117**
	(0.015)	(0.011)	(0.128)	(0.044)
log(net buy)*Full allotment	-0.00104	-0.000678	-0.000640	-0.00369
	(0.553)	(0.701)	(0.920)	(0.592)
log(net buy)*Extended basket	0.00315**	0.00343**	-0.0250	-0.0265
	(0.020)	(0.013)	(0.128)	(0.101)
eligible		-0.0420		0.790
		(0.671)		(0.217)
log(net buy)*eligible		-0.00370**		0.0192
		(0.050)		(0.276)
log(net buy risk group)	0.000440	0.00541	-0.00364	0.0211
	(0.651)	(0.102)	(0.244)	(0.218)
log(net buy risk group)*Lehman	0.0137***	0.0138***	-0.00252	0.00302
	(0.000)	(0.000)	(0.680)	(0.670)
log(net buy risk group)*Full allotment	0.00209	0.00242	0.00500	0.00938
	(0.451)	(0.385)	(0.502)	(0.255)
log(net buy risk group)*Extended basket	-0.00189	-0.00155	0.0489*	0.0484*
	(0.373)	(0.468)	(0.098)	(0.063)
log(net buy risk group)*eligible		-0.00569		-0.0336
		(0.123)		(0.141)
Daily FE	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes
ISIN*Period FE	yes	yes	yes	yes
N	434732	434732	140186	140186
R-sq	0.967	0.967	0.975	0.975
adj. R-sq	0.965	0.965	0.974	0.974

In this table, we estimate the regression Equation (8) using the transaction level prices of all OTC bond sales in columns 1-2 and of all exchange based bond sales in columns 3-4 as left-hand-side variable. The risk group banks are below the median of the tier-1 capital ratio as at end of June 2008. The following four periods are covered: pre-Lehman, Lehman, full allotment, extended basket. Standard errors are clustered at the ISIN level. p-values in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Sources: own calculations, Bafin, ECB, Deutsche Bundesbank.