

A shock to the system?

Market
illiquidity and
concentrated
holdings in
European
bond markets

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Central bank and prudential supervisor of financial institutions

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Communications

P.O. Box 98

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Market illiquidity and concentrated holdings in European bond markets

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¹ We thank Melle Bijlsma, Alina Borovitskaya, Peter van Els, Eva Janssens, Christina Strobach, Cees Ullersma, Robert Vermeulen, Pieter van Zwol (DNB) and Monika Züllig Erb (AFM) for valuable comments. With thanks to Jack Bekooij, Raymond Chaudron and René de Sousa van Stralen (DNB) for assistance with data and graphs, and to Philip Sommer (Bloomberg) for valuable data input.

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Summary

- 8 Do market illiquidity and concentrated holdings of bonds aggravate price volatility during periods of stress? We seek to answer this question with a new and unique ECB dataset and price information on European corporate, sovereign and bank bonds during the 2013 Taper Tantrum and 2015 Bund Tantrum. Results suggest that market illiquidity, as measured by bid-ask spreads and a new Bloomberg measure, is a strong and statistically significant driver of price volatility in European bonds during both periods. Concentration of holdings by one sector has a significant upward effect on volatility only during the recent Bund Tantrum. During both periods, we can show that households, money market funds and other financial intermediaries engaged in procyclical selling of bonds, while banks and pension funds have been contrarian investors. We sketch how liquidity shocks and concentration can impact financial stability in the euro area, through several amplification channels and the investment behavior of different sectors. The results have implications for systemic risk analysis and the design of macroprudential policy for the non-bank financial sector.

1 Introduction

In recent years, market illiquidity has become an increasing concern for systemic risk analysis. An illiquid market is one in which it is difficult to execute large transactions.² It is related closely with market volatility, which refers to large shocks in market prices. Recently, both public sector regulators and market participants have warned that bond markets have become less liquid and more volatile since the global financial crisis.³ There has been concern of a 'bifurcation' of market liquidity, with larger government bond markets experiencing an increase in trading, while smaller government and corporate bond markets have become less liquid (CGFS, 2015; Fender and Lewrick, 2015). Yet even in the deepest and most liquid market in the world – US Treasury bonds – market illiquidity may be a driver of shocks. In the 15 October 2014 'Flash Crash,' Treasury yields fell seven standard deviations from their intraday norm – an event that should, statistically, only happen every 1.6 billion years. While US officials⁴ did not find one single cause for this rare event, they cited the changes in intermediation and provision of liquidity as one of the possible drivers.

Meanwhile, the retreat of banks as market makers and the growth of the asset management industry have engendered large shifts in the investor base of global bond markets. The IMF has warned that for high-yield and emerging market bonds, concentrated holdings by a few institutions could trigger large shocks during periods of stress (IMF, 2015). Concentration risks can be even larger when many institutions trade in a manner similar to one another (herding), or if they tend to sell assets especially during market

2 Market illiquidity and its opposite, market liquidity, refer to trading conditions in financial markets. It is distinct from monetary liquidity, which refers to the money supply in the economy as determined by the central bank.

3 See for example IMF, 2014; BIS, 2014; Bank of England, 2015; ECB, 2015a; ESRB, 2015 for public sector perspectives, and BlackRock, 2014a/b; Goldman Sachs, 2015; Morgan Stanley/Oliver Wyman, 2015 for views of the private sector.

4 U.S. Treasury, FRB, NY Fed, SEC and CFTC (2015).

shocks (procyclicality). The IMF's warnings raise the question whether the holdings of bonds are also becoming more concentrated in other markets – such as the European bond markets – and if this could lead to more dramatic swings in market prices and yields. Yet with the exception of mutual funds, which report security holdings through their prospectuses, data on holdings in the bond markets is relatively scarce, making it difficult to monitor levels of concentration and gauge the impact on systemic risk, particularly in the euro area.⁵ While there is broad agreement on the potential drivers of market illiquidity and concentration (such as banking regulation and unconventional monetary policy), there is much less consensus on the impact of these two trends on systemic risk, the potential market failures involved and appropriate policy response.

This study poses the research question: do market illiquidity and concentrated holdings of bonds aggravate price shocks during periods of stress? Focusing on selected euro area government, bank and corporate bond markets, we examine price shocks in the past three years to distill lessons on systemic risk and the potential policy response. For our analysis, we make use of a new and unique dataset – the ECB's Securities Holdings Statistics Sectoral (SHS-S) – to evaluate the impact of concentrated bond holdings on market shocks (ECB, 2015b). The SHS-S database, which entered production in 2014 and is strictly confidential within the Eurosystem, gives detailed information on the holdings by country and sector in each individual security, on a quarterly basis. Together with price and liquidity data from Bloomberg, including the new liquidity assessment (LQA) data, and bond characteristics from the ECB Centralized Securities Data base (CSDB), Dealogic and Thomson Reuters, we are able to monitor net transactions, and test the

5 One recent exception is research on the shifts in bond holdings which stipulates that euro area banks showed a strong demand for domestic sovereign bonds in the wake of the crisis (see De Marco and Macchiavelli, 2014; Asonuma et al., 2015).

impact of market illiquidity and concentration on price shocks during two recent market shocks: the 2013 'Taper Tantrum', in which global bond markets reacted to concerns about US monetary policy, and the 2015 'Bund Tantrum,' in which yields on German government bonds ('Bunds') suddenly increased.

In an initial narrative analysis, we find that especially households, money market funds and other financial intermediaries behaved procyclically during the 2013 Taper Tantrum and 2015 Bund Tantrum, selling large shares of their euro area bond portfolios and potentially aggravating price shocks. Regression results suggest that market illiquidity, as measured by bid-ask spreads, is a strong and statistically significant driver of price volatility in European bonds during both periods. Concentration of holdings by investors sectors was only a significant driver in the Bund Tantrum, while illiquidity is a stronger driver in the Taper Tantrum. Together, these episodes show how structural shifts in European bond markets could interact to increase systemic risk, and offer a warning of the potential transmission channels for market shocks to spread to the financial system and impact the real economy.

The study is organized as follows. Section 2 sketches four recent periods of stress in bond markets, including insights into net transactions by euro area investors. Section 3 provides a brief overview of relevant literature on market liquidity and concentration, emphasizing that there has been a gap in research on combining both to analyze shocks in bond markets. Section 4 describes our data sources, empirical approach and key trends in holdings during the selected stress periods. Section 5 presents our regression results. Section 6 sketches transmission channels of market shocks to systemic stability and the real economy. Section 7 concludes with a critical discussion on the need for policy responses.

2 Context: four stress periods

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Since 2013, European bond markets have been characterized by falling yields and long periods of relative tranquility punctuated by sudden periods of stress. Particularly these stress periods have exposed potential vulnerabilities in the financial system, without triggering broader economic fallout. Such 'near misses' are an ideal testing ground for systemic risk analysis. Before embarking on our empirical analysis and previous related literature, this section offers a narrative description of market developments and of euro area investor behavior in the following four stress periods:

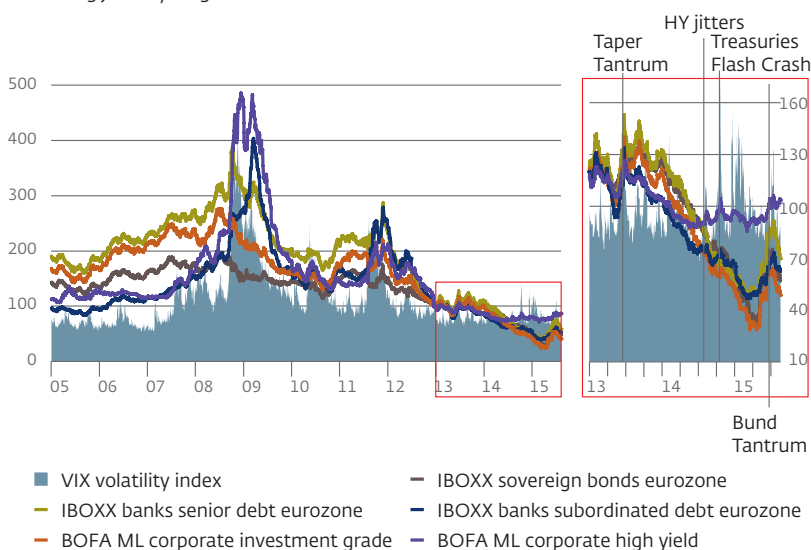
- i. Taper Tantrum (May 2013)
- ii. High-Yield Jitters (July 2014)
- iii. US Treasuries Flash Rally (October 2014)
- iv. Bund Tantrum (April 2015)

Each of these periods has been characterized by sudden (upward or downward) shifts in yields and surging volatility. In the first three cases, the shocks had their origin in US markets, but quickly spread to Europe. Figure 1 shows the average yields of five bond indices of European government, bank, and corporate bond markets, as well as the Chicago Board of Options Volatility Index (VIX), an often used measure of volatility. In general, the period 2013-2015 has been marked by low yields, yet these four stress periods stand out. In each of them, sudden changes in yields were accompanied by a spike in the VIX.

Especially the Taper Tantrum and Bund Tantrum have had fairly persistent effects on yields, which stayed higher for several subsequent months. These two relatively persistent and market-wide stress periods are particularly relevant for our analysis. By contrast, the High-Yield Jitters only affected the European high-yield market, and the effects of the Treasuries Flash Rally had largely dissipated by the end of the week in question.

Figure 1 Yields of selected bond indices

Indexed: 3 January 2013 = 100



Source Thomas Reuters

2.1 Taper Tantrum

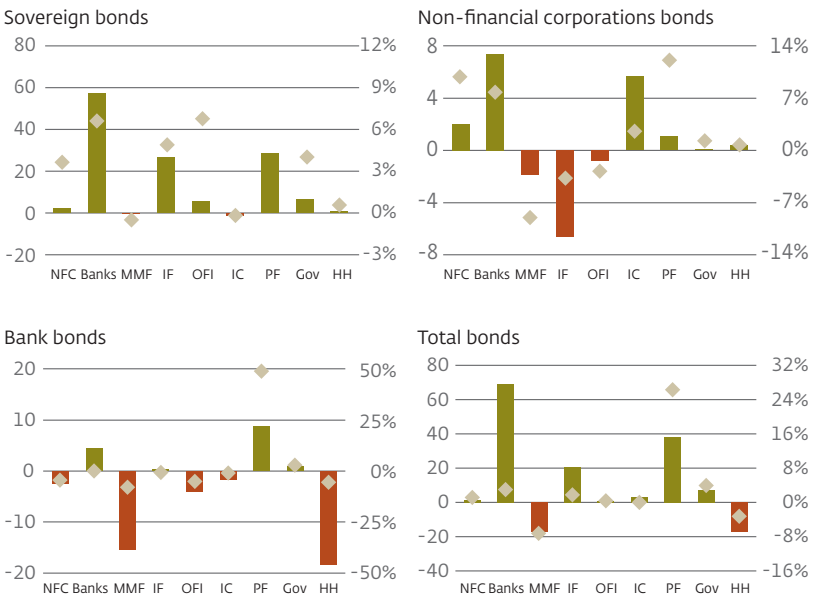
During the heights of the global financial crisis, the Fed initiated several unconventional monetary policy programs, including large-scale asset purchases, better known as quantitative easing (QE). The Fed announced the final QE program in September 2012 and pledged to buy USD 85 billion of Treasury bonds and mortgage-backed securities (MBS) each month. The so-called 'Taper Tantrum' began on 22 May 2013 after the testimony of Fed Chairman Ben Bernanke to the US Congress. In that speech, Bernanke stated that the improving economic outlook may allow the Fed to taper off monthly purchases in its ongoing QE program later that year. While the statement was only an indication of a potential future policy change,

the market response was large and swift. As yields on US Treasuries and risky assets around the world rose, so too did European government, banks and corporate bond yields. Hence, the announcement of the coming end to QE marked a period of rapid price adjustments known as the Taper Tantrum (Neely, 2014). The market reaction intensified following the 19 June 2013 meeting and press conference of the Federal Open Markets Committee (FOMC), which specified that the pace of purchases could be altered later in the year. Although it is difficult to assess the impact of QE on macroeconomic outcomes, the impact of the announcement was evident on intraday bond yields, exchange rates and prices of a broad range of other financial assets and persisted into the following months (Eichengreen and Gupta, 2014). For the Taper Tantrum and Bund Tantrum, the SHS data provides a unique insight into the investment behavior of European sectors (e.g. banks, insurers, pension funds, investment funds, etc.) by showing whether they were net sellers or buyers of the affected securities (Figure 2).

Overall, especially households and money market funds (MMFs) behaved procyclically during Q2 2013. On a net basis, these two sectors sold respectively €17.3 billion and €17.4 billion in euro area bonds, or 3.3% and 7.3% of their initial portfolios. Most of these transactions were in bank bonds. Meanwhile, investment funds sold €6.6 billion in euro area corporate bonds (3.6% of initial portfolios), while MMFs sold off a whole 9% of their initial corporate bond portfolios. Investment funds (IFs) and other financial intermediaries (OFIs) shifted portfolios from bank and corporate bonds to sovereign bonds. Banks and pension funds were net purchasers of government, corporate and bank bonds in the same quarter. Such countercyclical or 'contrarian' investment behavior is in line market making activities by banks, and rebalancing strategies by

Figure 2 Bonds holders per sector

Nominal (billion EUR - columns) and percentage (rhs - dot) change between 2013q1 and 2013q2



Source: ECB SHS-S

NFC = non-financial corporations, MMF = money market funds,
 IF = investment funds, OFI = other financial intermediaries,
 IC = insurance companies, PF = pension funds, Gov = governments,
 HH = households.

pension funds.⁶ This may have had a stabilizing effect on yields, as this created demand for such bonds at the moment that other sectors were selling. Non-financial corporates (NFCs), investment funds and insurers do not appear to have made large-scale net purchases during the stress period.

2.2 High-Yield Jitters

In July 2014, policy warnings triggered a new round of stress. After substantial spread compression in the previous year, the Fed and other observers began to worry about the potential for overheating in the high-yield (HY) corporate bond markets. Following the release of the Federal Open Market Committee (FOMC) minutes on 8 July 2014, in which the FOMC warned of excess valuations in the HY market, HY bonds sold off sharply and HY bond funds experienced sudden outflows, particularly by retail investors. The price impact of this episode in Europe was largely limited to the HY bond market. Yet the episode is notable given the interaction between liquidity concerns and the growing importance of investment funds, including exchange-traded funds and funds catering to retail clients. These funds had gained a larger market share up to 2014, making the HY market both more concentrated and more vulnerable to sudden redemptions by retail investors.

2.3 US Treasury Flash Rally

The 15 October 2014 US Treasury Flash Rally, meanwhile, represents an episode in which falling yields buffeted the markets.⁷ Treasury yields fell by

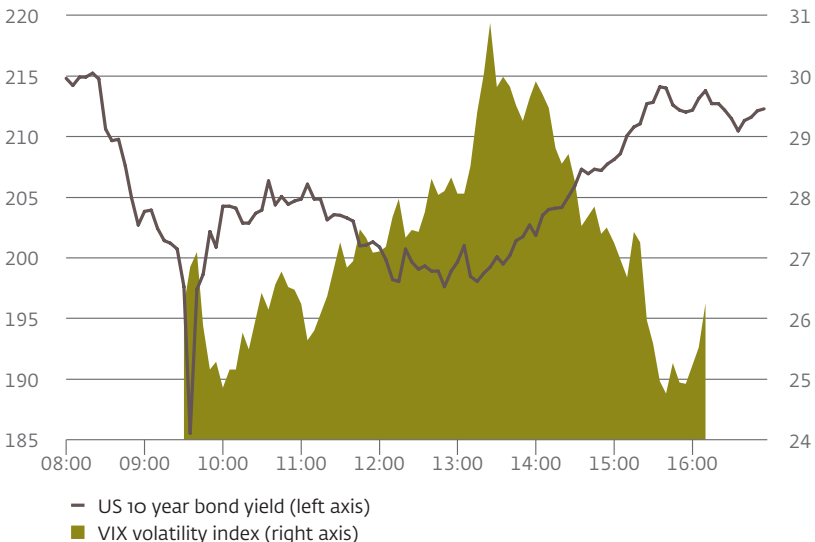
6 There is a large body of work analyzing whether insurers and pension funds play a contrarian role in practice. Bikker et al. (2010) and De Haan and Kakes (2011) find evidence that Dutch pension funds were contrarian investors before the global financial crisis. Looking at more recent data, Duijm and Steins Bisschop (2016) find evidence of procyclical investment by insurers, but do not find evidence for procyclical or countercyclical investment behavior by pension funds.

7 The episode is not to be confused with the 6 May 2010 Flash crash, which involved a sudden price shock in U.S. equity markets. For an analysis of the 2010 Flash crash and the role of high-frequency trading (HFT), see Kirilenko et al. (2014).

over 33 bp in intraday trading – including nearly 20 bp between 9:33 and 9:45 a.m. – before almost widening back to the opening yield by the end of the day (figure 3). While policy makers and market participants do not fully agree on the causes of the incident, it is generally recognized that one-sided market positioning (i.e. investor expectations of Fed rate hikes), unexpectedly weak economic data, procyclical reactions, including due to stop losses in electronic trading, and structural changes in intermediation and provision of liquidity worked together to cause yields to fall. In the EU, yields generally spiked upwards, perhaps due to uncertainty and selling pressures to compensate for institutions' liquidity shortages. Especially European HY bonds saw a large yield spike during the day.

Figure 3 Yields of US Treasuries on 15 October 2014

10-year bond yields, in bp, Eastern Standard Time (EST)



Source: Thomas Reuter Eikon

2.4 Bund Tantrum

The euro area experienced a more 'home-grown' episode of market stress in April 2015. After the announcement of the ECB expanded asset purchase program in January 2015, bond yields had fallen to unprecedented lows; short-term sovereign bonds of Germany and other core euro area countries even traded at negative yields. In mid-April, amid rumors that the ECB was running out of bonds to buy, yields suddenly surged, with German government bonds (Bunds) widening by over 70 bp within a week. The yield surge on 2 and 3 June was particularly notable, with yields jumping by 15 bp in an hour on 3 June (figure 4). Again, while the exact causes are still subject

Figure 4 Yields of German Bunds on 2 and 3 June 2015

10-year bond yields, in bp, Greenwich Mean Time (GMT)

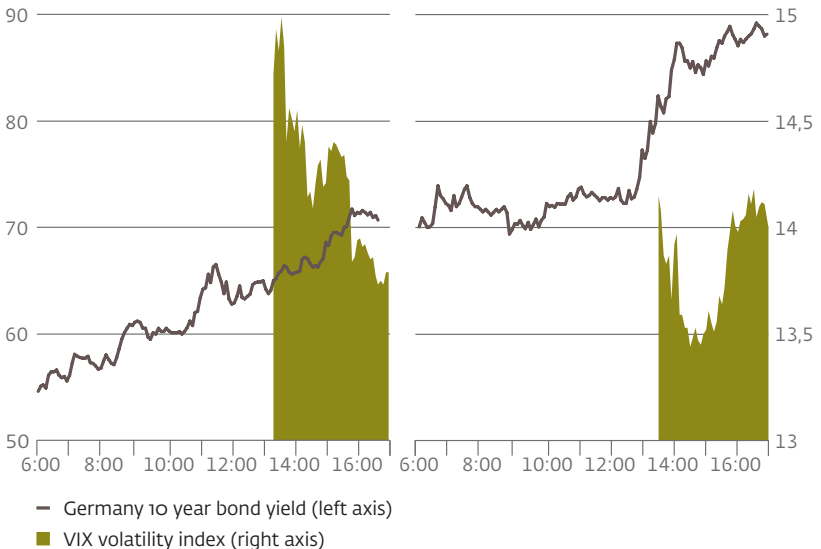
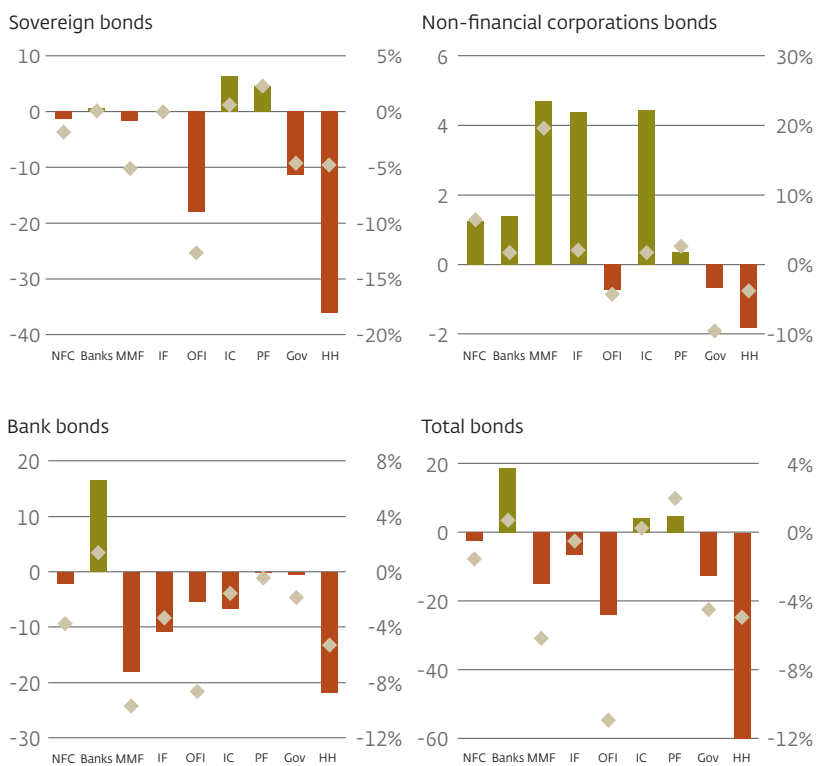


Figure 5 Bonds holders per sector

Nominal (billion EUR - columns) and percentage (rhs - dot) change between 2015q1 and 2015q2



Source: ECB SHS-S

NFC = non-financial corporations, MMF = money market funds,
 IF = investment funds, OFI = other financial intermediaries,
 IC = insurance companies, PF = pension funds, Gov = governments,
 HH = households.

to debate, it is widely believed that the reduced role of bank market making and procyclical behavior may have played an important role.

Again, the SHS data can offer insight into the net transactions of different euro area sectors during the Bund Tantrum, and into which sectors may act procyclically. These net transactions are also affected by the ECB Public Sector Purchase Programme (PSPP), under which the ECB purchases euro area bonds as of March 2015 onwards. Figure 5 shows the results. Similar to the 2013 Taper Tantrum, it appears that households, MMFs and OFIs were the largest net sellers of euro area bonds in the Bund Tantrum, offloading €59.9 billion, €14.9 billion and €24.0 billion or 4.9%, 6.2% and 10.9% of portfolios – a large amount for only one quarter. These large shifts in portfolio allocation potentially amplified the price impact of the initial shock. Once again, banks and pension funds seem to have played a countercyclical role in the market, with net purchases of €18.5 and €4.8 billion (0.7% and 2.0% of portfolios), thus partly offsetting the large net sales by households, MMFs and OFIs. Once again, NFCs, investment funds and insurers did not have large net transactions during the period, though it is possible that this masks larger weekly or months sales and purchases.

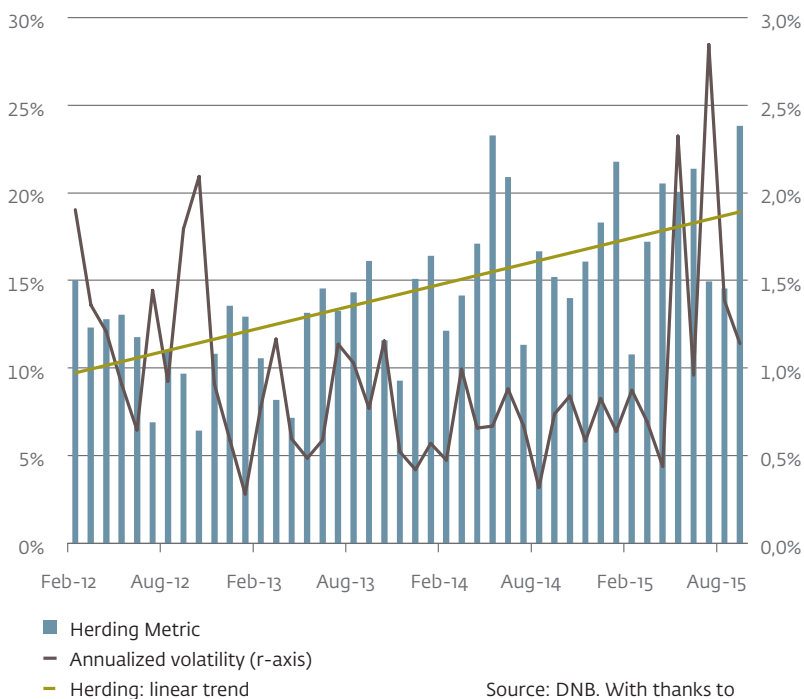
2.5 Has herding been on the rise?

Throughout the period under examination, there have been signs that large groups of investors take the same positions as one another during periods of stress – i.e. ‘following the herd.’ For publicly traded investment funds, such herding behavior can be estimated based on returns. In a first step, the returns of funds are regressed against the returns of underlying asset classes on a daily basis to determine the asset allocation of individual funds. In a second step, changes in asset allocation by each fund are compared with changes in the whole sample. The resulting Herding Metric shows the proportion of investors that are net sellers (or net buyers) in a particular

asset class on a given day (for further details, see IMF, 2015). By this measure, herding among investment funds in German government debt has increased since 2012, and peaked in Q2 2015 during the Bund Tantrum (figure 6). On several days during the stress episode, more than 25% of the funds which invest in the market for German government bonds were net sellers. This is substantial, given that average daily trading volumes are roughly 40% of outstanding bonds.

Figure 6 Herding by investment funds in German government debt

In percentage, January 2012 – September 2015



Source: DNB. With thanks to Alina Borovitskaya and Eva Janssens.

Herding can contribute to additional price volatility by creating imbalances in the supply or demand for individual securities and thus amplifying price adjustments. When markets are not characterized by a diversity of views and investment horizons among investors but rather by large groups of institutions following a similar strategy, there may be a heightened risk of price overshooting. In the recent period, the strategy followed by much of the sector may be a search for yield, driven by (expectations of) persistently low policy rates by central banks. The evidence from the Herding Metric suggests that the euro area investment fund sector may have contributed to short-term price volatility within the quarter. This is the case even if, as shown in section 2.4, investment funds ended Q2 2015 with only marginally lower holdings of bank, corporate and government bonds than at the beginning of the quarter.

3 Related literature

In this study we aim to shed more light on these recent periods of stress and to zoom in on the role of market illiquidity and the concentration of bond holdings in market shocks. Our study draws on a small but growing literature on the impact of concentrated holdings on securities pricing – itself a subset of the market microstructure literature. Based on existing empirical studies, we expect that more illiquid bonds will be subject to larger price shocks during periods of market stress. In line with economic theory, we expect that a higher concentration of holdings by any one sector leads to more severe price shocks for the respective security.

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There is a broad literature that highlights that less liquid bonds are more prone to price shocks (Houweling et al., 2005; Mahanti et al., 2008; Acharya et al., 2013). Liquidity, often defined as the ability to buy and sell assets with low transaction costs, has important links with market efficiency and with social welfare (Gorton and Huang, 2004). The role of liquidity increases during periods of market stress, as market participants are under greater pressure to change their portfolio allocations.

Bonds are less liquid than equities in part because of the large heterogeneity in this asset class. Individual issuers often have a large number of different bonds outstanding, with varying maturities, option structures, covenants and other contractual and legal characteristics. In addition, bond investors often hold assets to maturity, such that transactions in individual bonds may occur rarely, with few observable market prices ('stale pricing.'). Moreover, if traded, the institutional investors often exchange relatively large quantities of bonds at once to adjust their portfolios. This makes the trades in individual bonds 'infrequent and lumpy' (Fender and Lewrick, 2015; p. 98). Therefore, the concentration of bond holdings can have important ramifications for price shocks as mismatches between potential buyers and sellers must be sufficiently mitigated by intermediaries (market makers) that temporarily

are willing to hold bonds at their own risk. If bond holdings are strongly concentrated, market makers will demand a larger return, thus increasing the potential price shock (see e.g. Fleming, 2003, where the price impact coefficient indicates to what extent prices of bonds move when buyers and sellers initiate a trade).

In its essence, the idea that concentration has an impact on pricing is an affront to the efficient markets hypothesis (Fama, 1970), which even in its weak form envisages that asset prices should be driven by public information about the asset's fundamentals. If prices reflect such information, then the exact composition of the investor base should not matter, and price differentials arising from these factors should be arbitrated away in the market. Shleifer and Vishny (1997) show that 'limits of arbitrage' may prevent such effects from taking place, as arbitrage is a relatively capital-intensive activity performed only by a handful of professional investors. Academic literature lists several possible explanations for why concentrated holdings affect liquidity and price movements. Some researchers have suggested that risk management practices of certain institutions with large market shares may have been an important driver behind the scale of price shocks in individual markets (Eichengreen and Gupta, 2014). Another possible explanation is that when the number of holders is smaller, there are fewer parties who can make a trade (Bolton and Von Thadden, 1998). For equity markets, market makers may also charge a premium for the fact that large shareholders have more information about a company's performance than other market participants, since they are often more involved in the company's decision making than small shareholders (Claessens et al., 2002). Such market frictions may be particularly acute in crisis situations. During stress investors face increased holding and search costs due to financial constraints and more stringent capital requirements (Acharya et al., 2013). Also, investors may become more risk averse, shifting their holdings to more

liquid assets, often called a 'flight to quality' (e.g. Chen et al., 2007; Bijlsma and Vermeulen, 2015).

Most studies on the effect of concentrated holdings focus on equity, simple because of wider data availability. In many countries large stockholders face mandatory reporting requirements when their holdings reach a certain thresholds, typically five or ten percent. Heflin and Shaw (2000) use data from 260 US firms in 1988 and show that block holdings in certain stock increase bid-ask spreads, with estimated coefficients in the range of 4.8% to 30.0%. Attig et al. (2006) analyze the impact of large shareholding blocks on market liquidity for 610 Canadian stocks in 1996. They find that concentrated holdings negatively affect market liquidity: a one-standard deviation increase in concentration is associated with an estimated increase in bid-ask spreads between 5.1% and 19.2%. Jacoby and Zheng (2010) examine 3,576 US traded stocks in 1995 and confirm that concentration lowers liquidity. In line with this finding, Rubin (2007) finds that concentrated holdings of US stocks are indeed correlated with larger price shocks. Hence, from the equity side there is robust evidence for the association between concentration, illiquidity and price shocks.

The liquidity dynamics in equity markets differ from bond markets. To our knowledge, a similar study on concentration has not yet been performed for European bond markets, largely because data on bond holdings is much scarcer than that for equity holdings. A closely related study by Friewald et al. (2012) investigates whether market liquidity is a driver of bond US prices and if this potential channel is stronger during crisis periods. Using dataset with around 20,000 US corporate bonds, Friewald et al. find that market liquidity explains on average about 14% of the bid-ask spreads in the period 2004 to 2008, yet this impact is greater during the crisis periods and for non-investment-grade bonds. Other related work by Dick-Nielsen et al.

(2012) on US corporate bonds shows that liquidity is an important driver of price changes and that the contribution of liquidity increased at the onset of the financial crisis. Yet, the works by Friewald et al. and Dick-Nielsen et al. do not include any information on bond holding concentrations. New ECB data sources allow us to fill this gap.

4 Data and method

4.1 Dataset

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The data on bond holdings are taken from the ECB Securities Holdings Statistics Sectoral (SHS-S) database, a confidential data source of the Eurosystem which reports the holdings by sector and euro area countries of individual securities by International Securities Identification Number (ISIN) code. The data provide us with security-by-security data with general coverage greater than 90 percent for various holder sectors. We use a subset of the data covering only long-term debt securities for the period Q1 2013 and Q2 2015. As of the latest available period (Q2 2015) the SHS-S data includes approximately 500,000 unique individual bonds, leading to about 3 million observed holder country holder sector combinations.⁸

SHS-S data is complemented with price data for each bond from Bloomberg, and bond characteristics from the ECB Centralized Securities Data base (CSDB), Thomson Reuters and Dealogic. The categories were as follows:

- **Government bonds:** Dutch banks have the highest holdings of Dutch, German and French sovereign bonds. Therefore, all German, Dutch and French bonds issued by central governments (i.e. excluding local and regional governments), denominated in euro are included in our analysis.
- **Bank bonds:** Our sample includes all senior unsecured or subordinated bonds of the Single Supervisory Mechanism (SSM) significant institutions (SIs) and 4 significant British banks denominated in euro.⁹ With the exception of the Netherlands, Belgium, the UK and Italy, the selection also excludes bonds with < €100 million outstanding.

⁸ The holding sectors are based on the European System of Accounts (ESA) 2010 and include monetary financial institutions (MFIs; or banks), money market funds (MMFs), non-MMF investment funds (IFs), insurance corporations (ICs), pension funds (PFs), households (HH), other financial intermediaries (OFIs) and government.

⁹ The significant institutions refer to the 120 large banks under the prudential supervision of the ECB as part of the European banking union since November 2014. This contrasts with the less significant institutions (LSIs) which are under the prudential supervision of national authorities.

- **Corporates:** Using Dealogic, we have created a selection of investment grade (IG) and high-yield (HY) bonds by companies with headquarters or operations in the EU, denominated in euro.

The selection of bonds in Bloomberg and Dealogic yielded a list of 9,128 individual securities. Generally, our measures exclude highly illiquid bonds as no data on yields and bid-ask spreads are available for these securities (Mahanti et al., 2008).¹⁰ When combining the collected information with the commercial data providers, the holdings information for 4,970 bonds were matched for 2015 Q1. The total amount outstanding of these bonds was €4,283 billion. In terms of value, 39% was issued by French debtors, 32% by German debtors and 13% by Dutch debtors, with 16% from other countries. Of these, 3,800 have complete series for all relevant variables. For 2013 Q1 data was obtained for 3,477 bonds with a total amount outstanding of €3,636 billion. In terms of value, 32% was issued by German debtors, 27% by Italian debtors, 21% by Dutch debtors, 16% by French debtors and a remaining 4% from other countries. Of these, 1,743 bonds have complete price and holdings information and are thus tenable for regression analysis.

4.2 Estimation strategy

For the empirical analysis, our identification strategy consists of regressing yield changes of bonds during selected periods of stress against measures

¹⁰ In their sample of about 20,000 US corporate debt bonds, over 40% were not traded during a one-year period (using data from a custodian with an approximate market share of 15% in the years between 2000 and 2005). Our study focuses much more liquid bonds (government, banks, investment grade corporates) with larger face values. This is considered necessary to limit the problem of "stale pricing," but it may lead to underestimated results, as some particularly large price shocks in infrequently traded bonds are excluded from the analysis.

of illiquidity and concentration of holdings. These can be compared with tranquil periods for reference. Thus, regressions take the form:

$$\Delta P_{ij,t} = \beta_1 * L_{ij,t-1} + \beta_2 * C_{ij,t-1} + \beta_3 * X_{ij,t-1} + \gamma_i + \Sigma_{ij,t}$$

where $\Delta P_{ij,t}$ is price volatility, measured as the difference between the maximum and minimum spread of bond j of issuer i in quarter t over the benchmark rate (as quoted by Bloomberg). Among the independent variables, $L_{ij,t-1}$ is a vector of market liquidity characteristics of bond j at the end of the previous quarter $t-1$, $C_{ij,t-1}$ is a measure of concentration of holdings of bond j in the previous quarter, $X_{ij,t-1}$ is a vector of bond-specific controls, γ_i are issuer fixed effects, and $\Sigma_{ij,t}$ is the error term. We use ordinary least squares (OLS) regressions with Huber-White robust standard errors.

Market liquidity: Various studies on bond markets use bond characteristics as rough proxy for market liquidity such as age, amount issued, coupon, industry of issuer and covenant information (see Friewald et al., 2012, p.20), while more elaborate market-based measures often include trade volumes and spreads. We use the average daily bid-ask spread over the preceding quarter as our preferred measure of market liquidity, obtained from Bloomberg. For some securities such daily data were missing and we instead took the monthly average bid-ask spreads. The choice for the bid-ask spread is based both on data constraints and various studies highlighting that the bid-ask spread is a good proxy for market liquidity (see Houweling et al., 2005; Mahanti et al., 2008; Acharya et al., 2013 for discussions on the measurement of liquidity). For data from 2015, we can complement bid-ask spreads with the new and proprietary Bloomberg Liquidity Assessment (LQA) tool, which provides a more holistic view of a bond's liquidity based on trading volume, price impact of transactions and other indicators which are aggregated using a machine learning methodology. The LQA data are

available for 3,105 bonds in Q2 2015, and take a value between 0 (least liquid bonds) and 100 (most liquid bonds) in the government, supranational, agency and corporate bond universe.

Concentration: The SHS-S data provide us with granular data on the holdings of individual security identified by ISIN code for a holding sector s in holding country k . To measure concentration in bond j of issuer i by sector s , we construct the Herfindahl-Hirschman Index ($HHI_{i,j,t}^s$), which is the sum of each sector's squared market share per holder country, defined as the position of a particular sector in a euro area country divided by the amount outstanding of the bond. In the robustness checks, we take the maximum market share of any one sector as a maximum level of concentration. Of course, the holdings of a bond by one sector in a country (e.g. Dutch banks or German insurers) is not equivalent to holdings by one institution, and thus provides an overestimation of concentration by individual holders. Yet this sectoral data give us a unique proxy of concentration levels across the market. Where coverage in the SHS-S data is less than 50% (e.g. because of large non-euro area holdings), bonds have been dropped; in these cases, it would not be possible to draw conclusions on the level of concentration among non-euro area investors. Yet since most euro bonds, particularly of banks and corporates, are held primarily by euro area investors (see below), we lose relatively few observations due to the 50% limit.

Control variables: Other factors can also be expected to play a role in explaining price shocks, such as geographic distance between holder and issuer country, residual maturity and coupon rate. New bonds, defined as those have been issued in the last year may also be impacted differently than older ('off-the-run') bonds, which are often held to maturity and may exhibit 'stale pricing'. Moreover, fixed effects can be used to control for issuer sector (governments, banks or corporates) and issuer country.

4.3 Descriptive statistics

Table 1 shows the mean, standard deviation, minimum and maximum values of each of the variables used in the regressions. As is apparent from the dependent variable, the 2015 Bund Tantrum was less severe in terms of the average price shock (0.48%, or 48bp) than the 2013 Taper Tantrum (0.58%, or 58bp). Average bid-ask spreads before the start of market stress are broadly comparable across the two periods. Because of the skewed

Table 1 Descriptive statistics of the main variables

		Taper Tantrum (Q2 2013)				Bund Tantrum (Q2 2015)			
		Mean	St.Dev.	Min	Max	Mean	St.Dev.	Min	Max
Dependent variable:	Price volatility (%)	0.58	0.34	0.00	1.89	0.48	0.39	0.00	1.99
Independent variables:	Bid-ask spread (%)	0.12	0.10	0.00	0.97	0.12	0.18	0.00	1.99
	Bloomberg LQA score (pp)					47.47	26.49	1	100
	Concentration (HHI)	0.30	0.40	0.00	1.00	0.24	0.35	0.00	1.00
Controls:	Distance (km)	663	1,726	19	16,975	636	1,620	19	16,975
	Residual maturity (days)	2,071	2,730	72	67,998	1,836	3,070	1	67,267
	Coupon rate (%)	3.29	1.91	0.04	10.00	2.65	1.80	0.00	10.00
	New bond issuance (dummy)	0.06	0.24	0	1	0.05	0.21	0	1
Observations		1,743				3,800			

Table 2 Pairwise correlation between the main variables

	Taper Tantrum (Q2 2013)						Bund Tantrum (Q2 2015)						
	Bid-ask	HHI	Dist.	Res. Mat.	New Coup.	New bond	Bid-ask	LQA	HHI	Dist.	Res. Mat.	New Coup.	New bond
Price volatility (%)	0.20	-0.16	0.14	0.29	0.40	0.05	0.16	-0.33	-0.04	0.09	0.37	0.17	0.13
Bid-ask-spread (%)		-0.17	0.01	-0.38	0.35	-0.13		-0.40	-0.16	-0.09	-0.29	0.24	-0.07
Bloomberg LQA score (pp)									-0.04	0.138	-0.33	-0.29	-0.03
Concentration (HHI)			-0.16	0.13	-0.44	0.04			-0.17	-0.04	-0.27	-0.01	
Log distance				0.01	0.12	-0.02				0.14	0.00	0.08	
Log residual maturity					-0.01	0.13					0.10	0.17	
Coupon rate (%)						-0.17							-0.17

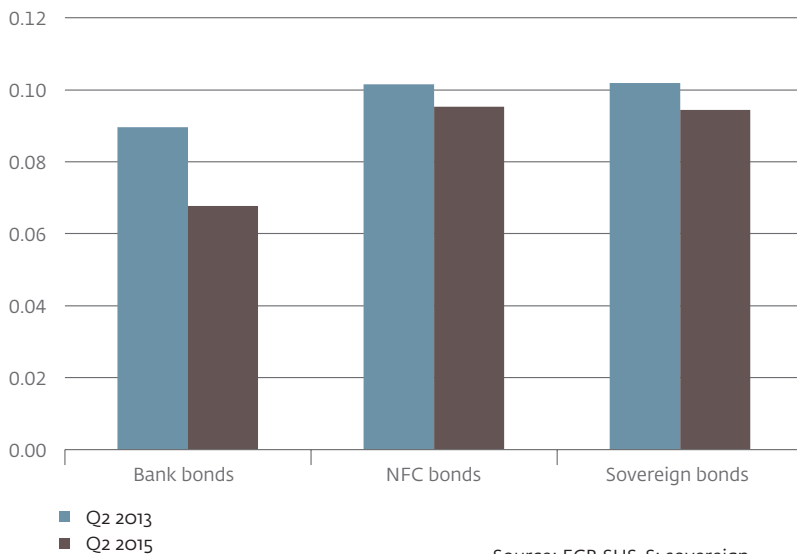
distribution of the residual maturity and distance between holder and issuer country, these variables will be calculated in the regressions as logs. Table 2 shows the correlations between the variables.

For the euro area bond markets as a whole, the SHS-S data show that the overall concentration of holdings has actually decreased slightly between Q2 2013 and Q2 2015 (figure 7). The decrease was most pronounced for bank bonds, and less so for corporate and sovereign bonds. Among holder sectors (figure 8), euro area banks are the largest holder of the relevant euro area bonds (20.8%), followed by insurers (13.7%) and investment funds (10.2%).

Interestingly, banks are especially dominant in the market for other banks' bonds. Over a third (37.5%) of the market is held either by non-euro area investors (and hence not reported) or by the ECB and national central banks, who report to a separate SHS database (under an additional confidentiality regime). This unexplained portion is especially important for bank bonds, but has remained relatively constant between 2013 and 2015.

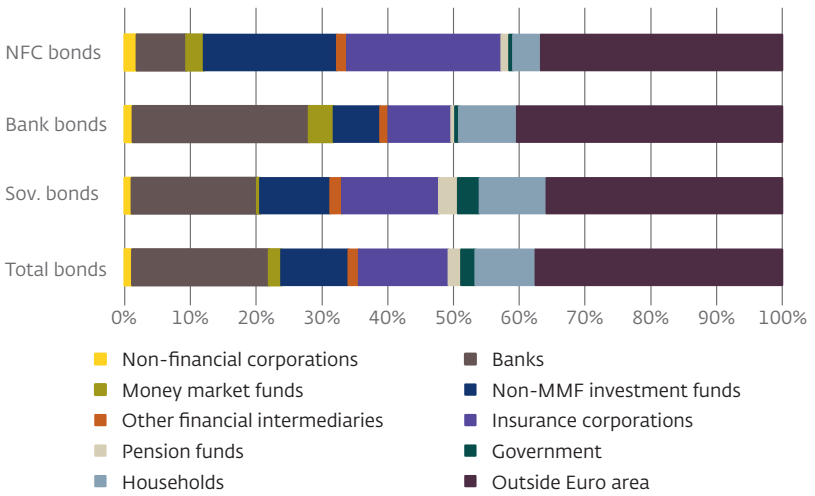
Figure 7 Concentration among issuer sectors

Herfindahl-Hirschman Index of aggregate asset class, in Q2 2013 and Q2 2015



Source: ECB SHS-S; sovereign refers to the subsample of German, French and Dutch bonds.

Figure 8 Distribution of bonds over euro area sectors by issuer sector



Source: ECB SHS-S

5 Regression results

5.1 Baseline results

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With our data set and methodology now defined, table 3 shows our regression results. We find that illiquidity of a bond, as proxied by the bid-ask spread, is associated with larger yield shocks during both the 2013 Taper Tantrum (column 1) and the 2015 Bund Tantrum episode (column 2). These results are robust in subsamples with four issuer sectors, five holder sectors and four holder countries. LQA data confirm this finding, as more liquid bonds (i.e. those with a higher LQA score) are found to have smaller price shocks (column 3). Notably, bid-ask spreads maintain their positive and significant coefficient in the regression with the LQA score, showing that they remain a useful complement to other liquidity measures. For the Bund Tantrum, we find a significant positive effect of concentration of holdings on yield shocks (columns 2-3). This effect of concentration is negative during the Taper Tantrum. As is shown in section 5.2, this effect is not robust to an alternative definition of the dependent variable. The difference between the two periods may relate in part to the rise in investor herding between 2013 and 2015 (see section 2.5). Differences could also come from the nature of the shock, which was largely external in the Taper Tantrum and more internal during the Bund Tantrum, which originated in European markets.

In order to see whether these results also hold in tranquil periods, we run the same regressions for the immediately preceding quarters – i.e. Q1 2013 and Q1 2015 – when spreads were generally declining and volatility was low. Here, we find that the effect of bid-ask spreads (columns 4-6) and the Bloomberg LQA score (column 6) remains highly significant. It appears that illiquidity of a bond is an important driver of price volatility both in tranquil and stress periods. Concentration has a significant positive impact on price volatility in Q1 2015 (column 5), but loses significance when the LQA score is included (column 6). It is not significant in Q1 2013. Most control variables maintain their positive sign and significance during the tranquil periods.

Table 3 Effect of market liquidity and concentration on price volatility

	Stress			Tranquil		
	(1) Taper Tantrum (Q2 2013)	(2) Bund Tantrum (Q2 2015)	(3) Bund Tantrum (Q2 2015)	(4) Tranquil 2013 (Q1 2013)	(5) Tranquil 2015 (Q1 2015)	(6) Tranquil 2015 (Q1 2015)
Bid-ask spreads	0.786*** (0.113)	0.492*** (0.051)	0.360*** (0.075)	1.062*** (0.114)	0.553*** (0.041)	0.291*** (0.069)
Bloomberg LQA score			-0.001*** (0.000)			-0.002*** (0.000)
Concentration (HHI)	-0.085*** (0.022)	0.131*** (0.019)	0.111*** (0.024)	-0.008 (0.019)	0.062*** (0.012)	0.017 (0.014)
Log distance	0.045** (0.009)	0.027*** (0.007)	0.028*** (0.007)	0.010 (0.010)	0.005 (0.007)	0.006 (0.007)
Log residual maturity	0.179 (0.015)	0.165*** (0.008)	0.163*** (0.011)	-0.002 (0.014)	0.041*** (0.006)	0.009 (0.008)
Last coupon rate	0.061*** (0.005)	0.019*** (0.004)	0.014*** (0.004)	0.033*** (0.005)	0.032*** (0.003)	0.025*** (0.004)
New bond	0.117*** (0.027)	0.181*** (0.029)	0.233*** (0.034)	0.067*** (0.013)	0.084*** (0.011)	0.074*** (0.012)
R ²	0.349	0.313	0.327	0.490	0.439	0.406
N	1,743	3,800	3,105	1,666	3,369	2,731

* = $p < 0.1$, ** = $p < 0.05$, *** = $p < 0.01$; OLS regressions with Huber-White standard errors.

The notable exception is log distance, which has no significant impact in either tranquil quarter. This may indicate that the geographic distance between a holder sector and the issuer matters primarily during market shocks, when home bias leads investors to seek safety closer to home.

The comparison between crisis and tranquil periods shows that bond illiquidity is a significant driver of price shocks across time. For the Bund Tantrum, it appears that concentration of holdings was a significant driver of the shock, and that this had a larger impact than in the immediately preceding tranquil period.

5.2 Robustness checks

In order to test the robustness of our results, we use alternative definitions of both the dependent variable – price volatility – and key independent variables. For example, for the dependent variable, we can use the standard deviation of bond yields instead of the maximum absolute change within a quarter. Table 4 displays the results. These confirm the general importance of market illiquidity, and the effect of concentrated holdings during the Bund Tantrum. While the scale of coefficients changes (in line with the smaller variance of the alternative dependent variable), their significance is largely unchanged. Only the effect of concentration loses significance, both during the Taper Tantrum (column 1) and during the Bund Tantrum when Bloomberg LQA data is included (column 3).

Similar exercises have been run for a measure of concentration based on the largest holding by any single sector (instead of the HHI), and for additional control variables. Again, the conclusions remain in line with the findings of the baseline regression.

Table 4 Regressions with standard deviation as dependent variable

	Stress			Tranquil		
	(1) Taper Tantrum (Q2 2013)	(2) Bund Tantrum (Q2 2015)	(3) Bund Tantrum (Q2 2015)	(4) Tranquil 2013 (Q1 2013)	(5) Tranquil 2015 (Q1 2015)	(6) Tranquil 2015 (Q1 2015)
Bid-ask spreads	0.232*** (0.032)	0.147*** (0.017)	0.095*** (0.024)	0.290*** (0.027)	0.152*** (0.013)	0.088*** (0.021)
Bloomberg LQA score			-0.0004*** (0.000)			-0.001*** (0.000)
Concentration (HHI)	0.012 (0.006)	0.017*** (0.005)	0.006 (0.006)	-0.002 (0.005)	0.017*** (0.004)	0.004 (0.005)
Log distance	0.014** (0.003)	0.009*** (0.002)	0.010*** (0.002)	0.001 (0.003)	0.001 (0.002)	0.001 (0.002)
Log residual maturity	0.046*** (0.004)	0.055*** (0.002)	0.054*** (0.003)	-0.004 (0.004)	0.012*** (0.002)	0.001 (0.002)
Last coupon rate	0.015*** (0.002)	0.003* (0.001)	0.001 (0.001)	0.010*** (0.001)	0.010*** (0.001)	0.008*** (0.001)
New bond	0.028*** (0.007)	0.051*** (0.008)	0.062*** (0.009)	0.020*** (0.004)	0.028*** (0.004)	0.025*** (0.004)
R ²	0.318	0.395	0.436	0.512	0.410	0.382
N	1,743	3,800	3,105	1,666	3,369	2,731

* = $p < 0.1$, ** = $p < 0.05$, *** = $p < 0.01$; OLS regressions with Huber-White standard errors.

5.3 Overall conclusions

The empirical exercise shows that less liquid bonds are impacted by higher price shocks during two recent stress periods. During the Bund Tantrum, we find evidence that concentration of holdings, as measured by the HHI, also has a significant upward impact on price volatility. These results continue to hold under plausible alternative specifications.

While the regression analysis is performed for cross sections (rather than a time series) and only for a sample of individual bonds, the results may have broader relevance. If market-wide liquidity conditions in the fixed income markets deteriorate or if concentration of holdings increases, this may lead to larger overall price shocks. Through various channels, these price shocks could in turn impact market functioning and systemic stability. The next section analyzes these channels.

6 Impact on systemic stability

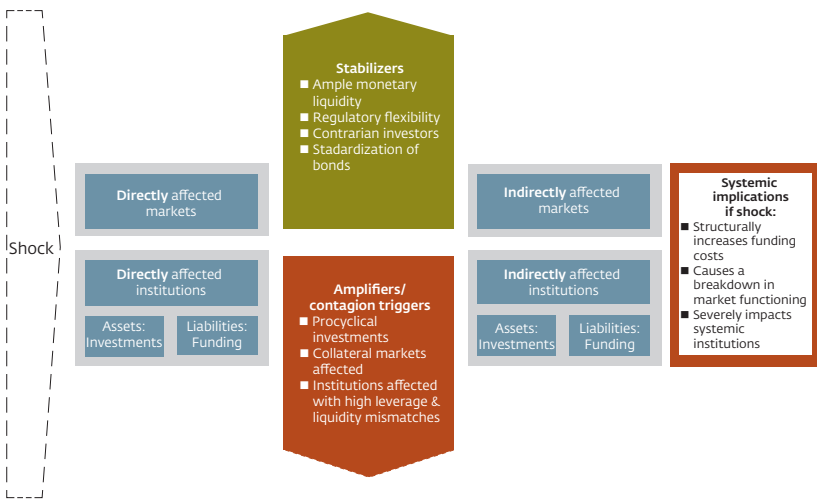
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The stress periods analyzed in this study have occurred against the backdrop of a larger shift toward market financing in the EU. This trend may augment financial system stability. Importantly, Europe is 'over-banked': the preponderance of (large) banks makes economies relatively vulnerable to systemic risks from bank failures (ESRB, 2014). Banks account for 61% of all private credit in the euro area (57% in the Netherlands) and 55% in the UK, compared with 31% in the US. Especially during downturns combined with financial crises, market-based financial systems are more robust than bank-based systems (Gambacorta, et al., 2014). A move toward greater capital market financing could reduce Europe's reliance on banks and thus add an additional 'pillar' to overall credit supply (EC, 2015). A shift of trading from banks to investment funds could also be constructive. As compared to banks, several characteristics of investment funds make them less systemic. For example, investment funds are often barred by mandate or regulation from using leverage.¹¹ As a result, losses are borne directly by fund investors, and fund closures are more orderly than bank failures. Moreover, funds do not benefit from implicit state subsidies, as they do not have explicit recourse to central bank liquidity operations or national deposit guarantee systems. This should mean that risks are priced more accurately.

Yet the trend towards increased market intermediation could lead to new systemic risks. Many non-bank entities nonetheless perform bank-like activities – so-called 'shadow banking' (IMF, 2014; DNB, 2015b). More generally, when markets simultaneously become less liquid and

¹¹ In the US, mutual funds are governed by the Investment Company Act of 1940, which limits leverage to 33% of net asset value (NAV). In the EU, the Undertakings for Collective Investment in Transferable Securities (UCITS) Directive, most recently revised in 2014, limits leverage to 10% of NAV. Hedge funds, private equity and other alternative funds are regulated in the EU by the Alternative Investment Fund Managers Directive (AIFMD), which has no minimum limits on leverage but gives macroprudential authorities the power to impose limits as necessary.

Figur 9 Transmission and amplification mechanism of market shocks to systemic stability



more concentrated, institutions could be confronted with frequent and severe episodes of market stress. Where individual asset managers have concentrated positions in one market, fears of sudden repositioning can damage confidence of other investors and thus liquidity in broader markets (see Massa et al., 2015 for an event study around the merger of BlackRock and Barclays Global Investors). The extent to which market turbulence affects the financial system and real economy depends on the contagion, stabilization and amplification dynamics that occur after the initial market shock.¹² Figure 9 provides a simplified visualization of this process. This rest

¹² For a good analysis of the distinction between the level and resilience of liquidity, and a description of many of the drivers sketched below, see Anderson et al. (2015).

of this section further elaborates on the key transmission mechanism through which market shocks can turn into a systemic event.

6.1 Stabilizers of market shocks

Market shocks can be amplified or stabilized, depending on the structure of the affected market, behavior of market participants, profile of the affected institutions and cyclical forces. Figure 9 lists some examples of stabilizers and amplifiers. [Standardization of bond contracts](#), for example, could make markets less vulnerable for overshooting risk premiums than in markets characterized by complex and opaque bonds, because of lower risk of mispricing. Cyclical factors such as the currently [ample central bank liquidity](#) could also dampen shocks, at least in the short term. Other potential stabilizers include [regulatory flexibility](#), which may enhance countercyclical investments in times of stress. An example is the so-called volatility adjustment in European regulation for insurers (Solvency II), which allows insurers to maintain lower buffers in volatile times. Moreover, the existence of long-term, [contrarian investment strategies](#) could also stabilize market shocks. Institutional investors such as insurers and pension funds often use long-term rebalancing strategies, i.e. they buy when prices are low and sell when prices are high, thereby stabilizing market movements (both up and down) if applied on a large scale. Some hedge funds may function as a sort of 'backstop' to downward price spirals by purchasing large amounts of distressed assets. Trading banks may also stabilize markets by buying during a downturn – but if this is accompanied by a reduction in credit to the real economy, this behavior may destabilize the real economy (Abbassi et al., 2015).

6.2 Amplifiers of market shocks

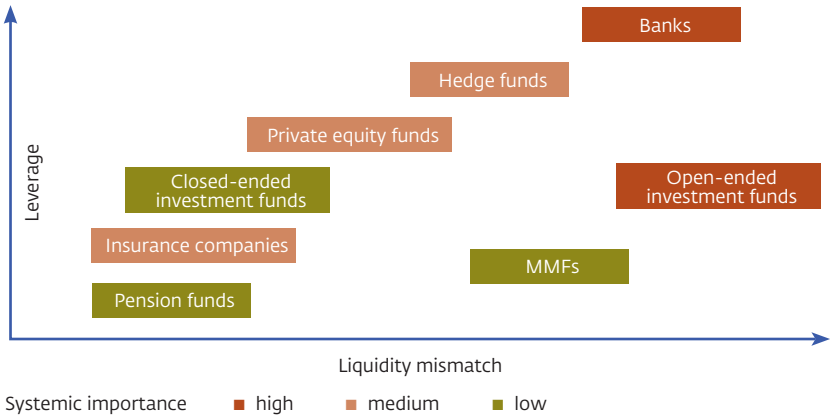
Shocks can be amplified by [procyclical investment behavior](#) of market participants. Investors sometimes tend to sell distressed assets simultaneously, particularly when they apply similar investment mandates

or similar volatility based risk models such as value at risk (VaR); if volatility rises, this can lead to an automatic reduction in institutions' risk budgets ('VaR aftershock'). Asset management by an external institution can lead to principal-agent problems, particularly when investors gauge the asset manager's quality based on relative performance benchmarks (Rajan, 2005). When returns disappoint, investors see this as a signal of poor-quality fund management and suddenly redeem their investments, in the worst case leading to a 'run' on an asset manager. Market stress and subsequent losses may be transmitted to other asset classes or institutions. Spill-overs to other markets typically occur when holders of the affected assets face liquidity constraints and are forced to sell assets in other less risky but more liquid markets. In extreme scenarios this may prompt further price declines, collateral calls and self-reinforcing fire sales, potentially also affecting other institutions with large positions of the asset that is being sold off. Other more direct sources for contagion between institutions are counterparty losses, funding changes or margin calls (Tirole, 2011).

Contagion risks are high when important [collateral markets](#) are impacted (such as government or bank bonds, which are often used as collateral in secured financing transactions with central banks or private counterparties), or when institutions with [high leverage and liquidity mismatches](#) are affected by the initial shock. If those institutions suffered large losses, they could be forced to sell assets at distressed or fire-sale prices. Figure 10 presents a simplified representation of key characteristics of different types of financial institutions. Banks generally operate with the highest leverage and open-ended funds with largest liquidity mismatches by offering daily or intra-day liquidity yet investing in less liquid assets. Banks also fund illiquid assets with short-term funding, but their 'net liquidity mismatch' is usually lower since they also have explicit recourse to national deposit guarantee systems or central bank liquidity operations.

Figure 10 leverage and liquidity characteristics of types of financial institutions

Institution	Amount of leverage	Liquidity mismatch:		Systemic importance
		Illiquid investments	Stable funding	
Banks	High	Medium	Medium	High
Insurers	Low	Low	Medium	Medium
Pension funds	Low	Low	Low	Low
Hedge funds	Medium	Medium	Medium	Medium
Private equity	Medium	High	Low	Medium
Closed-ended funds	Medium	Medium	Low	Low
Open-ended funds	Medium	Medium	High	High
MMFs	Low	Low	High	Low



6.3 Systemic impact of market shocks

The abovementioned contagion and amplification mechanism could pose systemic risk by triggering knock-on effects on the financial system and real economy. The financial system and real economy are particularly affected if market stress leads to one of the following representative scenarios:

- 1 **A structural rise in the cost of funding of companies, countries or financial institutions.** When market shocks are temporary and only affect few institutions or asset classes, they are unlikely to have systemic implications. But when a market shock triggers a widespread, sharp and persistent reversal of risk appetite among investors in fixed income markets, financing costs will be structurally higher. Experiences from the Taper Tantrum suggest that even without any contagion mechanism, market turbulence can move the financing cost of (emerging) economies to structurally higher equilibrium. This may hamper economic growth and the stability of the system if governments, companies and financial institutions have to issue or refinance credit at higher costs.
- 2 **A breakdown of financial market functioning.** Massive redemptions, declining asset prices or even self-reinforcing fire sale dynamics raise uncertainty and hurt investors' confidence in the functioning of financial markets. During the global financial crisis, the functioning of interbank markets became severely impaired as banks preferred hoarding cash instead of lending it out, despite of massive central bank liquidity injections. Where systemically important markets are impaired, this can cause losses at large and interconnected institutions, which are in turn spread through the financial system.
- 3 **Stress at systemically important financial institutions.** Institutions are considered systemically important when they are large, interconnected, and complex, and if there is a lack of readily available substitutes for the financial infrastructure they provide. Their failure can trigger widespread contagion across the financial system and negatively affect local or global economies. Banks are generally considered as highly systemically relevant. There are several forms of contagion of market shocks to banks. In general, losses can spread to banks through: market risk on banks'

financial assets (asset side); direct links with investment funds (asset side); and funding risk due to illiquidity spirals, especially in markets for short-term wholesale funding or commercial paper (liability side). Higher capital requirements for bank trading books and structural bank reform have reduced the potential for shocks to spread to banks on the asset side. Recent FSB work has extended the remit of 'systemically important financial institutions' beyond banks, including to some insurance companies, hedge funds, and possibly also to asset managers. While the economic impact of runs on asset managers is likely smaller than the impact of bank runs, they can have significant spillover effects on the functioning of markets (Table 5).

Table 5: Historical examples of large outflows ('runs') from investment funds

Fund name	Date and cause of run	Fund AuM at run	Impact
Long-Term Capital Management	May-Sep. 1998; losses on positions after Russia crisis	\$128 billion	Bail-out by private banks
Bear Stearns High-Grade Structured Credit / Enhanced Leveraged Fund	June-July 2007; large-scale investments in subprime	\$1.6 billion	Fund closure, bail-out by parent bank
US Reserve Primary Fund	16 September 2008; holdings of Lehman Brothers bonds	\$64.8 billion	Spillovers to other money market funds
AXA Rosenberg	Mar.-May 2010; valuation fraud	\$62 billion	Reputational damage
Gartmore Group	Nov. 2010-Jan. 2011; M&A and departure of senior staff	£20.9 billion	Decline in firm's market share
PIMCO Total Return Fund	Sep.-Nov. 2014; departure of CIO Bill Gross	\$250 billion	Loss of market share, brief market jitters

Overall, this qualitative description makes clear that market shocks can, under certain conditions, affect systemic stability. Reducing the probability and impact of such market shocks is a task for financial regulation and macroprudential policy.

7 Conclusion and policy implications

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This study offers insights into the impact of market illiquidity and concentration of holdings on systemic stability in European bond markets. Our narrative description of four recent stress periods shows that especially the 2013 Taper Tantrum and 2015 Bund Tantrum had widespread and persistent effects on market pricing. In both periods, we show that households, money market funds and other financial intermediaries engaged in procyclical selling of bonds, while pension funds were contrarian investors. There is some evidence for growing investor herding in European bond markets in the past three years. In our empirical analysis, we look at the impact of market illiquidity and concentration on price volatility. From regression results, we can conclude that illiquid bonds are more subject to spread widening during episodes of stress, but that an effect of concentrated holdings by any one sector was only significant and robust during the 2015 Bund Tantrum.

While increased concentration and market illiquidity may be partly driven by stricter bank regulation, the alternative of having riskier banks is worse from a financial stability perspective, especially in 'over-banked' Europe. Therefore, unintended consequences of bank regulation should not spark reversals of previous policy measures. Financial institutions and investors should rather take reduced market liquidity and greater chances of intense market shocks into account, e.g. by running liquidity stress tests and taking measures to mitigate funding risks (DNB, 2015a).

The results of our analyses do, however, raise questions for policymakers about the need for additional prudential regulation of markets, financial instruments and asset management industry. Regulators need to monitor financial stability risks, especially in smaller, less liquid fixed-income markets. Where possible, they may impose policy measures to improve stabilizing mechanisms of markets. For example, funds that invest in illiquid assets

could also be required to use redemption gates – which restrict withdrawals by investors – and redemption fees, which provide an incentive for investors to stay in the fund. Conservative or countercyclical margin requirement could also play a stabilizing role. Given the growing importance of securities financing transactions such as repos, and OTC derivatives transactions with similar economic functions, it may be important to target measures to collateral in these transactions. Margin requirements on collateral are often too low prior to a crisis, and tend to increase rapidly when stress materializes. Thus, sufficiently conservative margin requirements, or even the countercyclical use of margins, could help dampen excessive leverage and liquidity risks.

Finally, policy measures should particularly aim to increase the resilience of the system rather than to prevent shocks. To use a Dutch metaphor, policy should thus aim to raise the level of the dikes, rather than to control the storm.¹³ Financial institutions must be prepared for increasing unrest in the financial markets. To prevent risks from spreading to the banking sector, the large exposure regime could be extended to illiquid markets and financial products. Stress tests of asset managers, as recently conducted in the US, could also play a role to identify and mitigate risks. Table 5 provides an overview of these measures.

¹³ Constâncio (2014) uses the same metaphor to discuss operationalizing macroprudential policy in the banking sector. Yet unlike Constâncio, we will stop short of adding King Canute and the ocean waves to this description.

Table 5 Overview of potential policy measures

Policy goal	Potential policy measures
Improve resilience of institutions to market shocks	<ul style="list-style-type: none"> ■ Limits for banks' investments to illiquid markets (asset side) and interconnectedness with investment funds (liability side) ■ Stress testing of financial institutions to market shocks, in particular asset managers and banks ■ Leverage limits for investment funds ■ Liquidity regulation for investment funds (cash buffers, redemption profile)
Improve resilience of markets	<ul style="list-style-type: none"> ■ Conservative or countercyclical margin requirements ■ Ex-ante redemption fees and gates ■ Standardization of bond issues ■ Recovery and resolution plans for CCPs, insurers and investment funds

The shifting nature of systemic risks calls a number of new macroprudential policy measures beyond banking. Together, this points to an ambitious agenda for European policy makers.

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