The market for Federal securities: holder structure and the main drivers of yield movements

German government bonds play a key role in the euro area's spot and futures markets, and have become a major benchmark for the price of other financial instruments in the euro area. Their good availability and high liquidity have typically made German Federal securities an important and attractive investment instrument for national and international investors alike. This attractiveness is reflected in a broad international and sectoral holder structure. From a central bank perspective, the market for government bonds has taken on far greater significance over the past few years. The ECB Governing Council's decision to purchase public sector securities (public sector purchase programme, or PSPP) turned this segment of the bond market into a key area of engagement for monetary policy. Under the PSPP, the Bundesbank purchased just under one-quarter of the total outstanding volume of Federal securities up to the end of 2017, sharply altering the holder structure. Holders from non-euro area countries were the main sellers of Federal securities to the Bundesbank. Within the euro area, the securities were sold chiefly by monetary financial institutions (MFIs), ie investors with access to the deposit facility. Against this backdrop, possible effects of the purchase programme manifested in sectoral portfolio adjustments and the exchange rate. Generally speaking, the purchases reduced the freely tradable volume of Federal securities in free float; this spread to availability (scarcity premium) and market liquidity (liquidity premium). Over the longer term, the yield on ten-year Federal bonds (Bunds) was shaped by scarcity premiums, expectations regarding key interest rates, and international determinants.

The importance of the bond market to the central bank

Market for Federal securities: an important segment of the international bond market

The market for Federal securities is an important segment of the international bond market. Being highly liquid, German government securities play a key role in the euro area's spot and futures markets, and have become a major benchmark for the price of other financial instruments in the euro area.[1]

Bond market a key transmission channel for monetary policy

From a central bank perspective, the bond markets and hence the market for Federal securities have grown in importance over the past few years.[2] The Eurosystem's initial response to the financial and sovereign debt crisis was to start lowering the key interest rates and introducing a host of non-standard measures in 2007. As of June 2014 – with key interest rates near 0% – the ECB then adopted unconventional measures intended to further increase the degree of monetary policy accommodation. Alongside targeted longer-term refinancing operations, these included a series of asset purchase programmes, which, when the expanded asset purchase programme (APP) was adopted, ultimately also envisaged the purchase of public sector securities under a dedicated programme (PSPP) from March 2015 (see the box on pages 17 to 19). This made the bond market an important area of engagement for monetary policy. As monetary policy transmission also flows through the bond market, central banks consider it important to understand which transmission channels are activated by the measures. Changes in the holder structure can provide indications of this. In addition, unwanted side effects such as the relative scarcity of Federal securities or a possible deterioration in market liquidity, as influenced by the purchases, have to be monitored.

Market developments and holder structure of Federal securities

Outstanding volume and issuance of Federal securities

Federal securities are an important tool for Federal Government borrowing. Their share in the total volume outstanding in the German bond market has risen by 10 percentage points to just over 35% since the launch of monetary union in 1999.[3] Issuance follows a fixed calendar set by Federal Republic of Germany – Finance Agency (see the box on pages 23 to 25). It peaked in 2009 and 2010, during the financial and economic crisis. As central government's budgetary situation subsequently improved, net issuance dropped significantly and has hovered around the zero mark since 2014. Since then, at just under €200 billion each year, the Finance Agency has refinanced roughly one-sixth of outstanding central government debt using securities with a maturity of between six months and 30 years.

Federal securities highly relevant to international investors

Federal securities typically have a very broad investor base. Demand for German government bonds comes from all sectors inside and outside Germany. The launch of monetary union fundamentally altered the market environment for bonds issued by the domestic public sector. Within the euro area, the currency-specific advantage of issuing securities in Deutsche Mark fell away, meaning that German public sector issuance has since competed directly with public sector debtors of the partner countries in the euro area. However, thanks to their high

1 Futures on two-year, five-year and ten-year Federal securities are the most traded contracts on Eurex Frankfurt AG. In 2017, a total of 85% of bond futures traded had Federal securities as the underlying. Italian (8%) and French (7%) securities follow far behind. For information on the importance of the futures market for the benchmark status of German Federal securities, see also J W Ejsing and J Sihvonen (2009), Liquidity premia in German government bonds, ECB Working Paper No 1081.

2 See Deutsche Bundesbank, The macroeconomic impact of quantitative easing in the euro area, Monthly Report, June 2016, pp 29-53.

3 Aside from the rise in outstanding Federal securities, another factor was the decrease in outstanding public Pfandbriefe and other bank debt securities. The outstanding volume of bonds issued by specialised credit institutions and enterprises without a banking licence increased.

Public sector purchase programme

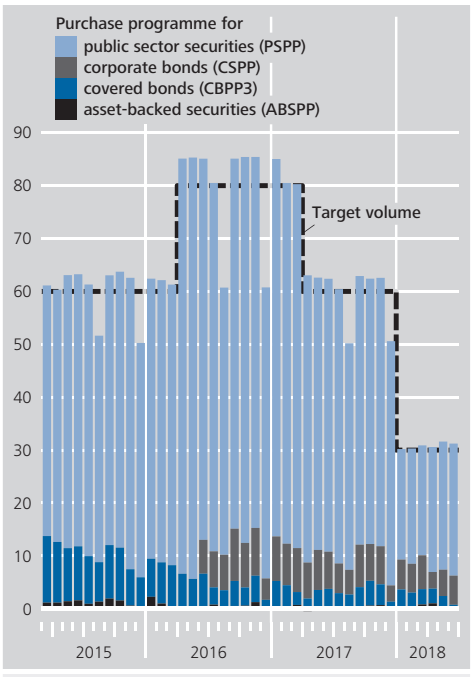
On 22 January 2015, the Governing Council of the European Central Bank (ECB) announced the launch of an expanded asset purchase programme (APP), which broadened the existing covered bond purchase programme (CBPP3; launched in October 2014) and the asset-backed securities purchase programme (ABSPP; launched in November 2014) to include securities issued by the public sector (public sector purchase programme – PSPP; launched in March 2015).[1] The corporate sector purchase programme (CSPP) was added to the APP in June 2016. The objective of the purchase programmes is to provide significant monetary policy accommodation, thus contributing to an inflation rate of below, but close to, 2% over the medium term. Initially, monthly net asset purchases (purchases minus reinvestments of maturing assets) under the APP amounted to €60 billion; the volume was then raised to €80 billion and has since been scaled back to €30 billion. The PSPP is by far the biggest component of the APP.

Under the PSPP, the European Central Bank and the Eurosystem national central banks (NCBs) acquire securities issued by central governments, agencies as well as international organisations and multilateral development banks (supranational bonds) located in the euro area.[2] Moreover, since January 2016, regional and local government bonds, such as the debt of the German federal states, have been eligible for purchase under the PSPP.

There are detailed rules and restrictions designed to keep risk to a minimum for purchases under the PSPP. All securities must be eligible as collateral for monetary policy operations, have minimum ratings from external credit rating agencies accepted in the Eurosystem,[3] be denominated in euro and have a remaining maturity of between 1 and 31 years.[4]

Net purchases under the asset purchase programme (APP)

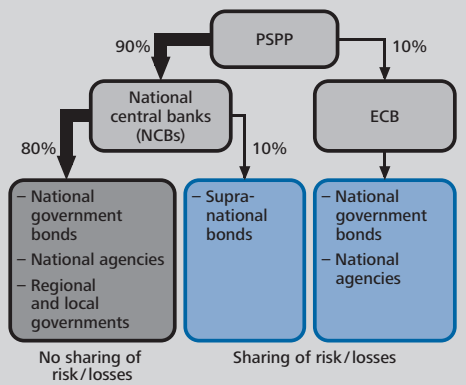
€ billion



Source: ECB.
Deutsche Bundesbank

1 Press release on the decision taken by the Governing Council of the ECB on 22 January 2015: http://www.ecb.europa.eu/press/pr/date/2015/html/pr150122_1.en.html
2 For a complete list of all eligible issuers, see https://www.ecb.europa.eu/mopo/implement/omt/html/pspp.en.html
3 Bonds that do not meet the minimum credit rating requirements can continue to be used as collateral for monetary policy operations where the issuing member state has successfully completed a (regular) review under a financial assistance programme. However, on 22 June 2016, the Governing Council of the ECB decided that Greek bonds which would otherwise fall under this regulation cannot be purchased under the PSPP until Greece can demonstrate reinforced debt sustainability and fulfil additional risk management considerations established by the ECB.
4 The parameters of the programme are regularly reviewed and updated if necessary. For instance, on 8 December 2016, the Governing Council of the ECB resolved on cutting the initial minimum remaining maturity from two years to one year. In addition, purchases of securities with a yield to maturity below the deposit facility rate were deemed permissible to the extent necessary.

Public sector purchase programme (PSPP)



Deutsche Bundesbank

As a result of the prohibition of monetary financing under Article 123 of the Treaty on the Functioning of the European Union, central banks may purchase government bonds on the secondary market only. In addition, there is a blackout period prior to and following an announced auction on the primary market before the bonds are available for purchase on the secondary market. There is an issue share limit of 33% per bond,[5] subject to verification on a case-by-case basis that holding such an amount would not lead to Eurosystem central banks having a blocking minority in the event of an orderly restructuring of the issuer.

One of the peculiarities of the PSPP is that the distribution of profits and possible losses arising from the securities purchased is governed by rules differing from those for the other programmes included in the APP. Under the PSPP, only 20% of the securities purchased are subject to joint liability at the Eurosystem level. This is broken down into purchases by the ECB (10%) and purchases of supranational bonds by the NCBs (10%). The remaining securities purchased by the NCBs are not subject to a regime of risk sharing.[6]

The implementation of the PSPP is based on a decentralised specialisation approach. Each NCB purchases public sector bonds in line with its share of the ECB's capital key[7] (the Bundesbank's current share is 25.6%), with each NCB only buying bonds from its own jurisdiction. The ECB purchases bonds from all jurisdictions.

The allocation of the purchase volumes in the PSPP is subject to a clear set of rules. There is no discretionary scope for tactical deviations to support individual government bond markets. The monthly targets are based on the shares of the individual member states' national bonds in the total volume at the end of the programme.

However, the monthly purchase volumes of national bonds by individual member states may, at times, differ from their capital key. A number of factors at play here are of a purely temporary nature. For instance, the Eurosystem and thus the Bundesbank, too, take account of the fact that market liquidity can vary seasonally and that bond-specific offer volumes may deviate from original expectations. In addition, all repayments on holdings that have already been accumulated are reinvested for a period of three months after the due date. This can also lead to temporary deviations. A conscious decision was taken at the beginning of the PSPP to keep purchasing behaviour

5 At the start of the programme, the Governing Council of the ECB initially set the limit at 25% and subsequently raised it to 33% with its decision of 5 November 2015.
6 At the beginning of the programme, the share of supranational bonds stood at 12% but was then cut to 10% in April 2016. The share of securities subject to joint liability remained unchanged at 20%.
7 The ECB's capital comes from the NCBs of all member states of the European Union (EU); each NCB's share is calculated from its share in the total population and gross domestic product of the EU. As not all EU member states have adopted the euro and only the central banks of the euro area member states have to pay the full amount of their capital share, the euro area member states thus have a higher share of the ECB's actual paid-up capital than stipulated by the capital key. It is this higher modified capital share per NCB that is relevant for purchases under the PSPP. For more information, see https://www.ecb.europa.eu/ecb/orga/capital/html/index.en.html

flexible in this way in order to ensure the smooth implementation of the programme.

However, other factors cause more persistent deviations from the capital key. For example, if there is an insufficient quantity of existing national bonds or if these bonds do not have the minimum rating required under the PSPP, the NCB concerned makes substitute purchases of debt instruments issued by supranational institutions in order to fulfil its share of purchases based on the capital key. As a result, these NCBs have a lower share of purchases of national bonds. To ensure that the stipulated total volume of national bonds remains constant at 90% and the total monthly volume does not fluctuate, the relative share of national bonds of NCBs that do not need to conduct substitute purchases of supranational bonds automatically increases. For this reason, the share of German bonds in the entire PSPP holdings of national bonds is currently somewhat higher than Germany's corresponding share in the capital key. However, this does not mean a departure from the principle that purchases generally follow the capital key. Gearing purchases to the capital key reflects the overarching guiding principle to preserve a single monetary policy.

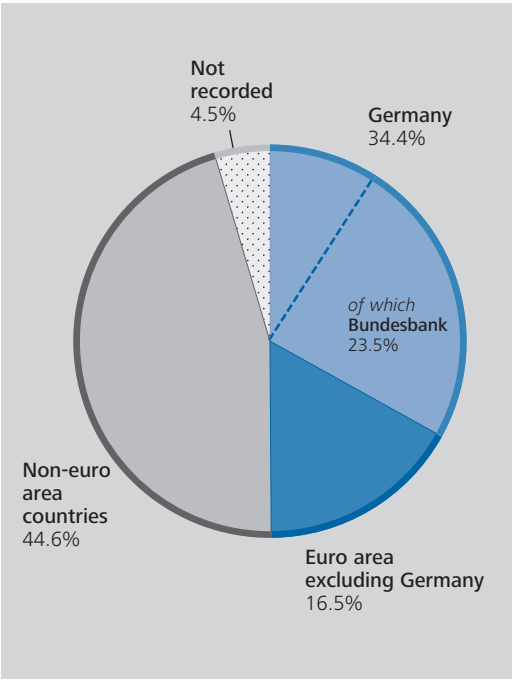
The majority of the Bundesbank's PSPP purchases on the secondary market are conducted in bilateral operations whereby the specific approach depends on the market in question. As a rule, before conducting a purchase transaction, the Bundesbank approaches a large number of counterparties via the common trading platforms and asks them to submit price quotations. In the case of low-volume bonds from issuers that are not regularly active on the capital market (for instance, smaller federal states or agencies), the purchase volume is strongly influenced by the supply of the specific asset. In addition, the Bundesbank has recently started using (twice monthly) auctions to purchase less liquid securities of government agencies as well as of regional and local governments.

As at 30 June 2018, the Eurosystem's holdings of assets purchased under the PSPP had a book value of €2,068 billion, of which around €492 billion were German bonds. This means, on average, around €590 million net of German bonds were acquired each day. Holdings have continued to be built up in line with the requirements defined above. However, in the summer months and at the end of the year, especially, the targets – as mentioned above – are reduced and reallocated to other months in order to take account of the lower market liquidity.

The Bundesbank makes a certain amount of assets that it has purchased under the PSPP available for securities lending. It thereby helps ensure that the market for German Federal bonds (Bunds) remains highly liquid. For this purpose, it uses three demand-driven lending facilities. Clearstream Banking Luxembourg (CBL) offers Automated Securities Lending (ASL) to ensure that borrowers' trades which would otherwise fail are settled on the settlement date, and its strategic lending facility ASLplus enables longer-term operations (maximum term of 35 days) to be concluded at a fixed minimum rate. In addition, the Bundesbank also lends its PSPP holdings via bilateral procedures. The individual design of such procedures may vary within a specified risk framework but the maximum term amounts to seven days. At present, the Bundesbank provides 460 different securities from the PSPP for lending, of which 63 are Federal securities. In June 2018, on average across all Eurosystem lending facilities, around €65 billion worth of bonds were lent to market participants.

Holder structure of Federal securities as at end-2017*

%



Sources: ESCB (SHSS database) and Bundesbank calculations.
* Holder structure of all outstanding Federal securities excluding FMSW bonds and central government off-budget entities.
Deutsche Bundesbank

credit quality and liquidity plus their benchmark status, German government securities remained a highly relevant and attractive investment proposition for international, non-European investors especially. Federal securities also continue to play a key role for the reserve assets of foreign central banks.

Regional and sectoral breakdown of the holder structure of Federal securities

The holder structure of Federal securities can be examined in detail on the basis of the European Securities Holdings Statistics by Sector (SHSS), which are collected in the Eurosystem. The SHSS capture both the proprietary and customer securities holdings of all reporting account-keeping institutions in the euro area. Data from these statistics were available up to the end of 2017 as this article went to press. The SHSS do not include the holdings of the ECB or the euro area national central banks. Combined with the Bundesbank's holdings, just over 95% of the total outstanding volume of Federal securities was captured at the end of 2017 and assigned to the sector and country of the respective holder according to the reporting template shown in the table on page 21. It seems most investors from non-euro area countries also trade German government securities via their own branches or authorised financial institutions within the euro area and accordingly hold the securities in safe custody at resident reporting custodians. One likely reason for this is that better market liquidity is ensured during trading hours at the main trading venue. The SHSS thus facilitate a detailed analysis of the holder structure for German government securities.

Change in the holder structure under the PSPP sheds light on transmission channel

The Eurosystem's purchases under the PSPP led to sharp shifts in the established holder structure of Federal securities. The Bundesbank built up holdings of just under 24% of outstanding German government securities up until the end of 2017.[4] On the basis of changes in holdings as shown in the SHSS, it is possible to deduce which investor groups were net sellers in the market. This, in turn, illustrates the transmission channels through which the purchase programme acts.

Non-residents the main holders

At the end of 2014 – that is, prior to the launch of the PSPP – investors from non-euro area countries held just under 60% of the outstanding Federal securities.[5] This high share, reflecting the importance of German government securities to international investors, was split fairly evenly between the private and public sectors. The public sector notably includes foreign central banks, which use Federal securities as a strategic investment (eg as reserve assets). Just over one-fifth was held by non-German euro area residents, almost all in the private sector. By comparison, German investors held a relatively small share of just under 12%. A little more than half of this (7%) was attributable to the private sector.

4 At the end of 2017, the Bundesbank held €263 billion worth of Federal securities. By the end of June 2018, these holdings had increased to €271 billion.
5 The unrecorded share can probably also be attributed to non-euro area investors for the most part.

Holder structure of Federal securities*

%

Holder	2014	2015	2016	2017
Geographical breakdown				
Germany (incl Bundesbank)	11.6	17.9	26.4	34.4
Euro area excl Germany	20.6	20.0	18.4	16.5
Non-euro area countries	59.8	55.0	48.2	44.6
Not recorded	8.0	7.1	6.9	4.5
Sectoral breakdown				
Private sector				
Germany	7.0	6.8	6.1	5.4
Financial investors	6.0	6.0	5.4	4.9
of which MFIs (banks)	1.6	1.6	1.2	0.8
Investment funds	3.2	3.3	3.1	2.9
Insurance corporations and pension funds	1.1	1.2	1.1	1.2
Non-financial investors	1.0	0.8	0.7	0.5
Euro area excl Germany	19.9	19.5	18.0	16.1
Financial investors	19.6	19.2	17.7	15.9
of which MFIs (banks)	3.4	2.2	2.0	-0.1
Investment funds	7.9	8.7	7.4	7.1
Insurance corporations and pension funds	7.8	7.9	8.0	8.3
Non-financial investors	0.4	0.3	0.3	0.2
Non-euro area countries	31.7	32.2	27.9	25.4
Public sector (central bank and general government)				
Total (all countries)	33.5	34.3	41.1	48.6
Bundesbank (PSPP)	0.0	6.4	15.4	23.5
Free float estimate (from … to …)[1]	49.7-58.6	49.5-58.6	42.9-52.0	37.4-47.0

Sources: ESCB (SHSS database) and Bundesbank calculations. * Holdings at year-end based on nominal values. Securities issued by FMS Wertpapiermanagement and central government's off-budget entities are not included. The figures for "euro area excl Germany" do not contain any own holdings of the ECB or the euro area national central banks. 1 The upper limit of the free float range is calculated as the sum of the total private sector; the lower limit reduces this figure by excluding insurance corporations and pension funds.

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Main PSPP sellers from non-euro area countries

Non-euro area investors significantly scaled back their holdings of Federal securities between the end of 2014 and the end of 2017, reducing them by a total of just over 15 percentage points.[6] Public sector holders from these countries had a major part to play in this decline. This can presumably mainly be put down to sales by China's public sector. This notion is backed up at the very least by the fact that Chinese foreign exchange reserves – the precise composition of which is unknown – shrank by US$700 billion between the end of 2014 and the end of 2017.[7] It is unlikely that these sales were triggered by the start of the PSPP alone. Instead, they coincided with spells of mounting capital outflows from China, which also put the renminbi under pressure.[8] The remaining (private) investors from non-euro area countries reduced their share of Federal securities by just over 6 percentage points, with investors from the United States and United Kingdom dominating this group.[9]

Euro area: mainly banks reduced their holdings

The private sector in the euro area excluding Germany has likewise pared back its percentage share of Federal securities since the end of

6 The aggregate of the PSPP purchases also shows the dominant role of sellers from non-euro area countries. See R S J Koijen, F Koulischer, B Nguyen and M Yogo (2016, revised in 2018), Inspecting the mechanism of quantitative easing in the euro area, Banque de France Working Paper No 601.

7 See People's Bank of China (PBC), The time-series data of China's foreign exchange reserves, 7 June 2018: http://www.safe.gov.cn/wps/portal/english/Data. See C J Neely, Chinese foreign exchange reserves, policy choices and the U.S. economy, Federal Reserve Bank of St Louis Working Paper 2017-001A, p 1: "Although the exact composition of the Chinese foreign exchange reserves is confidential, observers estimate that about 67 percent of the value consists of dollar-denominated assets, mostly U.S. Treasury securities but also many U.S. agency and corporate bonds."

8 See Deutsche Bundesbank, The Eurosystem's bond purchases and the exchange rate of the euro, Monthly Report, January 2017, pp 13-39.

9 The financial centres of London and New York are also behind the high figures in the United Kingdom and United States; many institutional investors are resident there and hold domestic securities on behalf of clients. In these cases, the SHSS data shed no light on the end investor. The SHSS data for non-euro area countries cannot be broken down in more detail, for example by financial and non-financial investors.

2014, with the decrease coming to just under 4 percentage points. Within the sector, financial investors constituted the largest investor group. Investment funds, in particular, initially increased their shares in Federal securities in the run-up to, and at the start of, the asset purchase programme before subsequently becoming net sellers from 2016 onwards and reducing their shares to just over 7% at last count. However, insurance corporations' and pension funds' share in Federal securities rose to a little more than 8%, leading them to supplant investment funds as the largest investor group among financial investors. By contrast, banks from the euro area excluding Germany considerably reduced their comparatively small share, even establishing a small net short position at the end of 2017, on aggregate. A similar picture emerges for German private investors. As is the case with the other euro area investors, insurance corporations' and pension funds' share remained broadly constant, whereas domestic banks scaled back their holdings over this period.

Signs that portfolio adjustment is homogeneous in regional terms, …

Viewed as a global aggregate, the private sector's behaviour was fairly homogeneous. Private financial and non-financial investors, regardless of their home region, have made similar cutbacks to their percentage shares in Federal securities since the launch in the PSPP (between the end of 2014 and end of 2017). Relative to the holdings at the end of 2014, the decline in the private sector ranged from 19% (euro area excluding Germany) through 20% (non-euro area countries) to 23% (Germany).

… but mixed within the financial private sector

When broken down by sector, the figures for the private sector show that private financial investors behaved very heterogeneously. There were significant portfolio shifts. Euro area banks, for example, reduced their percentage shares in Federal securities almost completely (-86%), whereas investment funds made only slight changes (-10%). Insurance corporations and pension funds, on the other hand, even upped their shares (+7%).[10] These varied reactions can also be explained by institutional factors. Unlike the other two sectors, euro area banks have access to the deposit facility, which can be a cheaper and safe alternative to investing in Federal securities.[11] In this sense, the PSPP also had an impact within the euro area via sectoral portfolio adjustments. Based on (absolute) transaction volumes, the portfolio effect was by far the greatest amongst investors from non-euro area countries.[12] In keeping with this, the share of absolute sales was low in the euro area private sector, on account of the small share of just under 27% of the outstanding volume prior to the launch of the PSPP. For the non-euro area countries, the reallocations could also have spread to affect exchange rate developments, in cases where bond sellers shifted into other currencies.[13]

Declining share of freely tradable securities

The share of freely tradable bonds (free float) declined under the PSPP. If free float is defined as the stock available to the private sector except for pension funds and insurance corporations, the volume of securities in free float came to less than 40% at the end of 2017.[14] This represents a decrease of just over 10 percentage points during the purchase programme, which may affect general availability and market liquidity.

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10 For the euro area as a whole, see R S J Koijen, F Koulischer, B Nguyen and M Yogo (2017), Euro-area quantitative easing and portfolio rebalancing, American Economic Review, Vol 107, No 5, pp 621-627.
11 The present analysis does not allow for a statement on how the individual sectors have adjusted their portfolios overall (portfolio rebalancing) under the influence of the PSPP.
12 There is no sectoral breakdown for investors from non-euro area countries, which means that this statement only holds under the assumption that private financial investors from non-euro area countries and from the euro area reacted in similar ways.
13 See Deutsche Bundesbank (2017), op cit.
14 Free float normally refers to the stock that is freely available for trading. It is not possible to gain a clear and complete picture of the investment motives of the sectors. For one thing, the banking sector is also required by regulation to hold highly liquid bonds. For another, sovereign funds tend to be more yield-focused, but are not distinguished from reserve assets in the SHSS.

Federal Government issuance activities and procedures

In Germany, the Federal Ministry of Finance is responsible for the Federal Government's debt management. The primary close-to-market and operational debt management tasks include managing Federal Government borrowing and liquidity, which has been entrusted to Federal Republic of Germany – Finance Agency (referred to here as the "Finance Agency") in Frankfurt am Main since June 2001. The Federal Government, represented by the Federal Ministry of Finance, is the sole shareholder of the Finance Agency. The main task of the Finance Agency is to provide timely, cost-effective and low-risk debt management services for the Federal Government, in particular through the initial issuance of securities in the primary market. At the same time, the Finance Agency's work is intended to cement and further extend the status of Germany's Federal Government as a benchmark issuer in the euro area.

Bundesbank the government's fiscal agent

As the government's fiscal agent, the Bundesbank performs technical debt management duties for the Federal Government, conducting auctions of Federal securities, carrying out market management operations on the German stock exchanges, and settling the Federal Government's securities transactions. These tasks are completed on behalf of and for the account of the Federal Government in coordination with the Finance Agency. It should be noted that, as the Federal Government's fiscal agent, the Bundesbank provides banking services which are strictly separate from its monetary and foreign exchange policy tasks. The Bundesbank does not grant loans when auctioning Federal securities in the primary market, nor does it take Federal securities into its own portfolio. On account of its fiscal agent role, the same applies to secondary market transactions.

Auctions: the main primary market procedure

The primary market is where securities are issued for the first time. It is where the Federal Government covers more than 90% of its annual borrowing requirements by issuing Federal securities in auctions. The Federal Government only commissions a bank syndicate as an alternative channel for issuing Federal securities for a handful of special Federal securities, such as the two US dollar-denominated bonds which were issued in 2005 and 2009 and have since been repaid.

Issuance planning

Market participants and investors value an issuer's continuity, transparency and reliability, and this ultimately pays off for the borrower in the form of favourable borrowing conditions. Auctions of Federal securities planned by the Federal Government over the course of a calendar year are therefore announced by the Finance Agency at the end of the previous year in an annual issuance calendar. The annual preview contains precise details on the Federal securities which will be put up for auction, such as the auction date, the planned issuance volume and the exact maturity date. Additionally, a quarterly issuance calendar is published, which may contain deviations from the annual preview. As an issuer, the Federal Government strives to conduct its announced issuance activities according to its published schedules. However, these plans

may need to be adjusted if borrowing requirements, the Federal Government's liquidity position, or the capital market situation as a whole change significantly during the course of the year.

Maturity profile

The Federal Government's commitment to continuity and reliability means offering Federal securities with an overall balanced maturity profile. First, it weighs the generally lower borrowing costs of revolving short-term debt against the certainty that borrowing in the long-term maturity segment can offer. Second, it takes into account the fact that offering a broad spectrum of maturities on a regular basis allows investors to invest in accordance with their respective duration goals. That way, the Federal Government can be sure of attracting a broad investor base. This is why Federal securities are put up for auction across all maturities: six-month Treasury discount paper ("Bubills") in the money market segment, and in the capital market segment, two-year Federal Treasury notes ("Schätze"), five-year Federal notes ("Bobls") and mainstay ten-year and thirty-year Federal bonds ("Bunds"). Inflation-linked Federal securities ("Bund-Linker") are also auctioned on a regular basis.

Bund Issues Auction Group

Members of the Bund Issues Auction Group, who have been approved by the Finance Agency, are eligible to bid in Federal Government auctions. The group currently comprises 36 credit institutions and investment firms which are established in a member state of the European Union. To remain in the auction group, members must subscribe to at least 0.05% of the total issuance allotted, weighted by maturity, in auctions in any one calendar year. Member institutions which fail to subscribe to this minimum share are required to leave the group at the end of the year. Apart from the minimum share requirement, members have no additional obligations. For instance, they are not expected to provide any market making services in the secondary market – ie quote bid and ask prices for Federal securities or provide mandatory reporting and advisory services for the issuer. On 30 June and 31 December each year, the Finance Agency publishes a list ranking Bund Issues Auction Group members by their share of the weighted issuance volume allotted, without quoting percentages.

Operational implementation

Federal Government auctions take place on the Bund Bidding System (BBS) electronic auction platform provided by the Bundesbank. The Bundesbank is responsible for technical implementation of the auction process; in other words, it announces the auction and the invitation to bid, monitors bidders' submissions on the day of the auction and publishes the auction results. The Finance Agency and the Federal Ministry of Finance both have direct links to the BBS, and they make the economic decisions – ie they determine the allotment conditions such as allotment prices and volumes on the day of the auction. Once the deadline for bids has passed, it is generally the case that the allotment decision is made and the auction results are announced via the BBS and financial information providers within the space of two minutes.

Auction procedure

Allotment is based on what is known as the multiple price method, meaning that the accepted price bids are allotted at the price specified in the respective bid. Non-competitive bids are filled at the weighted

average price of the bids accepted. Bids above the lowest price accepted are allotted in full; those below the lowest price accepted are not considered. Bids at the lowest price accepted and non-competitive bids can be allotted *pro rata* – in other words, bids can also be filled here, albeit only to a limited extent. March 2018 saw the Federal Government use the BBS's new multi-ISIN auction functionality for the first time. This enables multiple Federal securities to be offered to investors in parallel as part of a single auction.

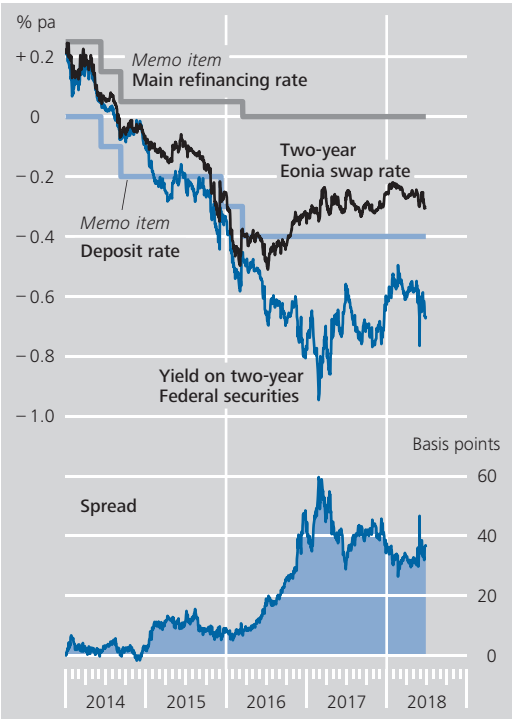
Secondary market activities

The Finance Agency sets aside a share of the securities issued in each auction as proprietary holdings of the Federal Government for secondary market operations. This amount is not defined in advance and varies from one auction to the next. On average, around 20% of the issuance volume is set aside for this purpose. Following the auction, these securities are gradually fed into the market by the Finance Agency in the context of secondary market activities. As a result, counterparties can still purchase Federal securities from the issuer after they have been issued in the primary market. In addition, the issuer might find it beneficial to smooth its borrowing to a degree over time. However, secondary market activities also include secondary market operations on the German stock exchanges, which entail the Bundesbank buying and selling listed Federal securities for the Federal Government's account. These operations aim to achieve fair prices which do not discriminate between different market participants (nor between institutional investors and retail customers) and to maintain liquid trading with low bid-ask spreads. The Bundesbank assists in setting a "Bundesbank reference price" on the Frankfurt Stock Exchange for every listed Federal security on every trading day, which provides an important benchmark, especially for the retail business. This institutional framework plays a part in ensuring that Federal securities can be traded at robust prices that are in line with the market every trading day.

The Federal Government's proprietary holdings can also be used by the Finance Agency to collateralise securities repurchase agreements (repos) and interest rate swap transactions, as well as for securities lending. The Federal Government's securities transactions are settled via the cash and safe custody accounts it maintains with the Bundesbank.

Eonia swap rate, Bund yield and their spread

Daily data



Sources: Bloomberg and Bundesbank calculations.
Deutsche Bundesbank

Scarcity premiums for short-term bonds

Greater scarcity one side effect of the APP

Federal securities have become more scarce for the private sector as a direct side effect of the asset purchase programmes, and their prices have risen. A key question is which investor group is willing to pay the scarcity premiums on Federal securities.

Scarcity premium: the spread between Eonia swap rates and matched-maturity Bund yields

Here, the scarcity premium is defined as the spread between interest rates on swap contracts pegged to the Eonia ("Eonia swap rates" for short) and yields on matched-maturity Bunds.[15] It is worth comparing these two interest rates because Eonia, being the reference interest rate for swap contracts, is an average rate for overnight money in euro interbank transactions which is calculated on the basis of actual transactions. Owing to its short maturity of one day, overnight money has negligible default risk. An interest rate spread between the two instruments therefore does not stem materially from different levels of credit quality. However, contracts based on Eonia swap rates cannot be used as stores of value – unlike government bonds, which are considered safe. This is because, during the term of the contract, only the net interest cash flows based on the notional amount (which is not invested) are swapped. The spread between the Eonia swap rate and bond yield thus also contains a premium for the scarcity of safe investments in times of high excess liquidity.

Growing scarcity since early 2016

By way of example, the scarcity premium can be illustrated by the yield spread between two-year Eonia swap rates and the yield in the two-year maturity category. It is apparent that there is a close connection between Eonia swap rates and bond yields over a longer horizon. But what is striking is that in 2016 only the yield on two-year Bunds systematically fell, leading to the yield spread between the two instruments widening to 60 basis points at its peak by early 2017.

Possible reasons for the widened spread: regulation, …

Possible reasons for this wider spread include the relevant liquidity regulations for banks (Basel III) and the European Market Infrastructure Regulation (EMIR), which, taken in isolation, could have induced stronger and relatively price-inelastic demand for short-term

15 The Eonia (euro overnight index average) is closely linked to the Eurosystem's key interest rates because, in times of a structural liquidity deficit, it is heavily geared towards the main refinancing rate or – in times of high excess liquidity – towards the deposit rate. Interest rate swaps are contracts in which two counterparties agree to exchange a series of fixed interest cash flows for floating interest cash flows at predefined future points in time. The interest cash flows stem from an underlying (but uninvested) amount of money and the agreed fixed and floating interest rates, with the level of the floating interest rate being adjusted at predefined future points in time over the term of the contract. The fixed interest rate is agreed between the counterparties at the beginning of the contract such that the present value of the net payment is zero.

bonds amongst institutional investors.[16] This effect is mitigated by the fact that central bank liquidity can also count towards regulatory requirements and excess liquidity has increased under the PSPP. This is why investors without access to the deposit facility, in particular, are more loath to part with Federal securities. They are willing to pay higher prices for these securities and to accept lower yields. Additionally, the Finance Agency reduced its previously planned issue volume owing to the sound budgetary position in the final quarter of 2016.

… asset purchase programme …

The Eurosystem's asset purchase programmes have probably increased the scarcity of Federal securities across almost all maturities, with both direct and indirect effects likely to be playing a role. The direct effects include purchases of short, medium and long-term German government securities under the PSPP.

… and excess liquidity

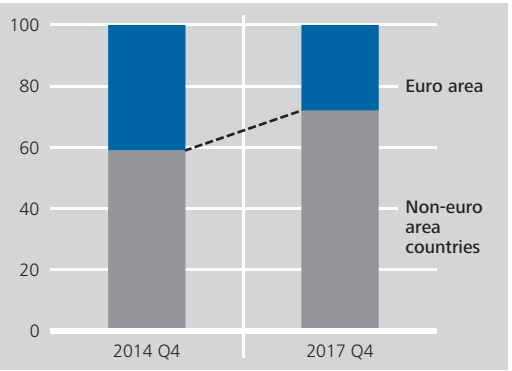
Indirect effects are likely to hit short-term securities first and foremost; they are connected with the mounting excess liquidity caused by the purchase programmes. It is presumed that chiefly market participants without access to the deposit facility – ie non-MFIs and the investors from non-euro area countries that dominate among sellers – invest funds in short-term Federal securities. MFIs appear to offer institutional investors such poor terms for deposits in times of high excess liquidity that the investors prefer to park their funds directly in Federal securities. Furthermore, investors with no access to the deposit facility also, of their own accord, avoid concentration risk stemming from bank deposits with individual institutions and invest funds in short-term Federal securities instead.

Mainly non-euro area investors use short-term securities as a safe store of value

This assumption is backed up by the holder structure. In the case of Federal securities with an original maturity of up to two years, there was a considerable percentage rise in the share of non-euro area investors (without access to the deposit facility) over the duration of the asset purchase programme, although the share of non-euro area countries' holdings of all Federal securities fell over the same period.[17] By contrast, euro area banks with access to the deposit facility reduced their holdings of short-term Federal paper. This means that some banks, unlike insurers, took advantage of the high prices of Federal securities to collect the yield spread between Federal securities and the expected rate of return on funds in the deposit facility. As mentioned above, the interest rate spread between Federal securities and the Eonia swap rate is also attributable to institutional factors in that the banking system does not have to compete for deposits from institu-

Change in holder structure of short-term Federal securities*

%



Sources: ESCB (SHSS database) and Bundesbank calculations.
* Proportion of short-term Federal securities listed in the SHSS at nominal prices with an original maturity of up to two years.
Deutsche Bundesbank

16 One regulatory ratio for banks is the liquidity coverage ratio (LCR). The LCR is a balance sheet ratio of unencumbered high quality liquid assets (HQLA) – which include Federal securities – to total assets. The LCR was phased in over time. The harmonised liquidity requirement for banks has applied EU-wide since 1 October 2015. Another ratio used in banking supervision is the structural liquidity ratio (or net stable funding ratio (NSFR)). It is defined as the ratio of sustainable funding (including equity capital and long-term liabilities) over the required stable funding. However, the NSFR rule only entered into force after the period analysed here. The EU regulation on OTC derivatives, central counterparties and trade repositories (European Market Infrastructure Regulation, or EMIR) of 2012 also contains rules on OTC derivatives trading. It requires open derivatives positions, ie positions where claims and liabilities have not yet been settled, to be collateralised – for example, by government bonds or cash deposits. The regulation entered into force on 1 September 2017 and will be phased in up until 1 September 2020.

17 See also the speech by Benoît Cœuré of 3 April 2017 entitled "Bond scarcity and the ECB's asset purchase programme" at https://www.ecb.europa.eu/press/key/date/2017/html/sp170403_1.en.html

tional investors when excess liquidity levels are high, thus pressuring them, by way of unattractive overall conditions, into investing in Federal securities. For the reasons given above, the observed scarcity premium probably declines in an environment of receding excess liquidity.

Market liquidity in the context of the purchase programmes

High liquidity important for effective implementation of the PSPP

High market liquidity is important for the effective implementation of the PSPP. However, the decline in Federal securities in free float reduced the volumes available for trading and thus, potentially, market liquidity. However, market liquidity is a multifaceted concept, and academic researchers, market participants and policymakers have yet to reach a consensus on how to measure it. Typically, there are three dimensions of market liquidity: "width" (cost of executing a trade at a given volume), "depth" (the tradable volume at a given price) and "resiliency" (the half-life of random price fluctuations). In view of the complexity of the concept, no individual ratio covers all aspects of market liquidity.

Declining trading volumes and more fragmented trading point to decrease in liquidity

Federal securities trading activity has been in decline since the 2000s, notably due to the effects of the financial and economic crisis. In the spot market, according to Finance Agency statistics, annual gross trading volumes transacted by the members of the Bund Issues Auction Group fell from more than €7,000 billion in 2005 to less than €5,000 billion in 2017.[18] Although the outstanding bond volume rose from 2005 onwards, 2016 saw the lowest trading volume in the spot market. The PSPP may also have played a part in this development. In the Eurex futures market, the volume of futures contracts with Federal securities as the underlying has also been lower since the financial crisis. Against this backdrop, trading in both the spot and futures markets has also grown somewhat more fragmented. This is borne out by the fact that trades have involved increasingly smaller transaction volumes over time. In particular, large transactions have become more expensive and thus less frequent.

Decentralised trading structure makes quantitative analysis difficult

Quantitative analyses are made more difficult by the fact that bonds are mostly traded over-the-counter (OTC); in other words, trading is conducted in a decentralised manner directly between market participants. Compared with listed shares, bond trading is therefore more fragmented, and scarcely any data on prices and volumes are available that are representative of the market. In addition to traditional bilateral telephone trading, more and more OTC transactions are being conducted on electronic trading platforms.

Limit order book as a further source of data

Individual operators of electronic trading platforms use a central order book with limits (known as a limit order book) to settle bond purchases. Buying and selling bids with the respective prices and quantities are collected in these limit order books. Since every bid is binding, a robust picture of the market is obtained which allows in-depth analyses. However, relatively low volumes are traded on trading platforms compared with OTC trading, which means that the results need to be put into perspective.

Order book illiquidity contains the liquidity dimensions width and depth

A ratio known as order book illiquidity, which can be determined on the basis of information on the limit order book, is of interest when analysing liquidity. This ratio contains the liquidity dimensions width in the numerator and depth in the denominator. The width of the order book corresponds to the average bid-ask spread of the five closest buy and sell orders. The depth of the order book, meanwhile, is derived from the total volume of these five bid and ask prices, respectively. Order book illiquidity rises as bid-ask spreads widen and volumes

18 When calculating volumes traded, trades transacted between members of the Bund Issues Auction Group are counted twice for statistical purposes. Transactions in which no member of the group is involved, on the other hand, are not included in the statistics.

decline.[19] This makes it more informative than a simple spread of the bid and ask prices that are closest together.

Increase in order book illiquidity since 2016

In the data used here, which are from the trading platform MTS (Mercato telematico dei Titoli di Stato) for the period from January 2014 to the end of June 2018, the difference between the simple bid-ask spread (between the best buying and selling price) and the order book illiquidity becomes clear. The simple bid-ask spread shows no clear trend. In contrast to this simple spread, it may be seen that the order book illiquidity for ten-year Bunds increased from the beginning of 2016. This was primarily due to the decline in order book depth. The corresponding width across the five best prices increased only slightly. The calculations based on the order book entries thus confirm the indications that the market liquidity for larger trading volumes has deteriorated.[20]

The Eurosystem uses securities lending to counter short-term illiquidity

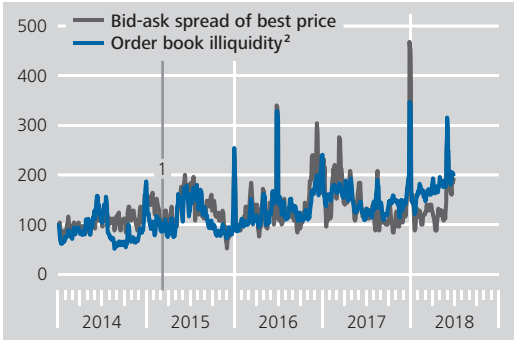
Spikes in the simple bid-ask spread as well as in order book illiquidity were found at the end of both 2016 and 2017. These spikes coincide with strong negative secured money market rates in the repo market over the balance sheet dates. However, these year-end effects were of a rather temporary nature and had no lasting impact on the repo market itself or on the liquidity of the government bond market. Ultimately, the Eurosystem's securities lending facilities, through which a certain amount of the securities purchased by the Eurosystem are made available for securities lending, are likely to have also contributed to this.[21] The lending plays a part in the fact that when demand for a specific paper is high, its supply can be temporarily increased. In this way, the market for German Federal securities as a whole can be kept highly liquid (see the box on pages 17 to 19).

In general, the functioning of the Bund market is not impaired

There is no indication of a fundamental impairment of the effective functioning of the market as a result of the PSPP in the segment considered here of recently issued ("on-the-run") bonds. Only in connection with larger trading volumes have some cases of deteriorating liquidity been observed since 2016. Beyond the on-the-run bonds considered here, there are also signs that the depth and resiliency of liquidity decrease in bonds purchased by the central bank, particularly older ones.[22]

Market liquidity

9 March 2015 = 100,[1] five-day moving averages



Sources: MTS and ECB calculations. **1** Date of the first bond purchases under the PSPP. **2** Order book illiquidity is a quotient of the width of order book liquidity (average bid-ask spread of the five closest buy and sell orders in the order book) and the depth of order book liquidity (sum of the volumes offered at these five bid and ask prices in the order book).

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Factors affecting the development of Bund yields

Factors affecting the development of Bund yields over a longer term

In the period after the PSPP was launched, liquidity and scarcity premiums rose somewhat on the whole in the Bund market. However, it is important for monetary policy to identify general macro, financial market and economic variables which have an impact on Bund yields. For this reason, it makes sense to take a some-

19 See ECB, Euro area sovereign bond market liquidity since the start of the PSPP, Economic Bulletin, Issue 2/2018, Box 2. Details may be found here on how to determine order book illiquidity and the underlying data of the provider MTS. The second-most recently issued ten-year Bund is considered in each case.

20 The rise in order book illiquidity is not reflected in the euro area aggregate. In the euro area as a whole, the share of APP purchases in relation to the outstanding volume is lower than for German paper, however.

21 For information on the role of the Eurosystem's securities lending in the repo market, see W Arrata, B Nguyen, I Rahmouni-Rousseau and M Vari (2017), Eurosystem's asset purchases and money market rates, Banque de France Working Paper No 652.

22 See K Schlepper, H Hofer, R Riordan and A Schrimpf, Scarcity effects of QE: a transaction-level analysis in the Bund market, Deutsche Bundesbank Discussion Paper, No 06/2017.

what longer view in order to examine factors affecting the development of Bund yields beyond the PSPP. To this end, the previously mentioned special developments arising in connection with the PSPP (scarcity and liquidity premium) are also taken into consideration. In addition, factors such as monetary policy as a whole (interest rate movements and PSPP), international effects and safe haven flows are also looked at more closely.

Bund yields down considerably overall, but yields also up at times

In conjunction with global interest rates, Bund yields fell considerably overall in the last few years. Yields also rose strongly at times, however. Two examples of phases of strongly increasing yields are the taper tantrum in the United States in 2013, which also affected Bund yields, and the Bund tantrum in spring 2015. The following analysis therefore also examines the extent to which the selected determinants may, during the two tantrum phases, have given rise to special factors which contributed to the temporary surges in yields.

Determinants of the estimation: …

The following individual factors are taken into account:

… slope of the Eonia swap rate curve measures policy rates expectations, …

– According to the expectations hypothesis of the term structure, the slope of the Eonia swap rate curve at the short end, calculated as the two-year Eonia swap rate minus the one-month Eonia swap rate (Slope_Eonia), is an indicator of future changes to short-term interest rates over the next two years and thus also of the expected path of future key interest rates.[23] Because central banks take economic activity and price developments into account when setting interest rate policy, this could indirectly also reflect the economic and inflation outlook. The slope of the Eonia swap rate curve is expected to have a positive impact on the (ten-year) Bund yield (Bund_Interest).

… the US interest rate measures the interest rate relationship, …

– The interest rate relationship with the United States is measured in terms of the yield of ten-year US Treasuries (US_Interest). US yields lagged by one stock exchange trading day are used to capture a potential impact of US yields on Bund yields in order to allow for the time difference between the USA and Germany. The impact of US yields is expected to be positive.

… the yield spread of government-guaranteed bank bonds measures the liquidity premium on Bunds, …

– The particularly high market liquidity of Bunds is measured as the difference between the yield of bonds issued by public promotional banks, such as Kreditanstalt für Wiederaufbau (KfW), and German Bunds. This means that, in contrast to the bid-ask spread, it is not an absolute but a relative measure of market liquidity. This measure takes into account not only the particularly high market liquidity of ten-year benchmark bonds, but also the general, maturity-independent liquidity advantage of Bunds. To this end, first the yield spread between the bonds of public promotional banks and Bunds is calculated for every full-year maturity between one and ten years.[24] A principal component analysis is then carried out to calculate the first principal component of the maturity-specific spreads, which then serves as a measure of the maturity-independent liquidity premium of Bunds (PC_Liquidity).[25] It is expected to have a negative impact on Bund yields.

– A potential scarcity of Bunds is interpreted as a response to excess demand which, like the liquidity premium, drives yields below

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23 According to the expectations theory of the term structure, the long-term interest rate is dependent only on the current short-term interest rate and the expected future short-term interest rates, whereas possible term premiums are disregarded. As term premiums play only a minor role in the short-term maturity spectrum, the slope of the yield curve in this segment probably mainly reflects the expected path of the short-term interest rate. This is in line, for example, with empirical evidence on US swap rates; see S Sundaresan, Z Wang and W Yang (2017), Dynamics of the expectation and risk premium in the OIS term structure, Kelley School of Business Research Paper No 17-41. See also S P Lloyd (2018), Overnight index swap market-based measures of monetary policy expectations, Bank of England Staff Working Paper No 709.

24 Data are not available for six-year bonds issued by public promotional banks. The yield spreads can therefore only be calculated for the other full-year maturities.

25 The first principal component explains 84% of the total variance.

… Eonia swap spreads measure potential scarcity premiums, …

the risk-free interest rate. The resulting scarcity premiums are reflected, for example, in the repo market[26] and in the difference between Eonia swap rates and Bund yields, which was discussed above in connection with the holder structure. In order to quantify general, maturity-independent scarcity premiums, the difference between the respective Eonia swap rates (as a measure of the risk-free interest rate) and Bund yields is calculated for each full-year maturity between one and ten years. As a measure of the scarcity premium, the first principal component of these maturity-specific Eonia spreads is factored into the estimation (PC_Scarcity).[27] It should have a negative impact on yields.[28]

… and the VDAX measures equity market uncertainty

– Lastly, the estimation takes into account the possible impact on Bund yields that may result from portfolio shifts by investors following a change in equity market uncertainty. The VDAX volatility index, which measures the implied volatility of the DAX calculated from options, is used as a measure of equity market uncertainty. The VDAX should have a negative effect on Bund yields.

This estimation is based on daily data, whereby all of the variables are measured in first differences in order to rule out the possibility of non-stationarity. The observation period from the beginning of 2012 until 23 May 2018 is selected such that it covers the impact of the sovereign debt crisis as well as the two tantrum phases. In order to avoid autocorrelation in the residuals, all estimations are supplemented by a lagged term for the Bund yield.

Scarcity premiums and slope of the Eonia swap rate curve are the key explanatory factors

The selected determinants explain 65% of the total dispersion of Bund yields.[29] All of the estimated coefficients have the expected sign and are significant at least at the 5% level (Estimate 1 in the table on page 32). The results suggest that the scarcity premiums and the slope of the Eonia swap rate curve both have a particularly important impact. In order to assess the strength of the effects, it is useful to standardise the estimated coefficients such that they reflect the impact on the dependent variable in standard deviations. A standardisation of this kind reveals that an increase in the scarcity premiums by one standard deviation lowers the Bund yield by 0.48 of a standard deviation. A slightly weaker (positive) effect (0.40 of a standard deviation) is derived for the slope of the Eonia swap rate curve.[30]

Possible reasons for the scarcity of Bunds

The reported effect of the scarcity premiums, which have risen considerably since the beginning of 2016, implies that they dampened yields in the last two years in particular. This effect apparently stemmed from scarcity premiums not only in the ten-year maturity segment but also at the shorter end, where the scarcity was particularly pronounced. Possible reasons for this are the above-mentioned growth in demand among institutional investors in a number of maturity segments, the Eurosystem's increased holdings as well as the rising levels of excess liquidity in the banking system.

Influence of the slope of the Eonia swap rate curve

The strong influence also exerted by the slope of the Eonia swap rate curve at the short end underlines the importance of expectations re-

26 In the repo market, repo rates below the deposit rate, for example, indicate scarcity premiums on the underlying Bunds. The scarcity of an individual bond is expressed, moreover, in its specialness premium. This represents the difference between the repo rate for the general collateral trade (where the collateral is only required to meet general quality standards) and the repo rate for the specific collateral (where a specific individual bond constitutes the collateral).
27 The first principal component explains 89% of the total variance.
28 In addition to the other full-year Bund yields, yields on ten-year Bunds are also factored into the measures used for the maturity-independent scarcity and liquidity premiums (the first principal components) in each case. An endogeneity problem cannot therefore be categorically ruled out. As this impact is relatively low for both measures, however, the possibility of such an endogeneity problem appears to be negligible.
29 Including the lagged value for the Bund yield in the estimation equation is immaterial for the coefficient of determination. This is demonstrated by a further estimation without a lagged Bund yield, with robust standard errors (Newey-West method).
30 As all of the variables are measured in first differences, the standard deviations also refer to the differences in the variables.

Determinants of ten-year Bund yields°

	Estimate 1		Estimate 2		Estimate 3	
Explanatory variable	Coefficient	p value	Coefficient	p value	Coefficient	p value
C	0.00*	0.05	0.00*	0.04	0.00*	0.01
Bund_Interest(–1)	– 0.05*	0.00	– 0.05*	0.01	– 0.05*	0.00
US_Interest(–1)	0.19*	0.00	0.19*	0.00	0.19*	0.00
US_Interest(–1) × Taper_Tantrum			0.01	0.86		
US_Interest(–1) × Bund_Tantrum					0.12	0.50
Slope_Eonia	0.99*	0.00	0.97*	0.00	0.95*	0.00
Slope_Eonia × Taper_Tantrum			0.17	0.34		
Slope_Eonia × Bund_Tantrum					2.51*	0.00
PC_Scarcity	– 0.02*	0.00	– 0.02*	0.00	– 0.02*	0.00
PC_Scarcity × Taper_Tantrum			– 0.01*	0.01		
PC_Scarcity × Bund_Tantrum					0.03*	0.05
PC_Liquidity	– 0.01*	0.00	– 0.01*	0.00	– 0.01*	0.00
PC_Liquidity × Taper_Tantrum			0.01*	0.01		
PC_Liquidity × Bund_Tantrum					– 0.05*	0.00
VDAX	– 0.31*	0.00	– 0.34*	0.00	– 0.32*	0.00
VDAX × Taper_Tantrum			0.68	0.06		
VDAX × Bund_Tantrum					– 0.84*	0.01
Adj R^2	0.65		0.66		0.67	

o The regression (estimated in differences) is based on daily data from 2 January 2012 to 23 May 2018. The dependent variable is the ten-year Bund yield (Bund_Interest). US_Interest is the yield on ten-year US Treasuries. Slope_Eonia is the slope of the Eonia swap rate curve at the short end (two-year Eonia swap rate minus one-month Eonia swap rate). PC_Scarcity and PC_Liquidity are each the first principal component of a principal component analysis which factors in the differences between Eonia swap rates and Bund yields and the yield spreads of guaranteed bank bonds over Bunds. VDAX is the volatility index. Taper_Tantrum and Bund_Tantrum are dummy variables for the taper tantrum and Bund tantrum. * Significant at the 5% level.

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garding the future path of key interest rates over the next two years. This applies not only to the monetary policy environment up until the end of 2014, which was characterised by falling central bank interest rates, but also to the period thereafter, when central bank rates were already close to zero and unconventional measures shaped monetary policy.[31]

Effects of US yields, liquidity premiums and the VDAX

Compared with the scarcity premiums and the monetary policy stance, US yields and liquidity premiums constitute weaker, yet still important, determinants of Bund yields.[32] The reported impact of US yields illustrates the importance of international capital flows and of the transatlantic interest rate linkage. As US yields lagged by one day are used for the estimation, the reported impact also implies a leading indicator property of US interest rates, which are reflected in Bund yields with a time lag.[33] Compared with the other determinants, the VDAX has a weaker impact on Bund yields.[34] However, that does not rule out the possibility that demand for Bunds as a safe haven is particularly strong in periods of heightened uncertainty (see the box on pages 33 to 37).

31 A further estimation for the subperiod from the beginning of 2015 indicates that the Eonia swap rate curve had a similarly strong effect even after the decision for the PSPP was adopted in January 2015.
32 Measured in terms of standard deviations, they amount to 0.24 of a standard deviation for US yields and 0.23 of a standard deviation for the liquidity advantage.
33 This leading indicator property does not exclude the possibility that yields on Bunds and US yields influence one another, however. See also S E Curcuru, M De Pooter and G Eckerd (2018), Measuring monetary policy spillovers between U.S. and German bond yields, International Finance Discussion Papers 1226; and Deutsche Bundesbank, International linkage of interest rates and the national term structure, Monthly Report, October 2007, p 28.
34 An increase by one standard deviation in the VDAX (measured in differences) lowers Bund yields (measured in differences) by 0.11 of a standard deviation.

How safe haven effects impact on Bund yields – a SVAR analysis

Times of crisis tend to depress the yields of German Federal bonds (Bunds) as investors often take flight to "safe havens" where they can evade the heightened uncertainty. But Bund yields are not the only variables that adjust in response to critical situations – other macroeconomic and financial variables are also affected, and in some cases interdependencies exist as well. Structural vector autoregression (SVAR) models can be used to shed light on these adjustment processes from an econometric vantage point.

Risk-averse households respond to a sudden onset of heightened uncertainty[1] surrounding future economic developments by reducing expenditure and building up financial buffers (precautionary saving effect). Enterprises, meanwhile, are more reluctant to make investments (eg real options effect) or hire new employees, with the result that they largely retain the revenue they earn.[2] The ultimate outcome of these two effects is a weakening of real economic activity with something of a time lag. Funding conditions might also tighten (financial constraints). Unlike real economic variables, prices and quantities in financial markets respond immediately to episodes of heightened uncertainty because investors instantly step up their demand for safe yet liquid alternatives. They also tend to switch between asset classes as securities generating more volatile cash flows in a less certain economic backdrop fall out of favour compared with assets with steady and reliable disbursement profiles. This response to heightened uncertainty is known as the flight to safety or quality, and also as safe haven flows.

Government bonds normally account for the bulk of safe (and liquid) securities.[3] As a result, a flight to safety event will typically depress the prices of equities, say, and push up government bond prices, thus reducing their yields.[4] To study the impact of an unexpected flight to safety event on Bund yields, it is important to account for any interdependencies that might exist between a given uncertainty measure, financial market variables and real economic variables. For example, (unexpected) monetary policy

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1 Strictly speaking, uncertainty denotes the inability of economic agents to determine a probability distribution for uncertain future events – ie they are unable to assign specific probabilities to a potential set of events. This is where uncertainty differs from risk, where economic agents are aware of, or can at least estimate, a probability distribution over a set of events. See N Bloom (2014), Fluctuations in uncertainty, Journal of Economic Perspectives 28(2), pp 153-176. As discussed in Bloom (2014), the term "uncertainty" will be used in this box text more as a combination of these two concepts, given the empirical difficulties involved in distinguishing them from one another.

2 See N Bloom (2009), The impact of uncertainty shocks, Econometrica 77(3), pp 626-685; and S Basu and B Bundick (2017), Uncertainty shocks in a model of effective demand, Econometrica 85(3), pp 937-958. For more on how elevated aggregate uncertainty impacts on enterprises' cash holdings, see J Gao, Y Grinstein and W Wang (2017), Cash holdings, precautionary motives, and systematic uncertainty, Indiana University.

3 An increase in money market instruments (such as transferable deposits) is another factor in this regard. See L Baele, G Bekaert, K Inghelbrecht and M Wei (2013), Flights to safety, NBER Working Paper No 19095.

4 See R B Barsky (1989), Why don't the prices of stocks and bonds move together?, American Economic Review 79(5), pp 1132-1145; or G Bekaert, E Engstrom and Y Xing (2009), Risk, uncertainty and asset prices, Journal of Financial Economics 91(1), pp 59-82. Another term used frequently in spells of heightened financial market stress is "flight to liquidity". Flights to liquidity can also be observed during bouts of elevated market uncertainty, in the form of portfolio reallocations into highly liquid securities, which particularly include government bonds. See D Vayanos (2004), Flight to quality, flight to liquidity, and the pricing of risk, NBER Working Paper No 10327. It is not always possible to clearly distinguish flights to liquidity from flights to safety, which is why flights to liquidity are often included in the flight to safety category.

decisions might also have a bearing on uncertainty.[5] Furthermore, there is a strong correlation between the financial risk which financial intermediaries are willing to bear, on the one hand, and uncertainty, on the other.[6] Thus, if the uncertainty measure is used in isolation to explain yields without considering potential interdependencies, one might conclude – incorrectly – that a flight to safety event has occurred. The aim, then, is to identify an unexpected increase in uncertainty (an exogenous uncertainty shock) as a factor driving the flight to safety. Hence the use of a structural vector autoregression (SVAR) model, as it is known, as an econometric methodology, which explicitly considers interdependencies between variables and is capable of depicting the dynamic processes of adjustment to economically interpretable innovations (shocks).[7]

The uncertainty measure used in this analysis is the VIX implied volatility index derived from options on the S&P 500, a broad US equity index.[8] Other variables included in the SVAR after the VIX are industrial production for the euro area (in logs), the rate of inflation for the euro area, the Euro Stoxx equity index (in logs), the yield of corporate bonds,[9] the short-term shadow rate,[10] the yield of ten-year Austrian government bonds, and the yield on ten-year Bunds. The observation period begins in January 2007, ie before the onset of the financial crisis, and ends in March 2018.[11] All variables are included at a monthly frequency.[12] The chosen ordering – putting macroeconomic variables ahead of interest rates and financial market variables – is standard in

5 See G Bekaert, M Hoerova and M Lo Duca (2013), Risk, uncertainty and monetary policy, Journal of Monetary Policy 60(7), pp 771-788. The authors show that an unexpected accommodative monetary policy measure (expansionary monetary policy shock) reduces uncertainty.

6 Hence the need to distinguish between financial shocks and uncertainty shocks. See D Caldara, C Fuentes-Albero, S Gilchrist and E Zakrajšek (2016), The macroeconomic impact of financial and uncertainty shocks, European Economic Review 88, pp 185-207.

7 The identification scheme is the Cholesky decomposition, which assumes that shocks to a variable affect all the other variables ordered afterwards in the same period, but only have a lagged impact on variables ordered beforehand.

8 Implied equity market volatility generally includes both uncertainty and risk aversion. However, since uncertainty dominates the variance in implied equity market volatility, it would appear that implied equity market volatility is a good proxy for uncertainty. See G Bakaert, M Hoerova and M Lo Duca (2013), op cit; and G Bekaert and M Hoerova (2014), The VIX, the variance premium and stock market volatility, Journal of Econometrics 13(2), pp 181-192. It is nonetheless worth noting that the measure used here for uncertainty also includes risk aversion. The reason for using the US equity market here is that the US has the most significant capital market worldwide. The VIX is, however, highly correlated with the implied volatility for the DAX (VDAX-NEW) or the Euro Stoxx (VStoxx).

9 The iBoxx non-financials BBB index for bonds with a residual maturity of between seven and ten years is used.

10 More information on shadow rates can be found in L Krippner (2015), Zero lower bound term structure modelling: a practitioner's guide, New York, Palgrave Macmillan US. They are also discussed in Deutsche Bundesbank, Monetary policy indicators at the lower bound based on term structure models, Monthly Report, September 2017, pp 13-34. The time series used (last accessed on 25 May 2018) can be found at https://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-of-international-monetary-policy-measures

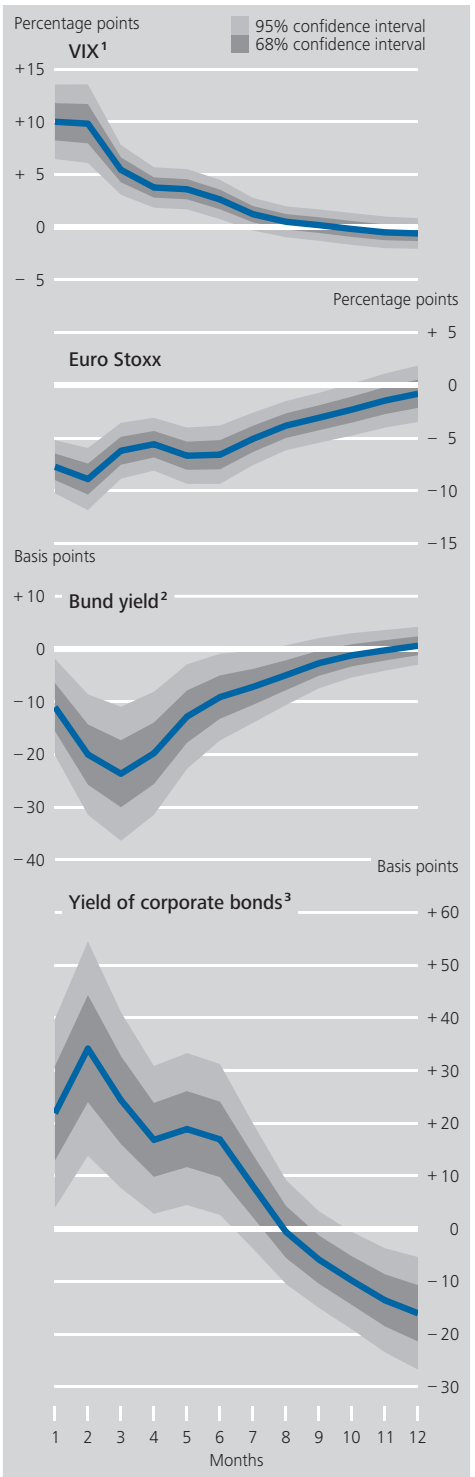
11 The end of the observation period is determined by data availability constraints. The shadow rate and the yields on corporate bonds, Austrian government bonds and Bunds all follow a clear downward trend during the observation period. This is derived using a Hodrick-Prescott filter. The SVAR therefore provides an explanation for deviations from this downward trend. The trend itself cannot be explained by the approach chosen. Further information on explanatory approaches for the trend can be found in Deutsche Bundesbank, The natural rate of interest, Monthly Report, October 2017, pp 27-42.

12 This means that flight to safety events which are more protracted and therefore feed through to real economic variables can be identified better. Using data at shorter intervals will tend to capture short-term flight to liquidity events. Monthly averages derived from daily data are used for the VIX, the equity index and yields.

the literature.[13] Uncertainty is ordered first in the SVAR.[14] This allows us to interpret that uncertainty shocks generally impact simultaneously on all the variables that follow them, but that all the other shocks only affect the uncertainty indicator with a time lag.[15] The equity market indicator is ordered before the yields of corporate bonds. The rationale behind this is that equity prices include more of a forward-looking component and can thus capture expectation effects surrounding economic developments that lie in the more distant future. Bund yields are ordered last so that all the other structural innovations which impact on Bund yields can be captured in the same period. Finally, the yield of Austrian government bonds is included to measure the yield spread between two government bonds which have an identical AAA rating and thus have the same credit quality. Any difference that might arise can thus be expected to reflect the benchmark status of Bunds in addition to possible market liquidity effects. The identification of the uncertainty shock is highly robust to changes in the order.[16]

The uncertainty shocks estimated and identified using the procedure outlined above show the responses typical to a fight to safety event discussed at the beginning of

Impact of an increase in uncertainty on financial market variables*



* Impulse response functions based on a vector autoregression model. Confidence intervals bootstrapped. **1** Implied option volatility of the S&P500 index for contracts with a maturity of 30 days. **2** Residual maturity of ten years. **3** Based on the iBoxx non-financials BBB index for bonds with a residual maturity of between seven and ten years.

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13 In a Cholesky decomposition, the ordering of variables has a bearing on the identification of the driving structural innovations. However, the ordering used here is of secondary importance for the uncertainty shock, which is ordered first, and only relates to the interpretation of the other shocks, which are not discussed in any further detail here.

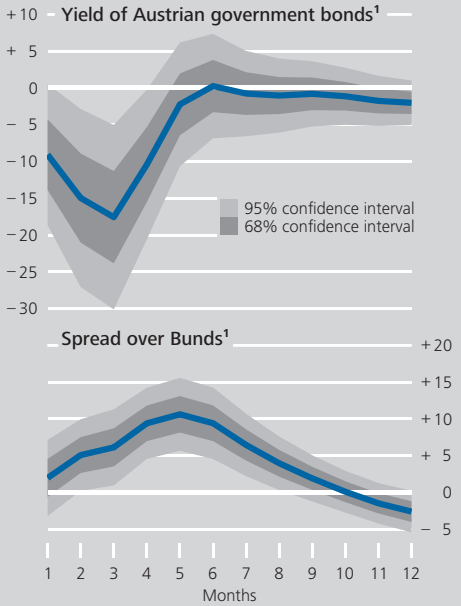
14 The SVAR is estimated using the ordinary least squares (OLS) approach. As an alternative, it is also possible to use Bayesian techniques to estimate the SVAR. However, since the estimation results do not differ substantially, the results are based on the OLS estimation.

15 See S Basu and B Bundick (2017), op cit; or D Caldara, C Fuentes-Albero, S Gilchrist and E Zakrajšek (2016), op cit.

16 Only if equity prices are ordered before the uncertainty measure does the structural shock to equity prices ultimately capture the uncertainty shock.

Impact of an increase in uncertainty on the yield of Austrian government bonds*

Basis points



* Impulse response functions based on a vector autoregression model. Confidence intervals bootstrapped. **1** Residual maturity of ten years.

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Importance of the increase in uncertainty for financial market variables (forecast error variance decomposition)*

%

Item	Yield after …			
	1 month	6 months	1 year	2 years
Bund yield1	9.6	22.9	22.9	22.5
Austrian government bond yield1	5.9	10.6	10.2	9.9
Equity prices	59.5	56.2	35.2	19.8
Corporate bond yield	22.8	25.4	20.3	19.0

* Table shows the importance of the uncertainty shock for the forecast error variance as a percentage at different points in time. **1** Residual maturity of ten years.

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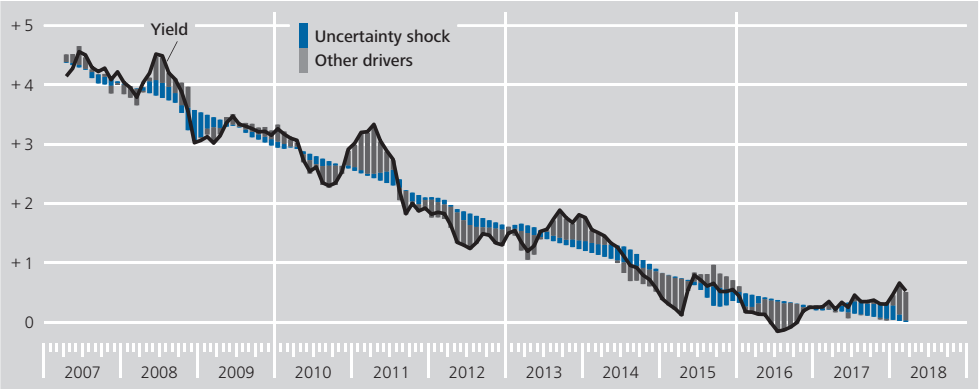
this box text (see the chart on page 35). Taken in isolation, an unexpected increase in uncertainty, measured in terms of a 10-percentage-point[17] increase in the VIX, depresses equity prices by just over 8%. Prices of risk-bearing non-financial corporate bonds likewise come under pressure, their yields climbing by as much as 30 basis points at their peak. That is, investors lower their valuations of assets whose (expected) cash flows have become more uncertain and "take flight" from these assets. As uncertainty recedes in the months that follow, equity prices recover and the yields of corporate bonds decline again. During this flight to safety, ten-year Bund yields fall initially by a little more than ten basis points. Yields decline even further over the course of the next half-year, depressing Bund yields by almost 25 basis points compared to the base level. This lagged response probably shows that flights to safety identified at monthly intervals do not end abruptly. It is also worth noting that Bund yields decline more sharply than the yields of Austrian government bonds with identical maturities (see the adjacent chart). While the shape of the responses is quite similar, the yields of ten-year Austrian government bonds fall less sharply – with a peak decline of just under 20 basis points. Note also that Bund yields take more time to recover than their Austrian counterparts. The spread between both yields therefore widens to a little more than ten basis points after roughly half a year.[18] The uncertainty shock – the driver behind flight to safety episodes – explains almost 10% of the forecast error variance of Bund yields in the first month, compared to just over 6% at most in the case of Austrian government bond yields (see the adjacent table). At the six-month horizon, the shock explains more than twice as much of the forecast error variance of Bund yields (just over 23%) compared to Austrian government bond yields (almost 11%). Over the long run, almost one-quarter of the forecast error variance of Bund yields can be ac-

17 This corresponds to roughly one standard deviation of the VIX in the observation period.

18 There is evidence that the different responses shown by the respective yields are statistically significant.

Decomposition of the yield of ten-year Bunds into its determinants*

Yield as a percentage and trend deviations in percentage points



* Yield deviation from its trend decomposed into the contribution of uncertainty shocks (driving the flight to safety) and the contribution of other drivers.

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counted for by the flight to safety.[19] The fact that Bunds show a stronger response to flight to safety events than their Austrian counterparts ultimately reflects the Bund's status as a benchmark security.

Flight to safety events occur whenever uncertainty rises (exogenously). This is why Bund yields usually edge lower during such episodes. The financial crisis, in particular, played a major role during the observation period because it can ultimately be interpreted as a combination of uncertainty and financial shocks.[20] After peaking at just over 4.5% in July 2008, Bund yields declined by a little more than 1.5 percentage points between October 2008, when the financial crisis came to a head, and December of that year (see the above chart). Flight to safety events during this period contributed roughly -1 percentage point to the decline in yields. During the sovereign debt crisis, a number of euro area countries went through spells in which flight to safety effects depressed Bund yields by roughly 50 basis points. While it would be wrong to dismiss a decline of this magnitude out of hand, uncertainty shocks were not the main driver behind the spreads of countries with poorer credit ratings observed during the sovereign debt crisis.

19 In a VAR, the path followed by variables is determined by exogenous drivers (shocks), allowing for interdependencies between the variables. This means that, following a shock in one period, it is possible to forecast the future development of variables. The difference between realised outcomes in a given period and their values forecast earlier (forecast errors) can be attributed to new shocks. As a result, the forecast error variance is linked to the variance of the variables that arises from the impact of the various shocks in each period and the feedback effects embedded in the model.

20 For evidence for the United States, see D Caldara, C Fuentes-Albero, S Gilchrist and E Zakrajšek (2016), op cit.

Analysis of the taper and Bund tantrums

Dummy variables measure taper and Bund tantrums

In the following, two further estimations examine the extent to which the chosen determinants had a stabilising effect on Bund yields during what are referred to as the taper tantrum and the Bund tantrum. To this end, the duration of both tantrums is defined in such a way as to fully cover the two (local) periods of rising interest rates. The time span from 3 May 2013 until 11 September 2013 is set for the taper tantrum; the Bund tantrum is defined as lasting from 17 April 2015 until 10 June 2015. For the further estimations, a dummy variable is then defined for each of the two tantrums, which are combined with the determinants (Taper_Tantrum, Bund_Tantrum).

Liquidity premiums during the taper tantrum insignificant

For the phase of the taper tantrum, the results indicate a significantly lower sensitivity of Bund yields to their market liquidity and to equity market uncertainty, as well as a heightened sensitivity to the scarcity premiums (Estimate 2 in the table on page 32). Thus, neither the liquidity premiums, which actually widened during the tantrum, nor equity market uncertainty had a significant impact on yields overall during this phase. Apparently, market liquidity and events in the equity markets were insignificant for the increase in yields at that time, while scarcity premiums, which were somewhat lower on balance, played an above-average part in this respect. No changed effects are found for the other determinants. Interestingly, this also applies to the (at that time, sharply rising) US yields, which continued to be reflected strongly in Bund yields.

The significant rise in Bund yields during the Bund tantrum by almost one percentage point probably largely reflects the fact that market participants at the time felt the previous decline in yields to be excessive and corrected it very quickly. The estimation results provide information on the respective contributions of the selected determinants. They point to a temporary, considerably weaker (and ultimately, therefore, to an insignificant) impact of the scarcity premiums and, at the same time, to significantly stronger effects stemming from the slope of the Eonia swap rate curve, the liquidity premiums and the VDAX (Estimate 3). Thus, the slope of the Eonia swap rate curve at the short end gained just under 10 basis points during the Bund tantrum, to which long-term Bund yields reacted particularly sensitively. At the same time, the liquidity advantage and equity market uncertainty decreased somewhat. This, coupled with the heightened sensitivity of Bund yields to these two variables, likewise made a significant contribution to the sharp rise in Bund yields.

Scarcity premiums and slope of the Eonia swap rate curve have particularly strong impact during Bund tantrum

Conclusion

The analysis of possible drivers of yields of ten-year Bunds reveals, in particular, that scarcity premiums were among the main determinants in explaining yield movements of late. These results therefore reflect the shifts in the holder structure of Federal securities, which show that the Eurosystem's purchases under the PSPP considerably reduced the volume of Federal securities in free float. Moreover, analysis of the holder structure suggests that the asset purchase programme is also having an impact via portfolio adjustments and the exchange rate. In addition, the moderate decline in market liquidity also plays a role as a driver of yield movements. This is consistent with a reduced free float, the decrease in trade volumes and the growing order book illiquidity recorded for ten-year Bunds since the beginning of 2016. However, this has not affected the proper functioning of the bond market as a whole.