

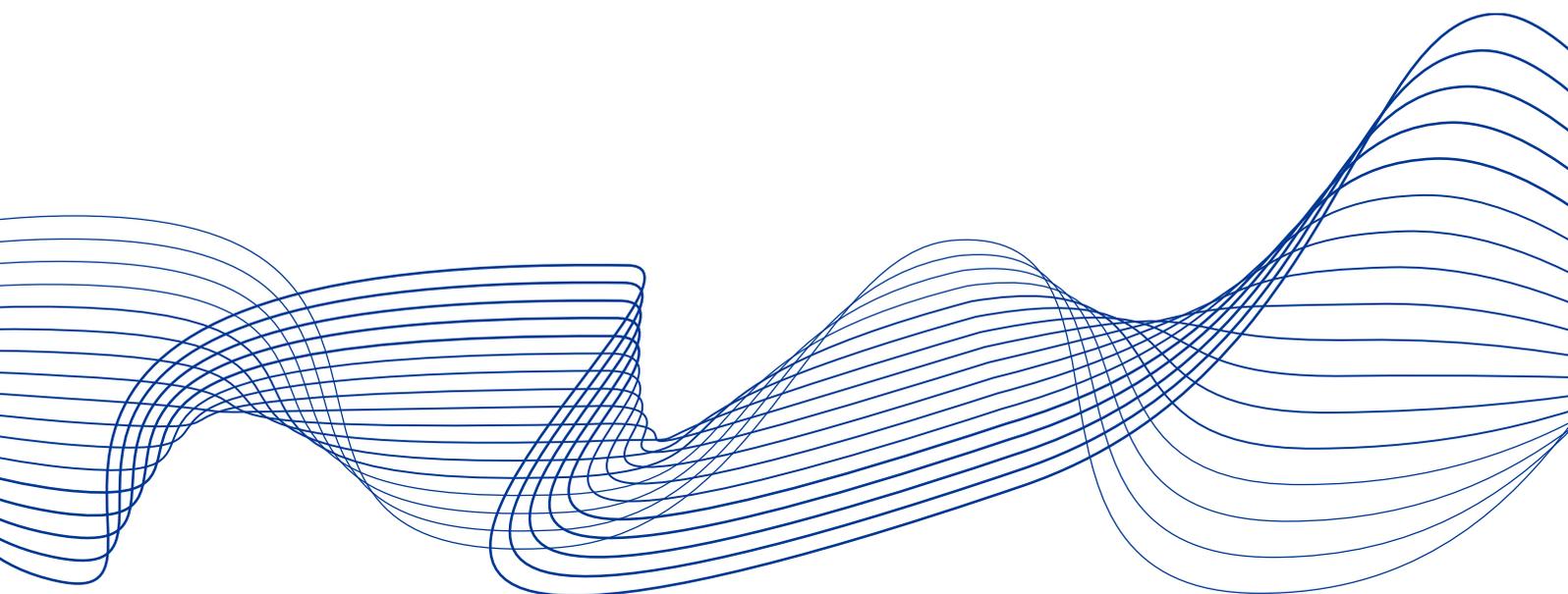
# Technical documentation

## Section D

November 2016

The impact of low interest rates and ongoing structural changes on financial markets and financial infrastructure: assessment of vulnerabilities, systemic risks and implications for financial stability

Joint ATC-ASC-FSC Task Force



**ESRB**

European Systemic Risk Board

European System of Financial Supervision

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## Executive summary

*Financial markets have been adapting to a low interest rate environment and undergoing major structural changes over the past decade. The changes have profoundly affected financial market functioning and structures, creating new vulnerabilities and systemic risks. This report considers the systemic risks under two scenarios, one a prolonged period of low interest rates, the other a gradual reversal in interest rates.*

### The impact of low interest rates

**There are many ways the low interest rate environment may impact financial markets and infrastructures.** The low interest rate environment may have encouraged search-for-yield mechanisms that have impacted asset markets. One consequence of this has been an apparent shift in asset allocation from higher-rated to lower-rated bonds, although this may partly reflect ratings downgrades. Another potential consequence of the search for yield could be an increase in leverage, although this is difficult to measure. The low interest rate environment may also increase vulnerability to structural changes in financial markets and their underlying infrastructures.

**Theory suggests that a low interest rate environment affects asset prices primarily through expected future profits and the discount factor – this includes its impact on risk premia.** A prolonged period of low interest rates would incentivise investors in search of yield to raise their portfolio risk. Higher demand for riskier assets and a low discount rate put upward pressure on the prices of correlated assets. As risks build up this could trigger asset misallocations within and across financial asset classes, typically in favour of higher-yielding market segments, and potentially reduce productivity. Such mechanisms could include the promotion of pro-cyclical investment strategies that run a greater risk of incurring losses. If search-for-yield persists over an extended period of time it may, as yield spreads fall, spread across asset classes.

**Meanwhile, the risks of financial stress would rise, with potentially negative consequences for the real economy if asset price bubbles are building up,** for example due to asymmetries between economic agents' risk aversion and financial intermediaries' incentives to deploy speculative investment strategies. Available data tend to show yield compression and upward price trends in almost all EU asset classes, with the exception of commodities. The question is still whether these trends reflect asset mispricing or economic fundamentals.

**It should be noted that financial assets could also be mispriced without the sustained divergence of asset prices from their fundamentals.** Financial market volatility, for example, appears to be mispriced, and evidence of asset mispricing is also available for equity and FX markets. The low interest rate environment adds to the potential for asset price booms, as negligible inflation and depreciation tend to shift purchasing power to domestic assets. Risks in this area could also accumulate over time, if volatility remains overstated and market participants take large positions against this backdrop. Conversely, the econometric evidence does not currently point to mispricing in the corporate bond market.

### The impact of ongoing structural changes

**The low interest rate environment is coexisting with major structural changes to the financial system.** The post-crisis regulatory reform process has affected the functioning of markets



and may have interacted with the low interest rate environment to reduce the level of inventories held by securities dealers. Overall, regulatory reforms have made the financial system – and the banking sector in particular – more resilient to shocks. The reforms have certainly increased the central clearing of transactions, although in some areas pro-cyclicality in asset allocations may have risen.

**Technological advances are influencing the structure and dynamics of financial markets through increasing reliance on electronic trading.** They are also altering market participants' business models and are interacting with the potential effects of the low interest rate environment. The impact of technological advances in stressed market conditions is uncertain, but it might have contributed to the speed with which adverse developments have taken place in a number of cases.

Given this background, systemic risks from an abrupt asset price correction could potentially be amplified by a range of structural factors including scarce market liquidity (e.g. due to reduced willingness to supply immediacy services), a dependence on highly leveraged investment funds, and increased interconnectedness. Adding to these vulnerabilities, the build-up of leverage and liquidity mismatches within the financial system could also be exposed over time, typically if credit were to deteriorate in quality, and asset risk premia were suddenly reassessed. Thus, an endogenous increase in default rates or a broader deterioration of the macroeconomic outlook could trigger an unwinding of positions, reveal liquidity mismatches and potentially scarce market liquidity, and involve fire sale externalities. The associated correction in asset prices might distort long-term capital allocation, while risks around future funding paths could increase, potentially feeding back negatively into economic growth. Demographic pressures on public budgets and related attempts to lock in low interest rates by frontloading debt issuance could add to the perception of sovereign debt as a risk-free asset, with a potential impact on the risk absorption capacity of capital buffers.

## **Assessment of vulnerabilities and systemic risks**

**One main risk and three structural vulnerabilities emerge.** Risk arises primarily from the ongoing effects of search-for-yield activity as described in Section 2.

**The first vulnerability is a result of the changes in market liquidity** as described in Section 3. Related vulnerabilities are caused by a growing liquidity mismatch in investment funds as a consequence of the coexistence of search-for-yield activity and changes in market liquidity.

**A second type of vulnerability is the result of incentives to raise leverage in a low interest rate environment,** possibly through derivative exposures. This could, in turn, amplify and propagate shocks through the system.

**A third vulnerability is the possible emergence of new contagion channels** as the financial system continues to evolve. A general decrease in counterparty exposures between financial market entities should be set against these vulnerabilities. The resulting systemic risks depend on the circumstances in which they arise and are explored under two scenarios.

### *Scenario 1: a prolonged period of low interest rates*

The main systemic risk under Scenario 1 stems from prolonged search-for-yield behaviour that leads to an increase in both the magnitude and the correlation of risks. A “new normal” regime, with interest rates continuing to stay low, would probably be accompanied by increased uncertainty over the fundamental level of asset prices. Elevated asset prices could lead to increased leverage and lower quality debt in the financial system and, at the same time, a growing gap could materialise



between rising demand and receding supply for liquidity services. There would also, therefore, be an increased risk of a financial crisis against a backdrop of weaker market liquidity. Greater reliance on some investment fund categories that are subject to liquidity and maturity transformation or are particularly reliant on leverage could expose the financial system to a number of systemic risks. While, in general, many fund categories require further assessment, initial evidence has been found, in particular, of market liquidity risks for bond funds. In a sustained search-for-yield context, the business models of money market funds and similar cash management products call for special monitoring, as these close substitutes to bank deposit have been shown to be particularly sensitive to runs. Similarly, increased reliance on market intermediaries could raise the risk of potentially inadequate business practices, causing principal-agent issues.

*Scenario 2: a gradual reversal in interest rates*

In its initial phase, Scenario 2 could be expected to be similar to Scenario 1, given that it also assumes that interest rates will remain low for the first few years.

Systemic risk arising from financial markets and infrastructures is perceived to be less acute if interest rates increase gradually over time. However, a sudden and unexpected reversal could cause the credit and asset cycles to accelerate and could trigger disorderly adjustments. Herding behaviour in particular, given similar risk models and investment strategies, as well as liquidity shocks could lead to a sharp portfolio readjustment and a major impact on the price of credit and financial assets. Under such a scenario asset managers could, in particular, face large-scale redemptions.

Under both scenarios cross-border and cross-sector interconnectedness could amplify the impact of an abrupt correction in asset valuations; imbalances in capital accounts could act as cross-jurisdictional contagion factors. An increased reliance on non-bank entities arising from reduced bank profitability and constraints placed on the traditional insurance sector would probably increase cross-sector and cross-border exposures, especially for asset managers. Similarly, the move towards market-based financing could reinforce existing contagion channels. In this respect, the authorities should be particularly mindful of collateral reuse and the extent to which it may provide room for contagion effects. Central clearing produces significant benefits for financial stability but it reinforces the need to ensure that CCPs risk management models do not exacerbate market stress.



## Introduction

**Financial markets have been adapting to a low interest rate environment and have been undergoing major structural changes over the past decade.** The low interest rate environment has led to a search-for-yield by investors, resulting in changes in asset allocation and valuation. Post-crisis financial reforms, while strengthening the core of the financial system, may have added to pressures on market makers to step back from their role as core intermediaries and may have supported the growth of asset management. Technological innovation has fostered the development of automated trading and algorithmic trading strategies in the equity, foreign exchange and government bond markets.

**These changes have profoundly affected financial market functioning and structures, creating new vulnerabilities and systemic risks.** The pronounced changes caused by search-for-yield may have created a range of vulnerabilities related to asset allocation and valuation risks. Search for yield may also have increased vulnerabilities from correlated trades and impaired market functioning through its impact on financial market infrastructure. The increasing divergence between the shrinking capacity of market makers to provide liquidity and growing potential demand for liquidity could accentuate order-flow imbalances and disorderly readjustments.

**This report considers the systemic risks under two scenarios, one a prolonged period of low interest rates, the other a gradual reversal in interest rates.** In terms of organisation, Section 2 considers the impact of low interest rates, particularly on asset markets and asset valuations. Section 3 looks at the impact of the ongoing structural change that has been taking place as a result of both regulatory and technological change. Section 4 examines vulnerabilities and systemic risks under the two scenarios.



# Section 1

## The impact of low interest rates

**There are many ways in which the low interest rate environment may impact financial markets and infrastructure.** There are some direct and potentially powerful links between low interest rates and risk-taking through so-called “search-for-yield”. This can lead to changes in both asset markets and asset valuations, including through incentives to take on greater financial and synthetic leverage. But there are also a number of indirect mechanisms that may encourage activities that could present financial stability risks. These include pro-cyclicality in collateral markets and securities financing transactions. This section focuses primarily on search-for-yield mechanisms, given that these are likely to present the greatest risks to financial stability, although it also considers how some elements of financial market infrastructure may have been impacted by the low interest rate environment.

### 1.1 Asset markets

**The low interest rate environment has encouraged search-for-yield mechanisms that have impacted asset markets.** This has affected absolute and relative asset valuations, as discussed in subsection b), and includes various market phenomena.

**One consequence of search-for-yield has been an apparent shift in asset allocation from higher-rated to lower-rated bonds, although this may partly be a reflection of rating downgrades.** Overall, EU bond funds’ holdings of sub-A-rated bonds increased from 31% in 2008 Q1 to 55% in 2015 Q4, with the outstanding universe of EU corporate debt experiencing a similar increase from 16% to 38%. Over the same period, holdings of AAA-rated bonds in EU bond funds’ portfolios fell from 39% of overall holdings to 15% (Chart 1 – RHS). Similarly, European insurers have seen their holdings of riskier bonds (BBB) rise and their holdings of safer bonds (AAA) fall. The increased weight of higher-rated bonds in investors’ portfolios is generated by lower average ratings due to declining average borrower quality. However, it also potentially comprises a shift by investors to riskier asset classes, which is clearly shown by the relative stability of the fund sector’s rate of return compared to fixed-income yields in general.<sup>1</sup> Issuers have responded to this environment not only by issuing more lower-rated bonds, but also by issuing record numbers of bonds with lower yields to maturity and longer maturities. In addition, syndicated loans and other debt contracts may be including less stringent covenants as issuers take advantage of a “sellers” market (Annex 1).

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<sup>1</sup> See ESMA (2015a), p. 56, A.26; p.58, A.43; p.60, A.57; p.65, A.89. In addition, the transition matrix for Standard & Poor’s ratings between 1H08 and 2H14 indicates a substantial proportion of ratings experiencing a one-notch downgrade.



Chart 1

**Volatility remains low and allocations have increased for lower-rated corporate bonds**

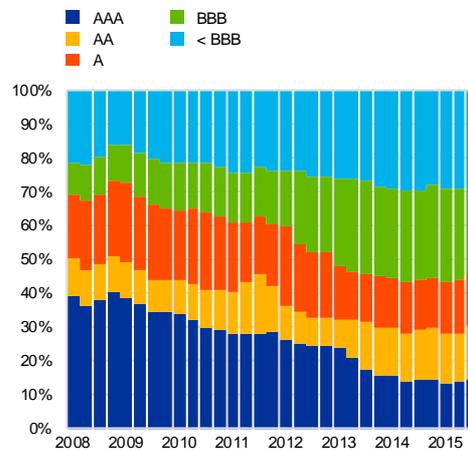
Implied fixed income volatility (basis points)



Sources: Merrill Lynch, ESMA.

Note: The Merrill Option Volatility Estimate (MOVE) Index is a yield-curve weighted index of the normalised implied volatility on one-month Treasury options.

EU bond funds' corporate bond holdings by rating (%)



Sources: Lipper, ESMA, Standard & Poor's

**Institutional investors and asset managers have been incentivised to shift to riskier portfolios, alternative investments and more complex product offers.**

Empirical evidence indicates that money market fund managers have been forced to either exit the market or increase their portfolio risk in order to offer positive returns (Di Maggio et al. (2015)). In particular, low interest rates are found to encourage the reallocation of funds from EU money markets to equity funds, especially in countries with a high level of participation by local institutional investors in domestic stock markets (Hau et al. (2014)). Yield compression also incentivises money market funds, especially Constant Net Asset Value (NAV) funds, to raise their portfolio's average maturity, or invest in either less liquid assets or those of lower credit quality. Bond funds, including high-yield bond funds, may be subject to similar pressures (Technical Documentation, Section C). Insurers' attraction to riskier corporate bonds appears to be negatively influenced by the relevant risk spreads (Becker et al. (2012)), while it has been shown more generally that fixed income investors accept higher levels of subordination and fewer covenants in a low interest rate environment (Haltom (2013)). Both asset managers and other institutional investors have opportunities to choose riskier investments without violating regulatory requirements, and which frequently build on predefined risk buckets such as credit ratings (Becker et al. (2012)). Asset managers, along with other non-bank institutions (Technical Documentation, Section C), may also engage in new capital market financing activities, typically in the form of loan origination and alternative types of lending to SMEs and other non-listed firms. New alternative or structured investment funds may offer return enhancements to investors, and these have added growth in assets under management (Technical Documentation, Section C and Annex 3). Reliance on these investment strategies often carries significant market risk as well as a potential mis-selling risk, notably with retail investors. Finally, collective trust in government intervention in the event of a systemic risk materialising has also been found to further motivate the acceptance of risks.

**Increases in leverage may also result from the search for yield.** Leverage can be obtained through direct borrowing (financial leverage), through (secured) funding operations and through the use of derivatives (synthetic leverage). In secured funding markets, the lower haircuts associated



with low interest rates may facilitate higher leverage within regulatory limits. For example, hedge funds rely heavily on collateralised borrowing/lending and derivatives trading from which they can build leverage. Collateral flows from hedge funds to the main EU broker-dealers exceed EUR 700 billion (ESRB (2014)). In a low-yield environment, higher asset valuations may come with lower collateral haircuts, contributing to increased leverage, especially for entities that tend to re-pledge collateral such as hedge funds, thereby boosting returns at the expense of magnifying potential losses and their transmission to the wider financial system.

**Available evidence indicates a limited rise in financial leverage for investment and hedge funds (Chart 5, Annex 1) while exposures obtained using derivatives are partly assessed.**

Risks from both financial and synthetic leverage may be rising and have a number of sources. Institutions' activities aimed at bypassing prudential requirements for financial leverage constraints may be an important driver of synthetic leverage. In a low interest rate environment, a key concern is the large notional exposures needed for hedge funds to generate returns from strategies based on the use of interest rate derivatives and options hedging volatility. Low interest rates may have contributed to the increasing prevalence of trading strategies that are implemented with a heavy reliance on derivatives, thereby taking on substantial market exposures and in some cases "netting out" their risks. Although a rise in leverage ratios can reflect revenue smoothing or adaptation to recent market developments, such as hedging against high-volatility, it may also be a symptom of greater – potentially excessive – risk-taking. Synthetic leverage gives rise to risks that are difficult to assess, also due to non-linearity in asset prices, which may create vulnerabilities whose significance is uncertain. Financial leverage may be encouraged to the extent that interest rates in Europe fall lower than in other countries, supporting the growth of carry trades in which leveraged positions are funded in European currencies. This could lead to an increase in risky counterparty exposures. Both types of leverage could introduce pro-cyclicality risks because leveraged positions in markets typically tend to exacerbate liquidity pressures and, when underlying positions are unwound, trigger fire sale externalities. These include a range of network externalities given the fact that leverage connects cash, derivatives and secured funding markets.

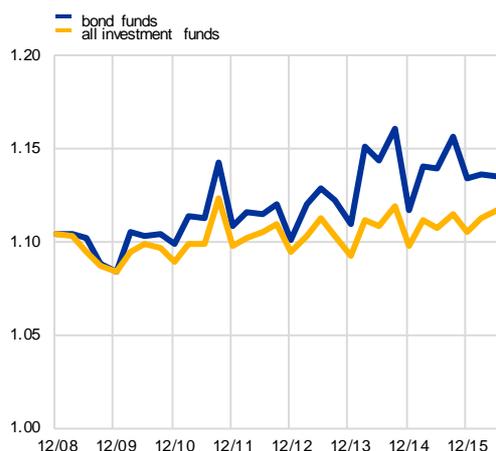


Chart 2

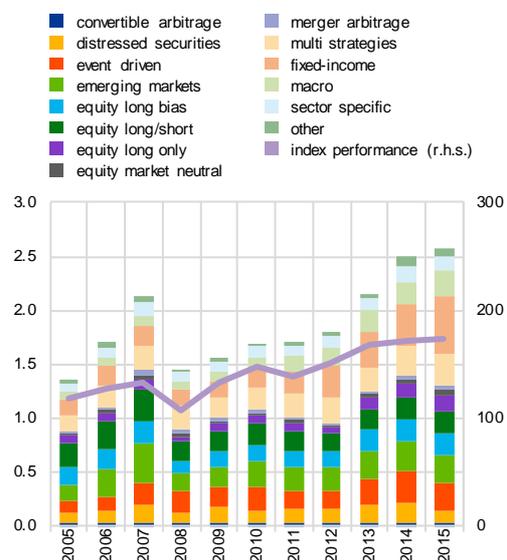
**Investment funds: evidence of a rise in financial leverage; limited and mixed evidence for synthetic leverage requires further assessment**

Financial leverage (Total assets / Fund equity) of EA investment funds

Hedge fund strategies over time: rise in fixed-income and global macro strategies



Source: European Central Bank.



Source: BarclayHedge, ESRB.

It has been reported that in the low interest rate environment margin models have been redesigned. Hinting at competitive pressures, CCPs have decreased initial margins to adapt to the associated fall in risk premia. Such incentives also apply, to some extent, to counterparties in bilateral trades. Volatility and competition are important drivers of margin changes by CCPs, which tend to adjust margins in a way that is asymmetrical to changes in volatility: initial margins are raised quickly following volatility spikes and lowered gradually when volatility declines (Abruzzo and Park (2014)). This could significantly impact financial stability as declining margin levels increase the likelihood and relative size of significant and sudden increases in margins during periods of financial stress. These increases could create liquidity pressure for market participants who would have to post more collateral and might have to fire sell assets to meet such requirements. Regulation aimed at addressing the pro-cyclicality of initial margins and haircuts set by CCPs is already in place through the European Market Infrastructure Regulation (EMIR), although the need to improve the provisions addressing pro-cyclicality is widely recognised (ECB (2015c), ESMA (2015) and ESRB (2015b)). The ESRB and ECB have also identified a potential role for the authorities whereby they intervene in the setting of margins and haircuts with a macroprudential objective in mind. For non-centrally cleared transactions, the FSB (2015) framework for minimum haircuts for securities financing transactions (SFTs) between non-banks and from banks to non-banks and the BCBS-IOSCO (2015) margin requirements for non-centrally cleared derivatives are



aimed, in particular, at addressing the pro-cyclicality of margins and haircuts in the non-centrally cleared space.<sup>2</sup>

**The pro-cyclicality of collateral requirements could be rising more generally.** Collateral requirements – e.g. margins and haircuts – may be lowered in reaction to positive long-term asset price trends. This could lead to a higher degree of leverage and the entry of highly leveraged firms into the market. Sudden volatility increases followed by significant and abrupt rises in collateral requirements could impact liquidity and, in extreme cases, trigger asset liquidations. In addition, low interest rates have the potential to put downward pressure on costs and cause undesired behaviour by FMI holding companies, e.g. a race to the bottom with regard to CCPs' general risk management standards, potentially eroding financial stability.

**Cross-sector interconnectedness, especially if combined with conflicts of interest involving market intermediaries, could propagate shocks or destabilise price dynamics (Technical Documentation, Section C).** The financial crisis highlighted the need to monitor shadow banking activities, in particular the reliance on short-term wholesale funding, lending standards and related incentives, and general transparency regarding the amount of leverage and maturity mismatches. Specifically, flawed credit risk transfer and transformation proved to have the potential to induce runs in securitisation markets (Acharya, Schnabl, Suarez (2013)), trigger fire sales and spread risk across networks of exposures in wholesale funding markets (Gorton and Metrick (2009), Acharya, Öncü (2012), Singh (2014)), with funding from money market funds drying up (MMFs) due to shareholder runs (Bengtsson (2014)). Public support was extended to some liquidity providing hedge funds (Bouveret (2011)), and (re)insurance firms that had issued excess credit guarantees in the CDS market. Lengthening intermediation chains in an increasingly market-based financial system have the potential to amplify asset market price shocks. Specifically, cross-sectoral linkages have been assessed in the context of banks' exposures to shadow banking entities (EBA (2015)) and remain subject to further investigation, also with a view to clarifying the perimeter of credit institutions and the harmonisation of the scope of prudential consolidation across entity types and EU jurisdictions. Similarly, the growth of market-based activities<sup>3</sup> within consolidated banking groups is contributing to the creation of transmission channels between banks and non-banks (Technical Documentation, Section C). In many cases these activities involve derivative exposures and/or the securing of related or financing operations. Accordingly, the markets in multiple financial asset products constitute multi-layered networks interconnecting financial institutions' balance sheets, and transferring idiosyncratic risks from an institution to its counterparties.<sup>4</sup> In reality, related exposures may not be properly captured by balance sheet data. Several regulatory market data collections – e.g. EMIR, AIFM, SFTR – aim to fill such information gaps in the coming years.

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<sup>2</sup> The BCBS-IOSCO framework will enter into force on September 2016 in the EU while the FSB (2015) recommendation may be implemented in the EU depending on the outcome of the regulatory process set out in the SFTR. See Regulation (EU) 2015/2365 of the European Parliament and of the Council of 25 November 2015 on transparency of securities financing transactions and of reuse, and amending Regulation (EU) No 648/2012.

<sup>3</sup> FSB (2015) proposed assessing shadow banking activities through a framework of five economic functions. The ESRB has initiated work on the EU shadow banking sector on this basis.

<sup>4</sup> Whereas the analysis of multilayer networks focused so far largely on interbank networks (ECB (2013), Kok, Montagna (2013)), it is worth extending it to non-bank entities.



## 1.2 Asset valuations

### 1.2.1 Theory

**Asset pricing theory suggests that the low interest rate environment affects asset prices primarily through expected future profits and the discount factor – this includes its impact on risk premia.** For example, it has been shown that real interest rate innovations positively correlate with risk aversion, measured as the volatility premium – i.e. the difference between implied and realised volatility (Bekaert et al (2013)) – thereby affecting asset demand and search-for-yield incentives. It has also been demonstrated that the distinction between nominal and real interest rates and its relationship to the valuation of assets by discounted future payment streams is frequently confused (Shiller (2007)).

**The low interest rate environment adds to the potential for asset price booms, as negligible inflation and depreciation tend to shift purchasing power to domestic assets.** Interest rate differentials balanced by depreciation, both realised and expected, and stalling inflation, due to pessimistic growth expectations aggregate demand remains subdued, attract purchasing power to domestic asset markets, pushing up asset price levels. If underlying macroeconomic factors become more optimistic, inflated asset valuations will be exposed to price corrections.

**Asset price uncertainty increases the need for hedging, which embeds possible valuation risk, as insurance costs – e.g. options risk premia – may be subject to pro-cyclical repricing.** Whereas the build-up of mispricing may not translate into durable unilateral distortions in the asset prices underlying hedging derivatives, the unwinding of hedges could have a significant asset price impact.

### 1.2.2 Evidence

**The available data indicate yield compression and upward price trends for almost all EU asset classes except commodities.**<sup>5</sup> Low risk-free interest rates have filtered through to other fixed-income assets including corporate credit, with spreads of both high-yield (HY) and investment-grade (IG) bonds now at low levels (Charts 16-19 of the main report, and the related discussion in Technical Documentation, Section E), and even below their long-run averages. The difference between HY and IG spreads is close to its lowest point since 2007, revealing the limited ability of investors to determine the compensation they require for bearing different levels of credit risk across bonds of different ratings.

**The question remains whether these trends reflect asset mispricing or economic fundamentals.** Fair value can be defined as compensation for idiosyncratic risk and observable systematic risk. Econometric analysis (Annex 2) suggests that credit spreads in the investment grade segment of euro area non-financial corporate bonds appear to have been below their fair value since August 2014 (Chart 3), when the launch of the ECB's Public Sector Purchase Program (PSPP) became more probable. However, the degree of valuation risk, defined as the excess bond premium measured as a percentage of fair value, turned positive in 2015 due to the downside risks for economic activity in Asia and the fall in commodity prices, and is estimated at its fair value in March 2016. Moreover, credit spreads in the high-yield segment have been close to their fundamental values since end-2012. Taken at face value, this could suggest that there is no

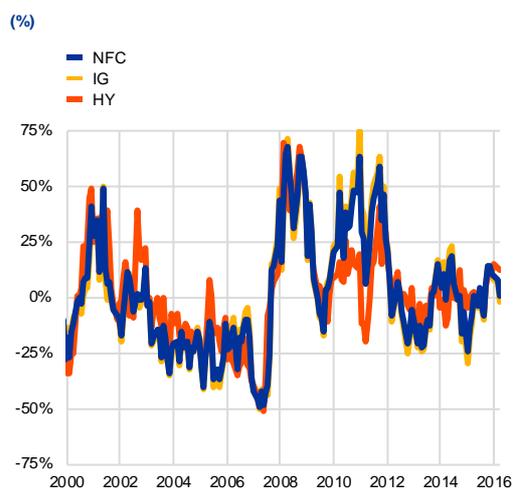
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<sup>5</sup> See ESMA (2015a), p.53, A.1.



persistent evidence for mispricing in the corporate bond market, when measured relative to the current state of the economy.

**Chart 3**  
**Corporate bond spreads have declined but do not reflect mispricing**  
**Relative excess corporate bond spreads in the euro area non-financial corporate sector**



Source: De Santis (2016), "Credit Spreads, Economic Activity and Fragmentation", ECB Working Paper, No 1930.  
 Note: The relative excess bond premium is defined as the difference between actual and justified credit spreads as a percentage of the justified credit spreads. Last observation: March 2016.

premia rely on the view that implied volatility overestimates future realised volatility, and they sell volatility protection on that basis. These trades put downward pressure on implied volatility and may therefore amplify asset price changes when the trades are unwound.<sup>6</sup> Likewise, by counteracting price changes in underlying assets, the ("delta") hedging behaviour of dealers, if great enough, may lower volatility and prompt other investors to follow similar investment strategies. The virtuous circle of self-reinforcing lower volatility could, however, reverse if the balance of investor strategies were to change. Opportunities for the use of volatility-based trading strategies are not only present in fixed-income markets, but can also be found in forex and stock markets (Chart 4 – LHS and RHS).

**Financial market volatility, however, appears to be clearly mispriced.**

The econometric analysis reported in Annex 3 explains how a regression of average returns of the EU bond fund industry on the volatility premium derived from interest rate swaptions is consistent with volatility mispricing. The results show the positive, albeit mild, impact of the volatility premium – the difference between implied and realised volatilities – on the performance of the bond fund industry. This suggests that the hedging of interest rate risk generates benefits for the sector and that interest rate risk may be overestimated by swaption prices, providing evidence of imperfect pricing. In an environment of general uncertainty with regard to interest rate expectations this may be more significant for asset valuations.

**In addition, new forms of hedging have been developed**

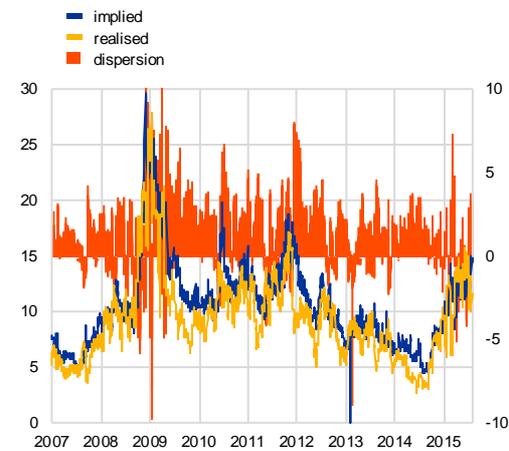
since the crisis which induce sophisticated investors (e.g. hedge funds, asset managers and pension funds) to sell volatility protection through derivatives (e.g. options). Such strategies "monetising" volatility risk

<sup>6</sup> See, for example, US evidence on the 15 Oct 2014 "flash rally" in Bouveret, Breuer, Chen, Jones, Sasaki (2015).

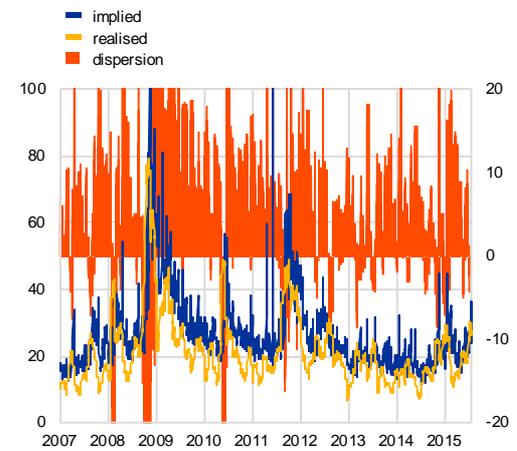


Chart 4

**Implied vs. realised volatility for USD/EUR (left) and EuroStoxx50 (right)**



Source: Thomson Reuters Datastream, ESMA.  
 Note: 1-month implied vs. realised volatilities for the exchange rate USD/EUR. Spread between implied and realised volatilities on RHS. Data in %.



Source: Thomson Reuters Datastream, ESMA.  
 Note: 1-month implied vs. realised volatilities for the Euro Stoxx 50. Spread between implied and realised volatilities on RHS. Data in %.

**Additional evidence of asset mispricing is reported by various sources for equity, bond and foreign exchange markets.** Concerning equity markets, over-optimistic investor sentiment may explain stock price deviations from fundamentals (Brown et al. (2005)) and valuation ratios (book-to-price, etc.) contribute to the value premium (Chaves et al. (2012)). In bond markets, Acharya et al. (2013) show mispricing in financial markets after 2008 – in this case portfolios of peripheral sovereign bonds funded by short-term debt raised in EU safe-haven markets were used to exploit interest-rate differentials. For US-syndicated bond markets, Aramento et al. (2014) report that non-depository lenders such as funds, trusts, investment banks and securities dealers react to reductions in long-term interest rates by adding riskier credit to their portfolios.

Kim (2015) presents evidence regarding the traditional carry trade, which exploited the exchange rate dislocations and interest rate differentials from equilibrium values that occurred between 1999 and 2013, and which includes carry trades between the US and the euro area. Finally, Alti et al. (2011) argue that empirical evidence may even underestimate the mispricing because price dislocations also stem from irrational beliefs, including overconfidence, and that price data used to detect relative price distortions between financial assets is not able to capture related misalignments.



## Section 2

### The impact of ongoing structural change

**Structural changes in financial markets are occurring in a context of an increasing reliance on non-bank and capital markets financing.** This is, in particular, highlighted by initial evidence concerning the prevalence of market activities and the materiality of related risks in the shadow banking sector (see Box 1 and Technical Documentation, Section E). These risks typically involve shadow banking entities (e.g. securitisations, investment funds and securities dealers) engaging in derivative (secured) funding and market liquidity activities and are assessed primarily through leverage, including its synthetic forms, and liquidity transformation metrics, as well as through an assessment of related interconnectedness.

**Against this background, structural changes in the markets, related to regulatory and technological progress, are significant from a financial stability perspective as they qualify the impact of the materialisation of risks.** The low interest rate environment exists alongside ongoing major structural changes to the financial system, which are primarily driven by regulatory reform and technological innovation. These translate into, and interplay with, changes to the business models of market intermediaries. In this section we focus primarily on the structural changes that have the potential to stabilise or amplify risks from the low interest rate environment. Insofar as these changes impact interest rates (Technical Documentation, Section A), they also affect the nature and extent of the vulnerabilities of financial markets and infrastructure stemming from the low interest rate environment. They may, specifically, amplify the risks from disorderly adjustments in asset market prices.

**The regulatory reform of financial markets is having an ambiguous impact on their resilience and warrants further review** (see Annex 4). It is likely that the post-crisis regulatory reform process is affecting the functioning of markets. Some of these reforms may have interacted with the low interest rate environment and technological developments (see hereafter), and may have affected the role of securities dealers in markets. Pro-cyclicality may be encouraged by the shift towards market-consistent valuations and risk-based capital requirements in both the insurance and pension fund sectors in some countries. The role of CCPs in the financial system and the prudential regulation governing CCPs has been enhanced since the financial crisis. On the whole, regulatory reforms have generally made the financial system and, in particular, the banking sector more resilient to shocks. However, some market participants claim to have noted unintended consequences of regulatory reform in some areas such as, for example, a reduction in the supply of immediacy services in less liquid debt markets and increased risk in centralised exposure pools.



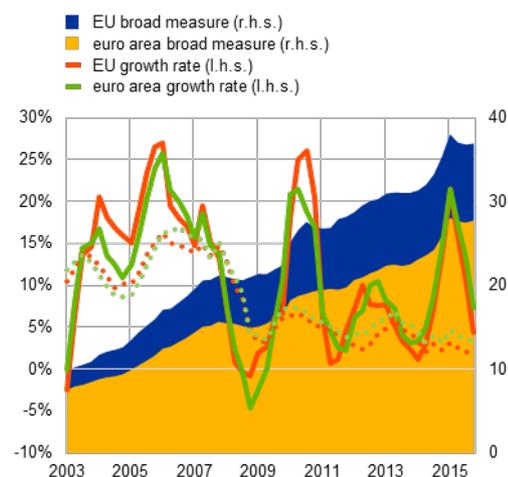
## Box 1

### Shadow banking: rising exposures from market interconnectedness and activities<sup>7</sup>

Chart A

#### Broad measure of EU and euro area shadow banking (investment funds and OFIs)

EUR trillion (right-hand side)  
Annual growth rates in % (left-hand side)



Source: ECB and ECB calculations.

Note: Last observation: 2015 Q4. Annual growth rates based on changes in outstanding amounts are indicated by the continuous lines. Dotted lines indicate annual growth rates based on transactions – i.e. excluding the impact of FX or other revaluations and statistical reclassifications.

#### Fast-paced shadow banking sector growth:

Total assets of EU shadow banking entities<sup>8</sup> rose by 22% (27% in the euro area) in the three years to end-2015, when they amounted to EUR 37 trillion (EUR 28 trillion in the euro area), or 37% of the EU financial sector (see Chart A). This growth partly reflects (fluctuating) asset valuation effects. On a rolling three-year period, growth rates based on transactions – i.e. excluding the impact of FX or other revaluations and statistical reclassifications – remained (though they have declined continuously since the crisis) strongly positive, and reached 9% (euro area: 12%) at end-2015. Reflecting the ongoing growth of the sector, this trend is expected to continue in the context of the Capital Markets Union.

#### Heterogeneity in growth across entity types:

Asset growth varies substantially across entity types. However, varying degrees of shadow banking engagement also need to be recognised since, for example, financial vehicle corporations (FVCs), securities and derivatives

dealers (SDDs) and hedge funds are generally strongly engaged. In this context, non-MMF investment funds have recorded rapid asset growth. This holds particularly true for bond and hedge funds and, among the latter, for funds implementing fixed-income strategies. FVCs' assets, for their part, have registered a decline in recent years. The assessment of SDDs remains largely subject to further investigation.<sup>9</sup>

Against this background, sources of potential financial stability risk in the shadow banking sector are found to derive in particular from **financial leverage**, present in real estate funds and some hedge funds, from **maturity and liquidity transformation**, especially by some bond funds, and from **systemic interconnectedness**, e.g. through MMFs and (secured) **funding transactions**. The latter involve both regular banking and shadow banking entities and appear to be important contagion channels. More generally, it is useful for the sector assessment to focus on shadow banking **interconnectedness and activities** in order to assess market dynamics, externalities and underlying information asymmetries.

<sup>7</sup> This box draws primarily on two ESRB publications, the 2016 Shadow Banking Monitor (ESRB (2016) and its background: Occasional Paper (Grillet-Aubert et al. (2016)), and builds upon the FSB's work in this area, including Financial Stability Board (2016). For more details on this section, readers may wish to refer to these publications.

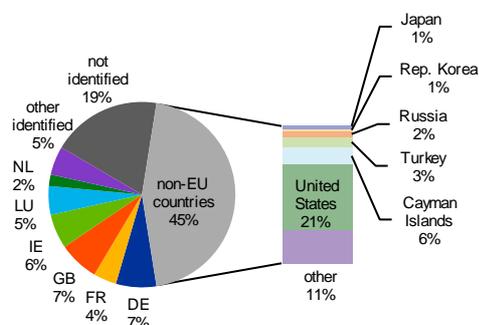
<sup>8</sup> Based on national account categories, this includes: Investment Funds (with MMFs), and Other Financial Institutions: Financial Vehicle Corporations (securitisations), Securities and Derivative Dealers, Financial Companies engaged in Lending, and residual Other Financial Intermediaries.

<sup>9</sup> Some SDD risks may also be considered from an activity perspective (see hereafter).



Chart B  
**Distribution of banks' exposures by country of residence of counterparty**

(percentage)



Source: EBA (2015).

Note: Individual exposures equal or above 0.25% after exemptions and credit risk mitigation.

**The interconnectedness** of shadow banking entities, also within the broader banking and global financial system, involves various bilateral balance-sheet and market exposures. For example, cross-sector balance sheet exposures to investment funds and OFIs represent 10% of credit institutions' assets. Reciprocal investment fund and OFI exposures to credit institutions arise, in particular, from their deposits and funding operations. A 2015 data collection by the EBA sheds some light on EU banks' exposures to shadow banking counterparties. 65% of these were found to relate to: securitisations (26%), non-MMF investment funds (24%) and finance companies (16%). The exercise also stresses the limited information banks have on the supervisory treatment of their shadow banking counterparties<sup>10</sup>, and the importance of exposures to non-EU (45%) and non-identified (19%) jurisdictions (see Chart B). Implicit or

explicit guarantees and step-in risk may add to these risks<sup>11</sup>, as might externalities, such as those involving indirect contagion or reinforcing contagion and fire sale risk.<sup>12</sup>

**An activity-based approach** has been developed by the FSB as part of its shadow banking monitoring, and as part of its analytical and policy work<sup>13</sup>. In the EU, as the Capital Markets Union (CMU) develops, this approach will help more specifically, capturing risks across entity types related to market (e.g. liquidity and leverage) externalities. It will complement cross-sectional analyses of interconnectedness by including assessments of vulnerabilities in financial market intermediation chains – typically by focusing on asymmetries of information underlying credit risk transfer and/or liquidity and maturity transformation. Building on the financial stability mandates granted to EU authorities (e.g. in AIFMD, EMIR, SFTR, MiFID), this approach requires granular – including market and off-balance sheet – data. So far, some evidence has been obtained for **funding and collateral markets**, whose role has increased since the crisis (also due to central clearing requirements), but has shrunk somewhat in recent years (both in repo and securities lending). **Market liquidity** risks may be reinforced by excessive **leverage, including synthetic leverage** (obtained through derivatives).

Available data for market liquidity have so far focused mainly on corporate bond markets and bond funds, pointing to potential imbalances between activities involving the provision of (typically by SDDs) and demand for (typically by investment funds) market liquidity services in these markets (see Charts C and D).

<sup>10</sup> For example, EBA (2015) notes that almost 90% of shadow banking counterparties are classified as “other” in the EBA data collection exercise, as they are either not supervised or not further identified by the reporting bank.

<sup>11</sup> See BCBS (2015).

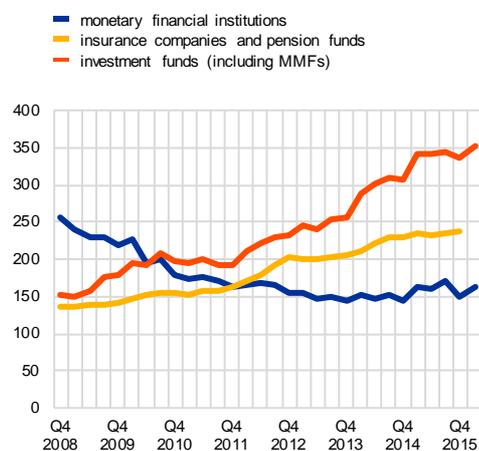
<sup>12</sup> See Clerc L., Giovannini, A., Langfield, S., Peltonen, T., Portes, R. and Scheicher, M. (2016).

<sup>13</sup> E.g. its work on SFTs and on investment funds (see FSB (2015) and FSB (2016)).



**Chart C**  
**Holdings of non-financial corporate bonds by financial sectors in the euro area**

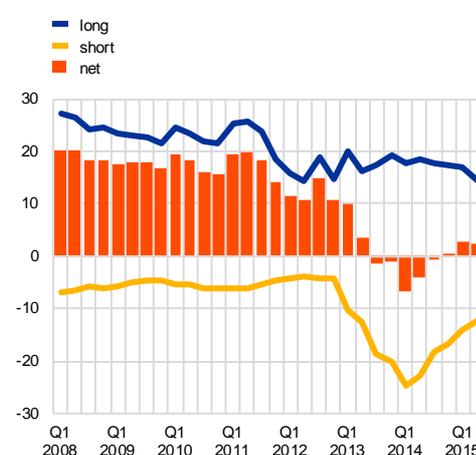
(EUR billion)



Source: ECB.

**Chart D**  
**Non-financial corporate bonds: net market maker inventories**

(EUR billion)



Source: ESRB data collection

The assessment of shadow banking interconnectedness and activities faces **major data gaps**, as available data sources do not generally meet the needs of a macroprudential assessment. It is therefore necessary to rely extensively on new market and regulatory data. Accordingly, new data sources (e.g. from AIFMD, EMIR, SFTR, MiFID) and, where needed, new analytical tools (e.g. multilayer network analysis), will support more detailed risk assessment in the future and will facilitate the development of the ESRB's monitoring of the shadow banking sector.

**Technological advances are influencing the structure and dynamics of financial markets through the increasing electrification of the trading process.** First, a high degree of automation characterises trading in markets such as equities and foreign exchange, as well as some of those for sovereign bonds and futures. These markets may, as a result, be considered structurally liquid.<sup>14</sup> On the other hand, corporate bonds have a very low level of trading process electrification – even lower than for certain derivatives (see Chart 5 – left-hand panel). The proliferation of electronic trading platforms (ETPs) has contributed to increasing trading efficiency, lowering transaction costs, improving price transparency, and developing a more effective price discovery process. This is supporting market liquidity and acting as an important price stabiliser in stressed markets. In addition, technological improvements have increased the efficiency of execution and help to monitor and mitigate the impact of temporary market shocks (e.g. through circuit breakers). However, automated trading may also be contributing to the concentration of volumes with a few large dealers in some markets. The diffusion of technological innovation is, in addition, typically accompanied by adaptation risks.

**Technological change is also altering the business models of market participants and interacting with the potential effects of the low interest rate environment.** One reason for the increasing focus by dealers on developing ETPs across asset classes and moving towards

<sup>14</sup> For example, the share of e-trading in European government bonds increased from 43% to 57% between 2008 and 2014, while nearly 75% of FX trading volume is electronic (Greenwich Associates (2014, 2015)).

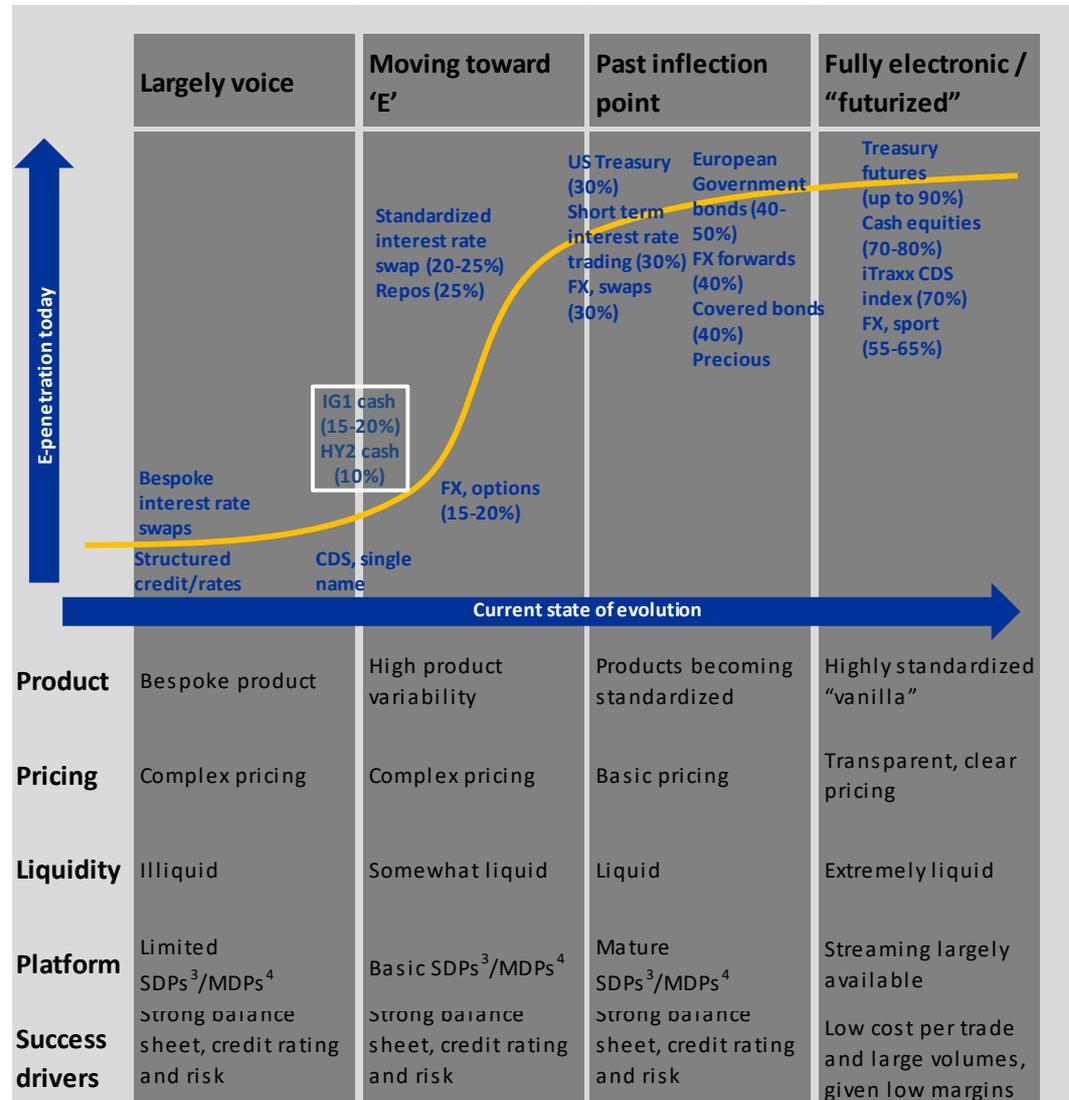


algorithmic/high-frequency (HFT) strategies is the ever-growing need to service client flow in a cost-efficient manner amid strong competitive pressures. Using sophisticated computer technology to deliver automated high-velocity execution, algorithmic and HFT strategies have proliferated in a number of markets, especially equities, FX and a small number of sovereigns (US Treasuries (USTs) and UST futures), although growth in volume terms has tapered off in recent years. Empirical research by Benos and Sagade (2012) indicates that HFT is correlated with low bid-offer spreads in some markets, given their lower operating costs due to a high level of automation and their capacity to update prices and orders at very high speed. Executing transactions in so-called “dark pools” allows efficient order-matching and permits multiple participants to pool liquidity without disclosing deal terms. This facilitates the execution of larger transactions without an immediate and significant price impact. In the light of these technological advances, the trading environment has changed fundamentally, becoming more anonymous and faster-paced.



Chart 5

**Electronification of markets may be leading to more volatile price dynamics under stress**  
 The electronification of trading platforms

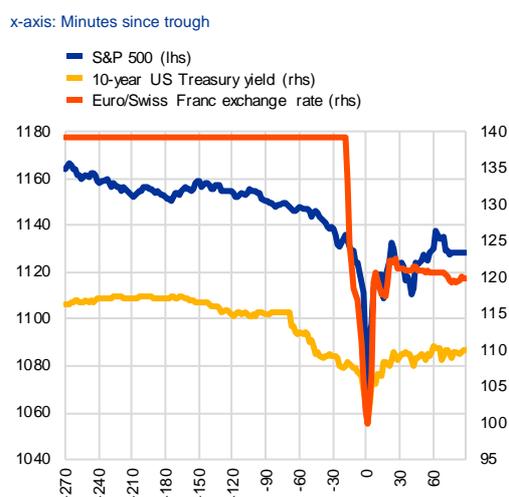


Source: McKinsey and Company.

Note: 1: Investment grade corporate bonds; 2: High-yield corporate bonds; 3: Single-dealer platforms; 4: Multi-dealer platforms



## Intra-day movements in selected asset prices



Source: Bloomberg and ESRB calculations.  
 Notes: Flash crash in US equity markets on 6 May 2010 (blue); flash rally in the US Treasury market on 15 October 2014 (red); and removal of the Swiss franc peg on 15 January 2015 (orange).

“flash rally” in US Treasuries, although it is difficult to isolate the effect of the so-called “gamma trap” and the trading of HFTs in these episodes. However, the near-continuous activity by HFTs following the withdrawal of the EUR/CHF peg by the SNB in January 2015 has been credited with stabilising the market in the aftermath (Chart 5 – below).

**The effects of technological advances in stressed market conditions are uncertain, but might have contributed to the way adverse developments unfolded in a number of episodes.** Technology has exploited a feature of market design – the continuous order book – that has allowed markets to rapidly react and adjust to new information. It may therefore have contributed to both exacerbating price corrections in down markets and to their subsequent recoveries, shortening the length of episodes of high uncertainty and volatility. During stressed market conditions, HFTs’ rapid withdrawal and/or selling into a down market can cause or accelerate negative price spirals. As HFTs do not warehouse risk for long periods, there is general scepticism regarding their capacity to provide liquidity in such circumstances. Examples include the May 2010 “flash crash” in US equities and the 15 October



## Section 3

# Assessment of vulnerabilities and systemic risks

### 3.1 Vulnerabilities

**A prolonged period of low interest rates would incentivise investors in search of yield to raise their portfolio risk and could lead to the mispricing of assets in financial markets.** Risks arise from the ongoing effects of search-for-yield activity as described in Section 2. This has moved asset allocation towards, and increased issuance of, lower-rated debts. It also has the potential to increase risks by incentivising the use of financial and synthetic leverage, for example through the use of carry trades as discussed in detail in Appendix 6, and by generating enhanced pro-cyclicality, in particular through collateral markets and securities and financing transactions. Search-for-yield has also increased valuation risks, given the evidence of asset mispricing in some markets. All in all, this suggests a general vulnerability to a reversal in interest rates as this could lead to increasing default risks for lower-rated debts as well as negative consequences for those with liquidity and maturity mismatches should asset mispricing unwind. A build-up of risks over time could reinforce asset misallocations and their unwinding could be amplified by pro-cyclical activities and strategies, reaching across asset classes. Available EU data indicate a compression of yields and upward price trends in a number of asset classes. The question is still whether these trends reflect asset mispricing or economic fundamentals.

**The first vulnerability arises from the changes in market liquidity as described in Section 3.**

It was previously noted that regulatory reforms have led to changes in dealer business models and, combined with a number of other factors including the low interest rate environment, have reduced the willingness of dealers to hold inventories of some securities. Several studies have documented that this may also have reduced the willingness of dealers to supply liquidity in secondary markets in some circumstances.<sup>15</sup> Although the contribution of regulatory reform remains uncertain, econometric evidence suggests that dealers are varying their inventories less to meet demand – for example, in response to sales of high-yield US corporate bonds by asset managers – with the result that spreads are varying more (Chart 6 – LHS). There is also evidence of the increasing bifurcation of liquidity towards the most liquid market segments (CGFS (2014)).<sup>16</sup> For electronically traded securities, however, the role of technology and, in particular, high-frequency trading is the most important driver. These new trading patterns raise questions as to which market participants will be willing to “warehouse” assets for liquidity provision purposes. The end result is a reduced supply of immediacy services, which may impact price dynamics under stress (BIS (2015, 2014) and IMF (2015)), leading to an increasing frequency of “flash” events.

**In addition, vulnerabilities arise from the growing liquidity mismatch deriving from the coexistence of search-for-yield activity and changes in market liquidity** (see also Box 2). The low interest rate environment may have contributed to the growth of assets under management in redeemable funds as end investors seek higher-yielding and liquid alternatives to bank deposits

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<sup>15</sup> See ICMA (2014), CGFS (2014).

<sup>16</sup> Relying on data collection undertaken in 2015 (ESRB/2015/NP5), the ESRB has assessed risks arising from developments affecting the supply of liquidity services by market makers. Despite mixed quantitative results for Europe, some evidence is found that liquidity has deteriorated in some markets, the corporate bond markets in particular.



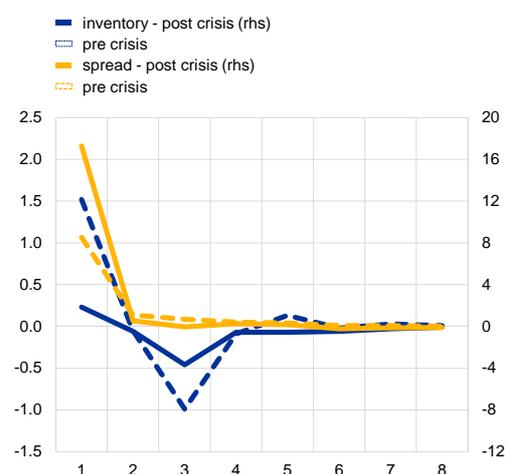
(Chart 6 – RHS). At the same time, however, some investment funds' portfolios have become less liquid, even though the redemption profile offered to investors has remained unchanged. An element of this vulnerability arises from a “first mover advantage” where expectations of fund outflows and redemption costs could push all investors (including those who would be happy to remain invested in the fund) to withdraw their funds when there is a negative shock.<sup>17</sup> If the negative shock is large enough and if it affects a large part of the investor base, it could have wider implications. However, the current regulatory framework (UCITS) has a number of provisions that help to deal with these issues (e.g. swing pricing and gates). The extent to which these provisions can effectively deal with the issues will partially depend on the speed with which asset prices change. Other elements of this vulnerability arise from the potential interactions between the market behaviours of investment fund managers, on behalf of their investors, and those of other market participants, especially in a context of fragile market liquidity.

Chart 6

### The decline in market liquidity and the growth of redeemable investment funds

#### Sensitivities in the US high-yield bond market

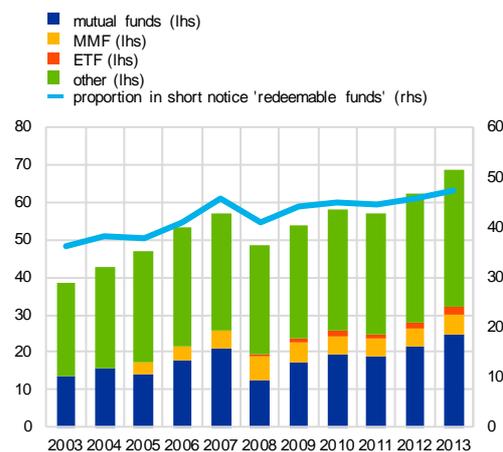
Basis points of market size (left-hand side), basis points (right-hand side)



Source: BAML, Dealogic, EPFR Global, FRB NY, SIFMA, Bank of England calculations.

#### Global funds by redemption profile

US \$ trillion (left-hand side), percentage (right-hand side)



Source: Boston Consulting Group, ICI, The City UK.

**A second vulnerability arises from the incentives that a search-for-yield environment would create to leverage exposures in the investment fund sector** (see also Box 2 and Technical Documentation, Section C). Financial leverage (on-balance sheet) plays an increasingly important role for some types of investment funds (Chart 2 - LHS), although the degree of engagement varies not only across fund types but also according to whichever investment strategy prevails at the time (Chart 2 - RHS). In particular, recent developments in the bond fund industry might be of concern due to the rising interest-rate sensitivity of portfolios. In addition, although a lack of data stands in

<sup>17</sup> Two main mechanisms are in play. The most important is the negative externality that withdrawing investors put on other investors as the cost of redeeming funds is borne by investors staying with the fund (e.g. large bid-ask spreads, commissions). This implies that the last redeeming investor would bear the cost of all other redemptions. This incentivises fund investors to be first in line when redeeming (Chen, Golstein and Jiang (2010)). The other mechanism relates to expectations similar to those of Diamond and Dybvig (1983).



the way of a comprehensive risk assessment, there is evidence to suggest that some hedge funds rely extensively on derivatives to build synthetic leverage.

**A third vulnerability concerns the possible emergence of new contagion channels as the financial system continues to evolve.** Bank deleveraging and the rise of non-banks as sources of financing may create new links between these two sectors and could potentially increase spillover risk potential (Gross et al. (2015)). In particular, the impact of non-bank liability constraints on market resilience still needs to be assessed and macroprudential risk management tools should be developed in this regard. The implementation of liquidity management tools, such as bank credit lines, by investment funds in response to deteriorating market liquidity, could represent another channel for the transmission of liquidity risks across the financial system.<sup>18</sup> In addition, risk transmission channels and dynamics in financial markets may require further attention, especially where new trading technologies and financial instruments interconnect asset classes/markets and may induce additional vulnerability to contagion effects or pro-cyclicality. The interconnectedness of markets themselves has also increased, as reflected in the correlated trading strategies of market participants amid a continuous search for yield, contributing to an increase in asset correlations. The low interest rate environment could therefore be a possible aggravating factor for contagion across financial markets via investor portfolio shifts.

**The general decrease in counterparty exposures between financial market entities should be taken into account when these vulnerabilities are considered.** The trend towards secured financial transactions in the run up to and in the aftermath of the global financial crisis was underpinned by the safe-haven status of the collateral securing these operations<sup>19</sup> and a potentially structural rise in the reliance on such collateral assets.<sup>20</sup> The role of collateral has also been enhanced by regulatory reforms introducing mandatory central clearing (ESMA (2016)) and incentives encouraging central clearing through collateral requirements on bilateral OTC derivative transactions (ESAs (2016)). However, current EU data remain scarce and limit the scope for assessing vulnerabilities deriving from secured funding markets.

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## Box 2

### Insights from the ESRB data collection for investment fund market liquidity risks

The ESRB has assessed risks from investment funds' liquidity mismatches and leverage in Europe.<sup>21,22</sup> **For liquidity**, the focus was on assessing the impact of fund liquidity mismatches on financial stability, mainly in times of changing market dynamics. The assessment was built largely

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<sup>18</sup> Exposures of euro area credit institutions to investment funds and OFIs are relatively significant – around 9% of total assets (though about two-thirds due to retained securitisations). Around 6% of deposits placed with euro area credit institutions can be attributed to shadow banking entities. See Second report of the JEGS Task Force on Risk Metrics for more details.

<sup>19</sup> Perotti ("The roots of shadow banking", CEPR Policy Insight 69, 2014) stresses the importance of the privileges granted to such secured lenders (exemption of SFT's collateral from mandatory stay under EU and US bankruptcy law).

<sup>20</sup> Di Iasio, Pozsar (2015), A model of shadow banking: Crises, Central Banks and Regulation points to a rising willingness of market participants to create and use "shadow collateral" from illiquid/risky private assets, and to subsequent financial stability implications.

<sup>21</sup> The topics are related as liquidity shortages due to the redeemability at short notice of funds' units create leverage if funds draw on credit lines or lend securities to meet redemptions. Conversely, higher leverage raises investment fund volatility and fund flows' sensitivity to price events.

<sup>22</sup> Accounting for the FSB's investigations, the need for formal ESRB recommendations remains under investigation.



on an ESRB data collection exercise which covered 274 EU asset management firms and 1,668 fixed-income investment funds.<sup>23</sup> The exercise included:

1. **A macro stress test of the EU investment fund sector.** The key aim of this was to assess whether available market liquidity could absorb fund liquidity demand in extreme (tail probability) redemption scenarios. Accordingly, sales of assets by investment funds hit by a shock were compared with trading volumes recorded for different asset classes, and the subsequent impacts on market prices were computed. The framework is conditional on assumptions regarding shock sizes, price impacts and second-round effects (namely on funds' and investors' subsequent trading behaviour).<sup>24</sup> It allows an estimation to be made of the share of investment funds which could meet redemption requests, as well as fund investors' aggregate portfolio losses. Overall, stress to at least some fund sectors could be triggered by "extreme but plausible" redemption shocks to the EU investment fund sector.
2. **Review of availability and use of ex post liquidity management tools.** Ex post liquidity management tools can be used by investment funds to manage liquidity risk during conditions of stress. The survey shows that a wide range of such tools are available, although there is also significant variation across and within jurisdictions. Similarly, the availability of tools to fund managers or, alternatively, to both fund managers and their regulator, is not homogeneous.<sup>25</sup> Moreover, the effectiveness of the tools in times of large-scale redemptions remains largely unassessed.

Overall, the evidence suggests that the current regulatory framework and liquidity management tools support the effective management of investment funds' microprudential (fund-specific) risks. However, their macroprudential efficacy (ability to mitigate systemic risks) remains largely untested and more analysis is therefore required.

**Work on leverage** has focused on assessing investment funds' reliance on leverage and the management of related risks. A survey was conducted by the ESRB<sup>26</sup> and the current regulatory framework was reviewed to assess its capacity to monitor the build-up of leverage. The EU's legislative framework<sup>27</sup> was found to have a limited ability to assess the build-up of excessive investment fund leverage. In particular, there is still no harmonised EU-wide measure of leverage (also through derivatives) or its computation. This fundamentally limits the ability of policy-makers to assess systemic risks in this area.<sup>28</sup>

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## 3.2 Systemic risks

**The systemic risks these vulnerabilities present will depend on the circumstances in which they are exposed.** For example, the impact of an unwinding of search-for-yield behaviour will depend on whether it follows a prolonged period of low interest rates or a gradual reversal. The rest

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<sup>23</sup> See ESRB/2015/NP5. With EUR 3,659 billion of assets, about 50% of the EU's fixed-income asset management industry is covered.

<sup>24</sup> NB: the analysis is also subject to data gaps. There is value in developing a first framework for macro stress testing which will provide a valuable reference for future exercises in this field.

<sup>25</sup> A recent survey by IOSCO's C5 of the availability of liquidity management tools in members' national liquidity regulation frameworks hints at this lack of consistency.

<sup>26</sup> In August 2015, the ESRB launched a survey on the use of leverage by EU investment funds. The aim was to fill data gaps at EU level, namely those regarding the assessment of leverage exposures of UCITS funds and AIFs, their reporting requirements and possible supervisory interventions. Twenty countries responded to the survey, ensuring comprehensive coverage.

<sup>27</sup> NB: UCITS are subject to a 10% temporary cap on direct borrowing, AIFs to leverage limits under Article 25 of the AIFMD.

<sup>28</sup> Such limitations have also been identified by the FSB and IOSCO.



of this section builds on the two interest rate scenarios described in Section A and briefly considers the possibility of a sudden and unexpected rise in rates.

### Scenario 1: a prolonged period of low interest rates

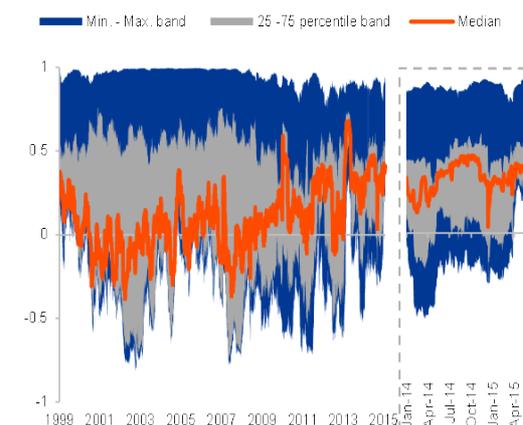
**The main systemic risk in Scenario 1 stems from prolonged search-for-yield behaviour that could lead to an increase in the magnitude and correlation of risks.** This could feed into asset valuations, leading to higher asset prices, fostering the further growth of correlated trades (Chart 7 – LHS). It could create asset price bubbles, as argued in Annex 7 of this report, also exacerbated by demographic change and low technological progress, and promote excessive investment and credit through inflated collateral values. This could lead to imbalances in resource allocation and the crowding out of R&D intensive industries in favour of the financial sector, resulting in lower productivity and a more pronounced cyclical downturn in the event of recessionary trends (Peydro (2013)).

**Elevated asset prices could lead to increased leverage and lower-quality debt in the financial system.** Lower funding costs incentivise further borrowing and stimulate primary market issuance volumes, although they could also increase default risk as leverage rises (Chart 7 – RHS). Wealth effects could also feed back into investors' risk preferences, causing investors to become less risk averse and more willing to accept lower credit ratings or higher maturities. If it is not occurring elsewhere, a prolonged period of low interest rates in Europe could, following the logic of Annex 6, also see increasing use of European currencies to finance carry trades. The progressive build-up in balance sheet risk could translate into greater credit or liquidity risk, especially if maturity mismatches have increased.

Chart 7

#### Search for yield could underpin further rises in correlated trades and corporate leverage under Scenario 1

Correlations across euro area financial assets



Source: Bloomberg, Merrill Lynch, ECB calculations  
Note: Dispersion of pairwise correlations over rolling 90-d windows.

European Investment Grade net leverage



Source: J.P. Morgan, S&P Capital IQ.

**At the same time, a growing gap could materialise between rising demand and receding supply for liquidity services.** This reflects a combination of the growing issuance of illiquid securities over time and the continued effects of regulatory reform and technological change. The result could be potential liquidity squeezes and



bouts of volatility in asset prices, exacerbating pre-existing valuation risk. In affected market segments, reduced liquidity would lower the probability of matching prices being met and increase the risk for market makers of suffering trading losses. With rapid liquidation of investment positions becoming more difficult and the risk of being locked out increasing, risks around the liquidity of funding instruments would rise. In fixed-income markets yield volatility could be exacerbated by the low interest rate environment, implying more volatile margins and spreads, and greater profitability risks for financial intermediaries.

**A “new normal” regime with interest rates continuing to stay low would probably be accompanied by increased uncertainty over the fundamental level of asset prices.** This could arise for two reasons. First, with such a low discount factor, the effect of news concerning fundamentals, and any uncertainty regarding the future path of interest rates, would have a pronounced effect on asset prices. Second, the build-up of lower-rated debt may increase the sensitivity of both corporate debt and equity to changes in the economic outlook. The extra asset price volatility could then have a number of counter-intuitive effects. For example, since it would increase the cost of external finance, it could lead to the postponement of investment decisions by firms, leading to a tailing off of issuance. Or, in combination with elevated correlations across asset classes, it might endogenously reveal excessive risk-taking to investors, leading to a partial unwinding of search-for-yield behaviour.

**Most importantly, the risk of a financial crisis would increase in a context of weaker market liquidity.** The build-up of leverage and liquidity mismatch in the financial system could be exposed over time if the quality of credit were to deteriorate. This could lead to an endogenous increase in default rates, triggering an unwinding of search-for-yield and exposing the liquidity mismatch in terms of demand for liquidity services and the supply of immediacy services. Given the high levels of secured funding, an additional channel through which this could cause problems is collateral markets and the drying up of funding liquidity. Consequently, although reforms implemented since the crisis may have reduced contagion due to uncertain counterparty exposures, this may have been achieved at the expense of increased risks to funding liquidity, suggesting that the possibility of fire sales in asset markets is still material, with negative consequences for financial markets’ ability to serve their main purpose of providing finance to the real economy.

## Scenario 2: a gradual reversal in interest rates

**In its initial phase, Scenario 2 could be expected to be similar to Scenario 1 given that it also assumes that interest rates will remain low for the first few years.** This suggests an accumulation of the effects of search-for-yield behaviour: a growing gap between rising demand and receding supply for liquidity services, increased uncertainty over the fundamental level of asset prices, and the growing risk of a painful financial crisis brought about by rising default risks stemming from either a steady increase in the issuance of lower-rated debts or a deterioration in economic growth prospects. However, the underlying vulnerabilities created by low interest rates would not grow to the same extent as they would under Scenario 1.

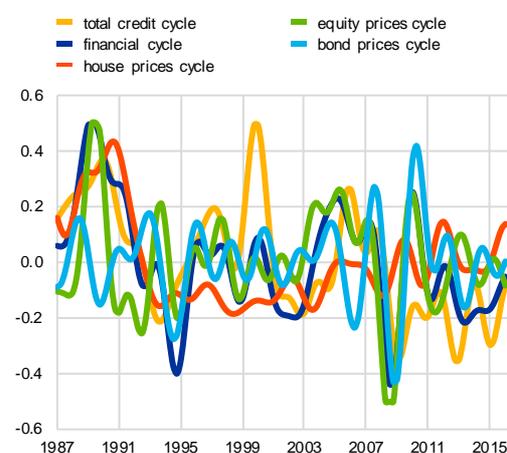
**In the gradual reversal phase lower asset prices and subdued economic growth could raise the risk of financial distress.** The reasons for this could include an expected increase in risk aversion and an expected decrease in the excess demand for assets driven, among other causes, by demographic changes and related budget pressures (see Annex 7). The resulting increase in borrowing costs – on new credit and variable interest rate debt – and the fall in collateral prices would lead to higher rollover risk and a rise in default rates on corporate bonds, potentially further reducing the appetite for riskier assets. Vulnerabilities concerning market liquidity and the growth of



redeemable investment funds could materialise to a certain extent, with contagion spreading to a broad range of markets. This would probably weaken the financial positions of some financial institutions, for example through margin calls. However, there are two points worth noting. First, downturns for the different components of the financial cycle are unlikely to be synchronised (Chart 8 – LHS). This could cushion aggregate demand effects and provide opportunities for macroeconomic policy to mitigate the overall impact on the financial cycle. Second, the extension of borrowing maturity during the period of low interest rates (Chart 8 – RHS) should limit refinancing risks and might be particularly important if there has been a prolonged period of low interest rates prior to the reversal.

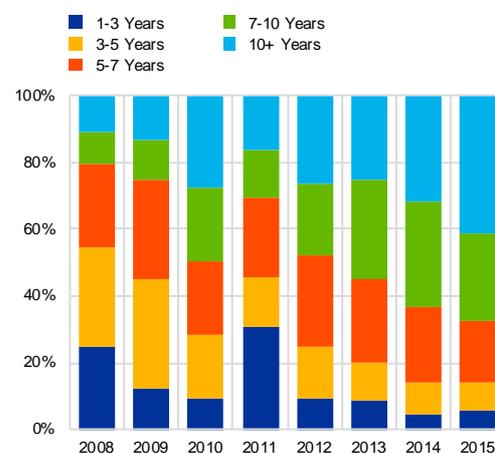
**Chart 8**  
**Decomposition of the financial cycle and redemption risks**

The trend for components of the EU financial cycle



Source: ECB (2014).

European investment grade issuance by tenor bucket



Source: J.P. Morgan.

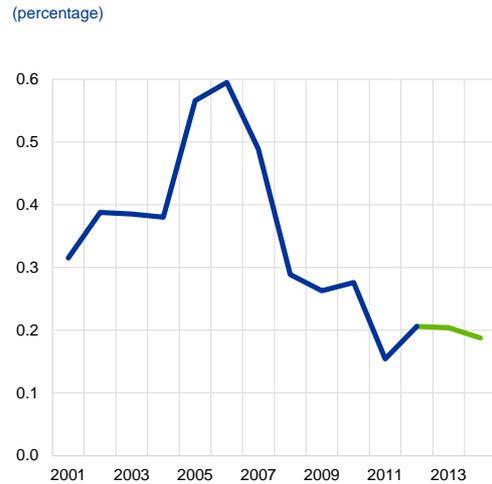
**If the reversal in interest rates has been sudden and unexpected it seems more likely that the credit and asset cycles would be accelerated and more pronounced.** The fragility of market liquidity would raise the prospect of a more disorderly adjustment. Herding behaviour, deriving from the use of similar risk models and investment strategies, could lead to a sharp portfolio readjustment, with major implications for the price of credit and financial assets. Under such a scenario, asset managers might face large-scale redemptions that could prove hard to manage. According to Hoberg et al. (2010), analysts' and investors' forecasts tend to over-predict returns for companies during upswings. The implication of this is that concerns over future credit quality could also accompany a sudden interest rate reversal, making the adjustment more painful. This illustrates that much is likely to depend on the underlying causes of the sudden and unexpected increase in interest rates.



# Annex 1

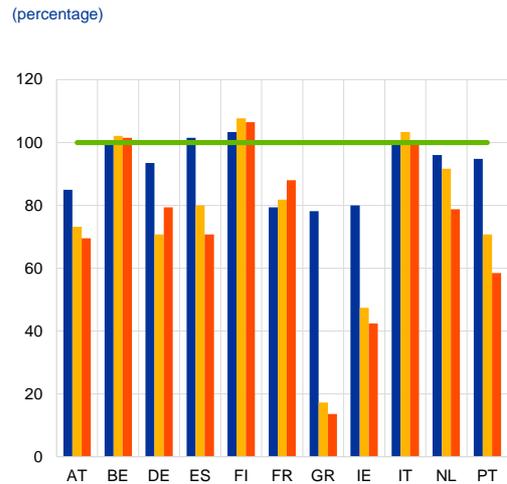
## Additional charts on financial markets and infrastructure

**Chart 1.1**  
**US dealer corporate bond inventories as a percentage of outstanding corporate bonds**



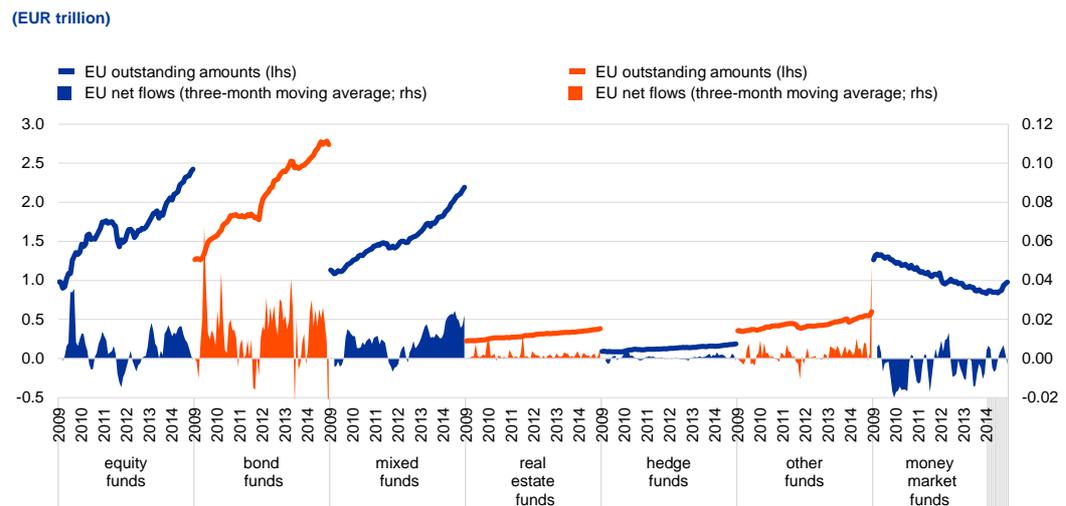
Source: Goldman Sachs, FRBNY, SIFMA, ESRB calculations.  
 Note: Dealer inventories until 2013 are Goldman Sachs estimates (blue); 2013 and 2014 are FRBNY data (green).

**Chart 1.2**  
**EU bond fund holdings by rating**



Source: Lipper, ESMA, Standard & Poor's.

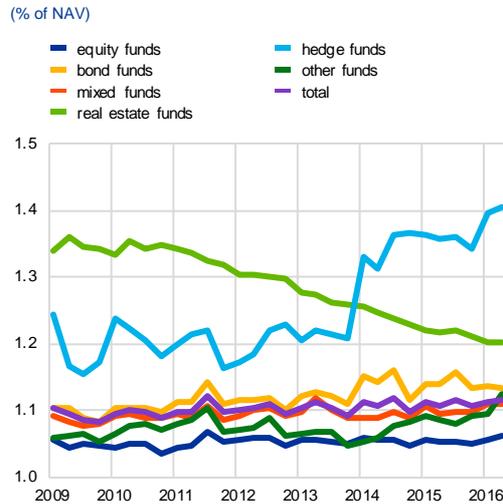
**Chart 1.3**  
**EU investment funds' assets and net inflows**



Source: ECB calculations, ESRB JEGS.  
 Note: Available data for the EU (excl. BG, HR, DK, SE, UK).

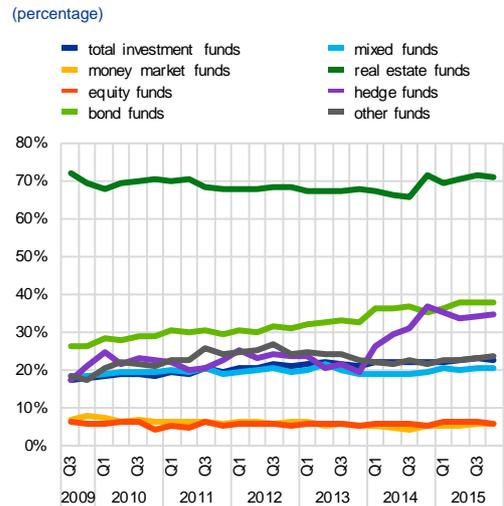


**Chart 1.4**  
**Headline leverage in the investment fund sector (2009 to 2014)**



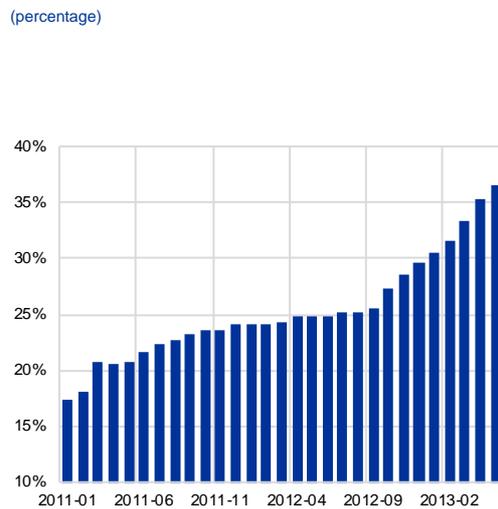
Source: ECB and ECB calculations (MPAG report 2015).  
 Note: Graph depicts total assets to shares/units issued.

**Chart 1.5**  
**EU investment funds: Liquidity transformation**



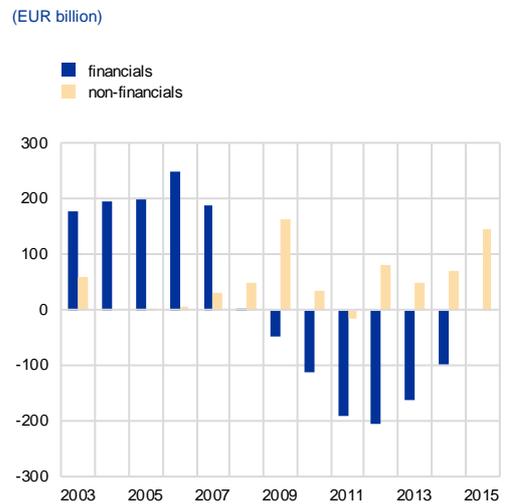
Source: ECB.  
 Note: Using available EU data (BG, HR, DK, SW, UK not included). Total assets less liquid assets (deposits, sovereign bonds, debt securities issued by MFIs, equity and investment fund shares) as percent of total assets. Closed-end funds not included. Estimates for holdings of non-euro area securities and funds not resident in the euro area.

**Chart 1.6**  
**Covenant-lite loans as a share of overall US loans outstanding**



Source: S&P Capital IQ/LCD.

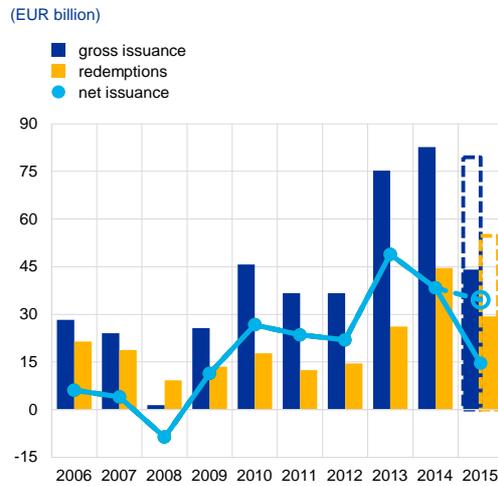
**Chart 1.7**  
**EUR-denominated investment grade net issuance**



Source: JP Morgan.  
 Note: 2015 numbers are estimates.

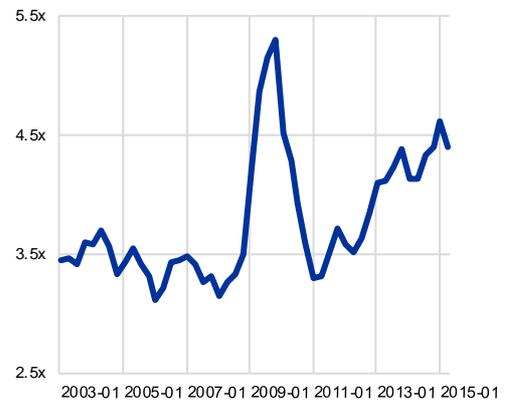


**Chart 1.8**  
**European currency high-yield issuance**



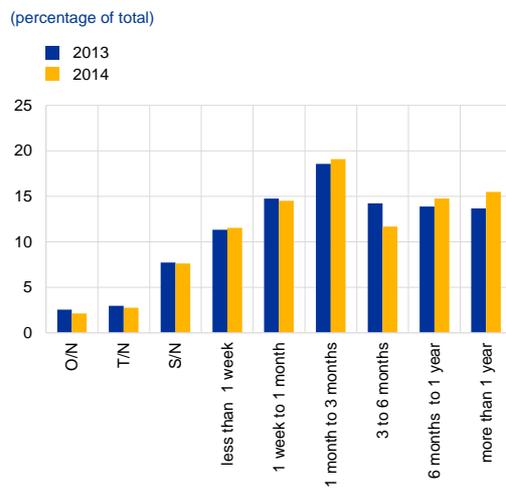
Source: JP Morgan.  
Note: Dotted lines represent 2015FY forecasts.

**Chart 1.9**  
**European high-yield issuer net leverage**



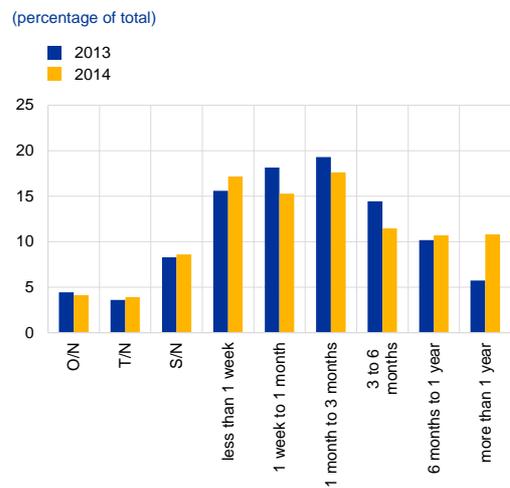
Source: JP Morgan, S&P Capital IQ.  
Note: Historical series adjusted for composition changes.

**Chart 1.10**  
**Maturity-weighted breakdown of cumulative quarterly turnover in secured lending**



Source: JP Morgan, S&P Capital IQ.  
Note: The panel comprised 154 institutions.

**Chart 1.11**  
**Maturity-weighted breakdown of cumulative quarterly turnover in secured borrowing**



Source: JP Morgan, S&P Capital IQ.  
Note: The panel comprised 154 institutions.



## Annex 2

### Are corporate bond spreads mispriced?

Deciding whether asset prices are “mispriced” is challenging since there is no consensus on how to measure fair value. However, given the low interest rate environment, it is natural to ask whether recent developments are a reflection of investors’ increased risk taking – i.e. a focus on “current yield” (e.g. high coupons on a corporate bond) or whether low corporate bond yield spreads are driven by long-term investment decisions based on economic fundamentals.

To address this question, individual bond data for nine euro area countries (AU, BE, DE, ES, FR, FI, IE, IT, NL) were used, including both investment-grade and high-yield bonds issued in euros by the non-financial sector with a duration of above one year but below 30 years. In total, about 104,000 observations were collected (84,000 for investment-grade bonds and 20,000 for high-yield bonds). The sample period was October 1999 to March 2016, covering about 2,529 bonds (1,919 in the investment-grade segment and 770 in the high-yield segment).

The framework described in detail in De Santis (2016) is a static panel model with two-way clustering across countries and over time to take into account potential correlation across time and within countries, which can be summarised by the following expression:

$$Y(i, m, j, c, t) = a * X(i, m, j, c, t) + d(j) + error(i, m, j, c, t)$$

where  $Y(i, m, j, c, t)$  is (the log of) the spread of corporate bond  $i$  with duration  $m$ , in sector  $j$ , in country  $c$  and at time  $t$ ;  $X(i, m, j, c, t)$  is a vector of determinants;  $error(i, m, j, c, t)$  is the error term; and  $d(j)$  is a sector-specific constant to capture unobserved heterogeneity across sectors. Credit risk is proxied by (i) bond-specific credit ratings; (ii) the median of sector and country-specific expected default frequencies; and (iii) sector and country-specific realised stock market volatilities. Systematic risk is proxied by (i) expected (consensus) real GDP growth one year ahead; (ii) expected (consensus) inflation one year ahead; (iii) the 3-month EA OIS rate; and the standard deviation among professional forecasters of (iv) country-specific expected real GDP growth and (v) expected inflation one year ahead. Other term premia are proxied by bond-specific (i) duration, (ii) coupon and (iii) outstanding amount.

In a second step, we regress

$$error(i, m, j, c, t) = f(t) * D(t) + eta(i, m, j, c, t)$$

where  $D(t)$  is a time-varying dummy to capture pricing effects that are not explained by fundamentals and are common across countries, and  $eta(i, m, j, c, t)$  are model residuals containing idiosyncratic credit and liquidity risk premia which cannot be observed and cannot be easily controlled (i.e. the publication of firms’ reports, news on mergers and acquisitions, news on earnings, etc.).

The variable  $f(t)$  is the time-varying coefficient of interest: after controlling for credit risk and systematic risks,  $f(t)$  fluctuates around zero if the bond is not mispriced. If corporate bond spreads are misaligned, then  $f(t)$  will be systematically negative (possible indicator of the underpricing of risk) or positive (possible indicator of the overpricing of risk). De Santis (2016) shows how the estimated  $f(t)$  can be used to compute the relative excess bond premium, i.e. the excess bond premium as a percentage of the justified credit spreads.

The key results for the euro area are reported in Chart 2.1. They suggest that risk has been underpriced in the investment-grade segment since August 2014, when the launch of the ECB’s Public Sector Purchase Program (PSPP) became more likely. However, the degree of valuation



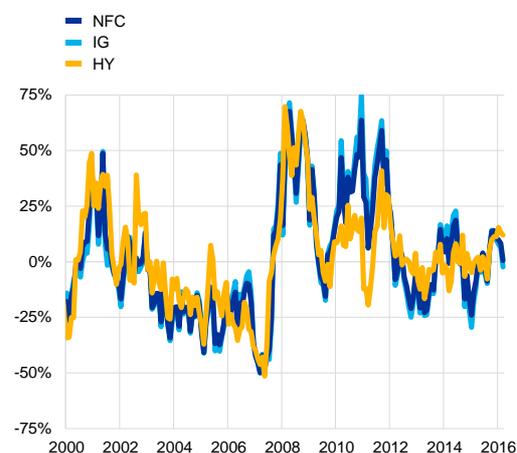
risk, defined as the excess bond premium measured as a percentage of fair value, turned positive in 2015 as a result of the downside risk for economic activity in Asia and the fall in commodity prices, and is estimated at its fair value in 2016. Moreover, credit spreads in the high-yield segment have been close to their fundamental values since end-2012. There is no evidence of the underpricing of risk in the high-yield segment.

Results for individual countries are shown in Chart 2.2 based on the following second step:

$$error(i, m, j, c, t) = f(t, c) * D(t, c) + eta(i, m, j, c, t)$$

where  $D(t, c)$  is a time-varying country-specific dummy to capture pricing effects that are not explained by fundamentals and are potentially common within countries.

**Chart 2.1**  
**Misalignment in EA non-financial corporate spreads – Relative Excess Bond Premium**  
 (Oct. 1999 – Mar. 2016)



Source: De Santis (2016), "Credit Spreads, Economic Activity and Fragmentation", ECB Working Papers, No 1930.  
 Note: The relative excess bond premium is defined as the difference between actual and justified credit spreads as a percentage of the justified credit spreads.

Before the financial crisis started in August 2007, corporate bond spreads were below fundamental values in all countries except for Austria. Between Lehman's bankruptcy in September 2008 and the end of 2011, corporate spreads in the investment-grade segment were above fundamental values in all euro area countries. The adjustment took place after the launch of the 3-year LTROs in December 2011. Valuation risk was subsequently negative in many countries in 2012 and 2013, before aligning again with the fundamentals at the end of 2013. Conversely, the degree of under- and overvaluation in the high-yield segment has fluctuated more frequently since Lehman's bankruptcy. The only exception is the undervaluation in Spain, Italy, Germany and the Netherlands in 2012 and 2013. More recently, credit spreads have been close to their fundamental values in many countries, with the exception of Spain. This contrasts with developments in the high-yield segment where in some countries, such as Belgium, France,

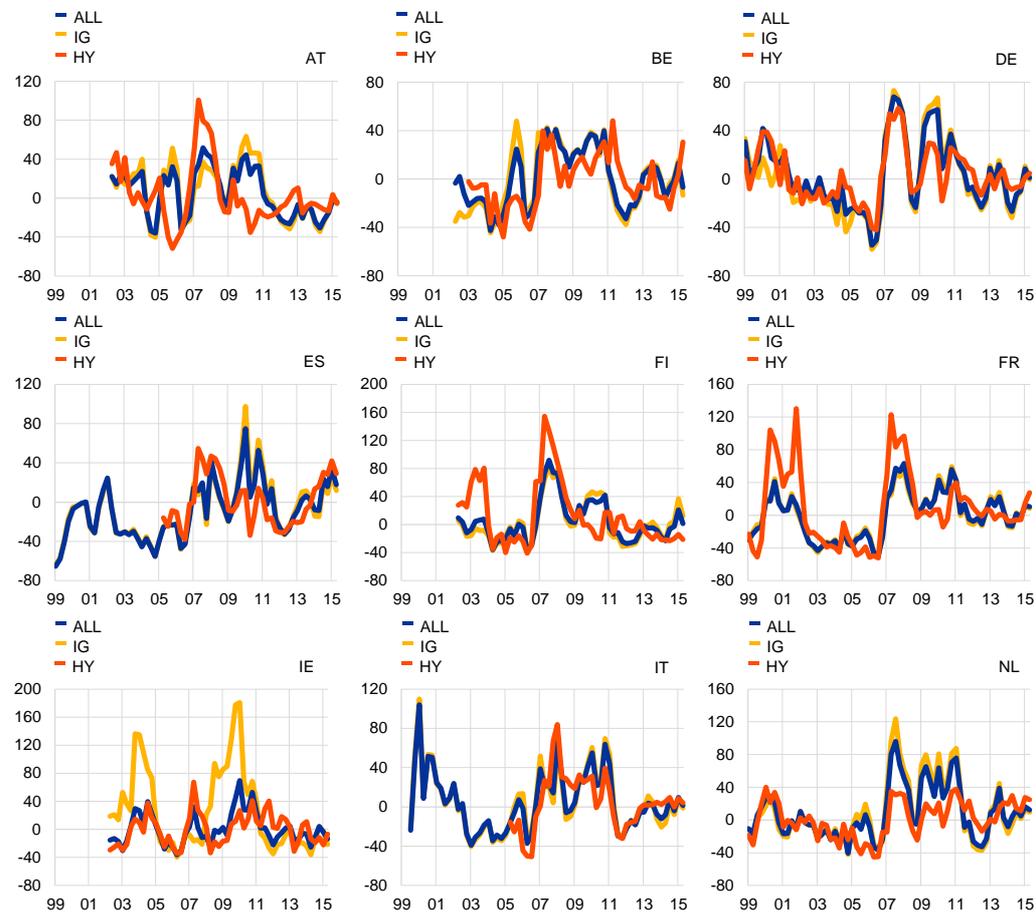
Spain and the Netherlands, valuation risk is estimated to be positive, which means that risk is not underpriced.



Chart 2.2

Misalignment in selected euro area countries' non-financial corporate spreads

(percentage)



Source: De Santis (2016), "Credit Spreads, Economic Activity and Fragmentation", ECB Working Paper, No. 1930.

Note: The relative excess bond premium is defined as the difference between actual and justified credit spreads as a percentage of the justified credit spreads.



## Annex 3

# The bond fund industry and hedging against interest rate volatility

The increasing depth of financial markets and the growing complexity of professional investors' risk management techniques have, in recent years, incentivised an increased use of hedging techniques to insure against various market risks. A typical example, interest rate risk, is particularly important for professional investors in fixed-income markets and is frequently hedged through swaptions – i.e. options on interest rate swaps. The observed divergence between implied and realised volatility (the volatility premium) shows that risk costs are partly based on investors' risk aversion and their inability to perfectly anticipate interest rate volatility.

In order to assess the use of swaptions by investment funds for hedging purposes, and to understand whether the difference between implied and realised volatilities may have an impact on bond fund returns, we regress

$$r_t = c + \beta IV_t + \theta X_t + \epsilon_t \quad (1)$$

where  $r_t$  is the monthly rate of return for EU bond funds,  $IV$  is the volatility premium computed as the difference between the implied and realised interest rate volatility indicated by swaption contracts, and  $X$  is a vector of controls including bond index returns, and liquidity, credit and term-structure risk premia. We use monthly data from January 2007 to June 2015. Our dependent variable  $r_t$  is computed as the average monthly rates of return for all EU bond funds (around 27,000) using individual fund data obtained from Thomson Reuters Lipper. Realised volatility of the underlying asset is computed as the standard deviation over either 22 working days (for the ICAP euro vs. Euribor 1m10y swaption) or 66 working days (for the ICAP euro vs. Euribor 3m10y swaption).<sup>29</sup> We compute two different versions of volatility premia: the first is calculated by matching current market expectations of future interest rates from current swaption prices with the standard deviation of average bond fund returns realised in the past; the second is calculated by matching the standard deviation of average bond fund returns realised in the past with the information from the swaption contracts traded at the beginning of the period used for the computation of the realised volatility. Our controls,  $X_t$ , include monthly returns of the Iboxx benchmark bond index (BI) covering all sectors and maturities, a liquidity risk premium (3M EU sovereign benchmark bonds minus 3M Euribor, LP in Tables 1-4), a term structure premium (7-10Y EU sovereign benchmark bonds minus 3M EU sovereign T-bills, TP in Tables 1-4), and a credit premium (Iboxx 7-10Y EU corporate minus Iboxx 7-10Y EU sovereign, CP in Tables 1-4). Given the construction of the controls, these variables are correlated and liquidity and credit risk premia are orthogonalised by regressing the first on the second, dropping the second from the set of controls, and using the residuals of the auxiliary regression in their place. The fixed term,  $c$ , is the constant in the regression.

Our hypothesis is that  $\beta > 0$  because the fund industry should benefit from this hedging activity. A positive  $\beta$  has several non-exclusive interpretations: a) there is positive demand in the market for volatility hedges, b) the bond fund industry benefits from hedging volatility and c) there is an economic incentive for hedging interest rate volatility, although swaption prices are imperfect monitoring devices that exaggerate expectations of future interest rate volatility and add valuation risk to markets. The ex post volatility premium indicates that ex ante volatility risks are expected to

<sup>29</sup> Implied volatilities are downloaded directly from Thomson Reuters Datastream and computed by ICAP.



be more pronounced and that the market does not, in general, perfectly predict the future course of interest rate volatility. This can be interpreted as a form of imperfect asset pricing or, alternatively, as the effect of agents' risk aversion. However, even in the latter case, dynamically, the premium should be corrected, at least marginally, over time, as a persistent overestimation that generated costs would not be efficient over time.

The results of various regressions provide support to our hypothesis of a positive relationship between the volatility premium and the bond fund sector's average returns. In particular, for models with a time horizon of one month for swaptions volatility hedging, coefficients for the volatility premium and its lags are positive in the majority of cases, especially those significant at the 10% level or higher and those that are more contemporaneous (see Table 1). Matching the horizons of implied and realised volatilities in interest rates lowers the size and the significance of coefficients significantly (see Table 3). The results for the model with a horizon of three months for swaptions volatility hedging are similar (see Tables 2 and 4). However, due to the longer time horizon of the forward-looking swaption contract, significant positive coefficients appear more frequently in the second lag of the volatility premium, signalling that hedging activity impacts the returns of the bond fund sector with some delay. The generally low size of the significant coefficients is not surprising: hedging should generate a positive, but mild, impact on profitability as its expected benefits should at least cover hedging costs.

The results are fairly robust model variations: adding various combinations of control variables, using different versions of volatility premia, both in terms of the construction and lengths of swaption contracts, does not significantly impact on the qualitative results. The goodness of fit measure R2 increases with the integration of more control variables. However, as our goal is not to fully explain bond fund sector returns, but only to gauge the qualitative nature of the marginal impact of the volatility premium on this variable, this is not critical to our analysis.

Tables 1-4

Table 1				Table 2								
	1 BF and IR_1m10y no overlap			BF and IR_3m10y no overlap								
IV	0.0555	0.0556	0.00349	0.0368	0.00980	0.0556	0.0195	0.0230				
IV 1L	0.0192	0.0198	0.00543	-0.0514	-0.0240	0.0198	-0.0114		0.0212			
IV 2L	0.0138	0.0139	0.00637	0.0532	0.0489	0.0139	0.0308				0.0238	
IV 3L	0.00356	0.00379	0.0104	-0.0373	-0.0280	0.00379	-0.0156					
IV 4L	-0.0434	-0.0432	-0.0286	0.0214	0.0121	-0.0432	0.0102					
BI10Y					0.419							
BI All			0.495					0.471	0.454	0.514	0.513	
LP			0.0492									
TP		0.0698	-0.888			0.0698	-1.059	-0.960	-0.938	-1.039		
CP			-2.137				-2.310	-2.364	-2.331	-2.260		
C	0.280	0.275	0.382	0.276	0.207	0.275	0.140	0.210	0.218	0.204		
Obs	97	97	97	97	97	97	97	101	100	99		
R2	0.128	0.128	0.469	0.080	0.266	0.128	0.497	0.478	0.476	0.482		
Significance:			***		**		*					





## Annex 4

### The impact of regulatory reform

It is likely that the post-crisis regulatory reform process is affecting the functioning of markets. The banking system is now more resilient due to the higher capital and new liquidity requirements introduced by Basel III (via the CRR/CRDIV in the EU). Policymakers have supported a move to central clearing to reduce counterparty risk and have introduced reporting requirements to increase transparency in OTC derivatives markets. In December 2015, the Regulation on Transparency of Securities Financing Transactions (SFTR) was adopted, significantly improving the transparency of secured funding markets, facilitating monitoring and mitigating the risks associated with market-based financing. Bank structural reforms have been implemented to reduce risks associated with systemically important institutions. MiFID 2 and MiFIR, the new EU legislative framework for markets in financial instruments, encompassing rules and guidelines on execution venues, transaction execution and pre- and post-trade transparency, has also been adopted, but is yet to enter into force.<sup>30</sup>

Some of these reforms may have interacted with the low interest rate environment to reduce the role of securities dealers in markets. Elements of certain regulatory reforms, especially the increase in capital requirements for bank dealers, have increased the capital costs of holding inventories of securities. This has put downward pressure on market makers' return on equity and required significant changes to business models (Chart 4 – LHS). Restrictions on proprietary trading and the ring-fencing of some trading activities introduced by bank structural reforms, coupled with other factors such as the earlier pressure from shareholders to scale down these activities, have also been important influences on market makers' risk appetite. At the same time, the low interest rate environment could be contributing to lower profits realised on dealer inventories, by compressing yields, and hence the "carry" of bond holdings. All these factors have contributed to a decline in dealer inventories and, potentially, their willingness to supply liquidity in some markets.

The shift in some countries towards market-consistent valuation and risk-based capital requirements in both the insurance and pension fund sectors may encourage pro-cyclicality in asset allocations and investor behaviour in response to shocks.<sup>31</sup> In order to counteract these unintended consequences, the Long Term Guarantee measures and UFR included in Solvency II are designed to avoid excessive volatility in insurers' balance sheets.

The role of CCPs in the financial system and the prudential regulation governing CCPs have been enhanced since the financial crisis. The G20 agreement in September 2009 that "all standardized OTC derivative contracts should be traded on exchanges or electronic trading platforms, where appropriate, and cleared through central counterparties" and "Non-centrally cleared contracts should be subject to higher capital requirements" (Pittsburgh, 2009) has been implemented in several jurisdictions through regulatory changes and has significantly increased the proportion of OTC derivatives that is cleared through CCPs (Chart 4.1 – RHS). A stronger preference for conducting secured money market transactions against general collateral, and with limited counterparty credit risk, has also led to an increase in the central clearing of repo transactions in the euro area (ECB, 2015a). The move towards central clearing has been accompanied by the

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<sup>30</sup> See "European Commission extends by one year the application date for the MiFID II package" ([European Commission](#)).

<sup>31</sup> This could materialise because sudden falls in the value of assets may reduce measured solvency due to marking to market, at the same time as they increase risk-based capital or funding requirements; see "Procyclicality and structural trends in investment allocation by insurance companies and pension funds: Discussion Paper by the Bank of England and the Procyclicality Working Group", July 2014.

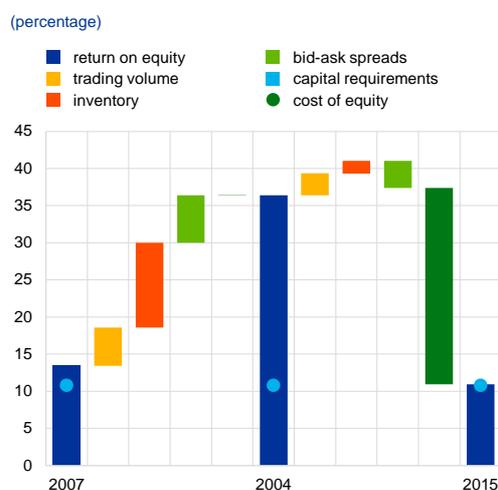


enhanced prudential regulation of CCPs and their risk management practices (CPSS-IOSCO (2012) and EMIR (2012)). Nevertheless, the failure of a CCP can never be completely ruled out and the concentration of counterparty risk in CCPs means that a CCP could trigger or transmit significant stress in the financial markets, even under a scenario where the CCP does not go into resolution.

Regulatory reforms have generally made the financial system, and especially the banking sector, more resilient to shocks. The resilience of intermediaries and markets is mutually reinforcing and only resilient institutions will be in a position to provide liquidity when it matters most, i.e. in periods of market stress. Higher capital requirements and lower leverage will ensure that banks can absorb losses that may arise from changes in asset prices due to a gradual reversal of interest rates, and other factors. In addition, the intended de-risking of banks could also have the effect of reducing pro-cyclical trading in stressed or volatile market conditions. New liquidity requirements will allow institutions to weather adverse shocks if market liquidity suddenly dries up. In addition, as banks have become less vulnerable to liquidity shocks, the links between funding and market liquidity have weakened, possibly facilitating more resilient market-making under normal conditions. The potential for liquidity contagion between banks has also been reduced.<sup>32</sup>

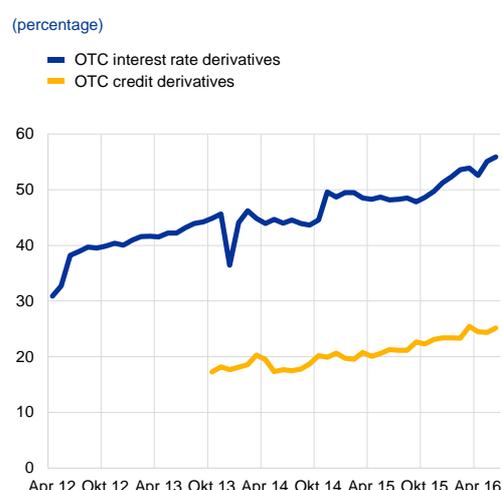
**Chart 4.1**  
**Regulatory reform is affecting market makers and the extent of central clearing**

**Decomposition of market makers' ROE**



Source: ESRB.

**Proportion of the outstanding stock of OTC interest rate and credit derivatives that is centrally cleared**



Source: Bank of England (2015). Based on DTCC trade information warehouse reports; Bank of England calculations.

<sup>32</sup> Fender and Lewrick (2015) point to several notions of illiquidity contagion that have been studied in the literature including, for example, Huberman and Halka (2001) and Comerton-Forde et al. (2010).



## Annex 5

# Low interest rates, regulatory reform, and the changing nature of market making

### Market making

Market making in fixed income has traditionally taken place on a principal basis, whereby dealers take on exposure to securities they hold as inventories, which also need to be funded. In this regard, an important component of the profitability of traditional market making is so-called inventory revenues. In contrast to this model, agency-based market making involves dealers simply intermediating between buyers and sellers, with the aim of locking-in a margin on the securities they sell (vs. the price at which they were purchased, i.e. “realising the bid-offer spread”), without taking on risk or using the balance sheet for inventory holdings. Thus, facilitation revenues are part of both principal and agency-based market-making models. Whilst the provision of immediacy services (under an agency-based model) supports market liquidity and price discovery, it is the capacity of banks to step in as counterparties to their clients' trades (the principal-based model) that helps “ensure the robustness of market liquidity by absorbing temporary supply and demand imbalances, dampening the impact of shocks on market volatility and quoting prices to support investors in valuing assets” (BIS (2014)).

### Risk-weighted capital requirements

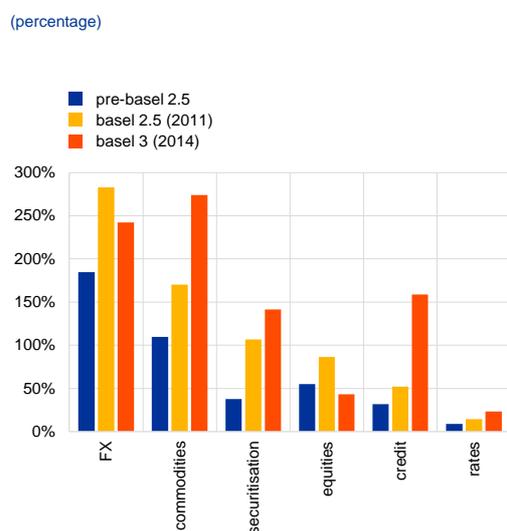
Elements of bank prudential regulation could be negatively impacting principal-based market-making in some fixed-income assets, mainly due to the increased capital cost of holding inventories. Changes to the market-risk framework under the so-called Basel 2.5 standard (CRD III in the EU) have been estimated by the BCBS to have contributed to an average increase in RWAs of 3.6% for large and internationally active banks, while IRC and SVaR capital charges account for 0.7% and 1.6% of these banks' total capital requirements respectively<sup>33</sup>. Risk-weighted capital charges have also significantly increased across different business areas and markets since the introduction of the Basel III standard (CRR in the EU), especially for corporate credit (Chart 5.1). At the same time, sovereign bonds denominated and funded in local currencies within the EU benefit from special treatment with regard to bank prudential regulation. This entails no capital cost when these bonds are held in inventory, which – combined with higher capital requirements for other bonds – could be contributing to a concentration of market-making activities in more liquid/lower-risk securities, while liquidity is deteriorating in higher-risk securities. Fender and Lewrick (2015) identify signs of such “liquidity bifurcation” due to a combination of post-crisis cyclical conditions (such as diminished bank risk appetite and strong bond issuance) and structural changes in the markets themselves (such as tighter risk management or regulatory constraints). An analysis carried out by PwC, consistent with the reduction in the number of active market makers in corporate bond markets, suggests that the business lines that have experienced the highest increase in capital intensity are also those in which banks have most actively reduced activity (Chart 5.2).

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<sup>33</sup> See BCBS Basel III Monitoring Report, March 2014. Note: the potential impact of the ongoing fundamental review of the trading book (e.g. proposed transition from VaR to expected shortfall measures) is also still uncertain.

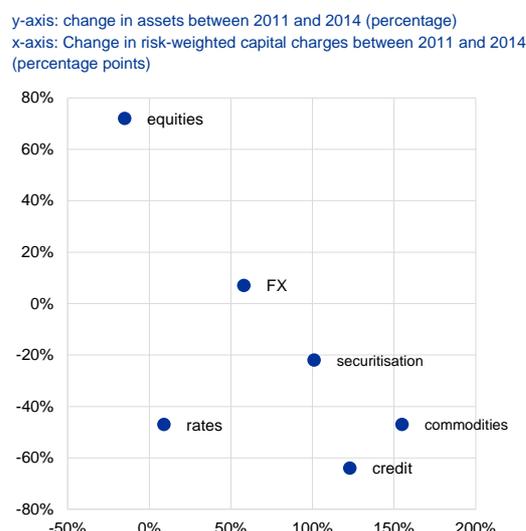


**Chart 5.1**  
**Changes in RW capital charges due to changes in the Basel capital regime**



Source: PwC analysis, Tricumen (PwC Global financial market liquidity study, August 2015).

**Chart 5.2**  
**Degree of asset reduction in relation to change in RW capital charges by area of capital markets activity**



Source: PwC analysis, Tricumen (PwC Global financial market liquidity study, August 2015).

### Leverage ratio

Though not yet implemented as a prudential requirement in the EU, the leverage ratio could affect liquidity in some market segments, both directly and indirectly.<sup>34</sup> As with risk-based capital requirements, one possible direct effect of the leverage ratio on market-making and liquidity could stem from an increase in capital, and hence inventory, costs which cannot be sufficiently offset by facilitation revenues. While risk-based capital requirements have a relatively greater impact on riskier securities, such as corporate bonds and ABS, the leverage ratio could additionally constrain the lower-margin/high-volume market-making in sovereign bonds. Furthermore, it could have indirect adverse effects through its contribution to reducing dealer repo activity (also low margin and balance-sheet intensive) which could pose challenges for market makers in managing their securities' inventories (for instance, it may no longer be cost-effective to repo certain bonds, thereby earning an incremental margin on holdings). This could also have the undesired effect of tightening the supply of high-grade securities to the market via banks' reverse repo activities. Survey evidence indicates that market participants consider the leverage ratio to have a greater impact on their fixed-income business than other regulatory reforms.<sup>35</sup>

<sup>34</sup> This could be the case because the largest market-makers globally are subject to such requirements on a consolidated basis in the US and the UK, while other European dealers could also seek compliance with the Basel III leverage standard due to market and competitive pressures (compliance in many cases is also the result of higher risk-based capital requirements in general).

<sup>35</sup> More than half of the participants in a July 2014 BIS CGFS survey of major market makers (from 11 advanced and six emerging market economies, covering 40 and 44 participants, respectively) attributed at least a moderate decline in their facilitation activities to the introduction of the leverage ratio, and roughly two-thirds expected at least a moderate decrease in bond inventories and trading profits. Roughly half of the US and UK respondents suggested a significant decrease in facilitation activities and inventories.



## Liquidity requirements

Prudential liquidity requirements may contribute to higher funding costs for dealers' activities and to liquidity bifurcation, although they do not appear to be significantly affecting market making in general. On the one hand, the LCR requirement could support demand for eligible high-quality liquid assets (HQLA) such as government bonds, while potentially making lower-quality/ineligible assets relatively less attractive. This could lead to liquidity bifurcation effects following the reallocation of dealer inventories away from non-eligible assets (e.g. corporate bonds). It is worth noting in this regard that under the LCR standard in the EU, eligible assets also include some less-liquid securities such as ABS, the demand for which would therefore also be supported. However, as markets become more volatile, the demand for HQLA is likely to increase even more, while the holders of these assets will be less willing to lend them (the effects of the leverage ratio on repo activity could also be involved), reducing their total supply. With regard to the NSFR – still under calibration – a possible adverse effect could materialise via increased short-term funding costs, which could act as a disincentive to securities trading (generally funded short-term via repo or a bank's internal treasury function). On the other hand, the new prudential liquidity requirements will allow banks to weather adverse shocks if market liquidity suddenly dries up. Survey evidence also indicates that market participants do not expect significant adverse effects on their market-making activities stemming from the new liquidity rules, although significant deterioration is expected by some dealers in the HY credit space.<sup>36</sup>

## Post-trade transparency and mandatory buy-in requirements

Price transparency is desirable in that it supports market liquidity,<sup>37</sup> although in fixed-income markets it may limit dealers' capacity to make profits by realising bid-offer spreads and closing out risk positions. In a study covering US securities markets, Asquith et al. (2013) find that "mandated transparency may help some investors and dealers through a decline in price dispersion, while harming others through a reduction in trading activity", with credit quality being the most consistent factor explaining the reduction in trading activity (a 41.3% reduction in trading activity was observed for HY bonds). Since MiFID 2 and MiFIR are yet to enter into force and their effects are therefore still unknown, efforts are already under way, via level 2 measures, to address the potentially adverse effects of post-trade transparency in fixed-income markets, through introducing, for large-in-size transactions and those in illiquid securities, appropriate time lags before disclosure is required.

Mandatory buy-in requirements (CSD) have a positive impact on settlement discipline, although they will impose additional risks and costs on market makers. Market makers who supply liquidity in securities they do not necessarily hold in inventory (also as a result of increased balance sheet costs in accordance with prudential requirements) are subject to an additional risk. They may therefore pass on the additional cost in the form, for example, of an additional premium to their market offers, or may simply choose not to show offers in certain securities.

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<sup>36</sup> More than half of the respondents to the July 2014 BIS CGFS survey of major market-makers anticipated no change to their institution's facilitation activities in response to the introduction of the LCR and NSFR. Roughly 10% of the respondents anticipated a significant decrease in facilitation activities and inventories for HY credits.

<sup>37</sup> See, e.g. on US markets: Bessembinder, Maxwell, Venkataraman (2006), "Market transparency, liquidity externalities, and institutional trading costs in corporate bonds", *Journal of Financial Economics* 82-2; Cici, Gibson, Merrick (2011), "Missing the marks? Dispersion in corporate bond valuations across mutual funds", *Journal of Financial Economics* 101; Goldstein, Hotchkiss, Sirri (2007), "Transparency and liquidity: a controlled experiment on corporate bonds", *Review of Financial Studies* 20-2.



### The interplay between the low interest rate environment and market-driven factors

While certain regulatory effects may have contributed to a reduced tolerance of risk by dealers, this is difficult to determine conclusively as other factors have also played a role. On the one hand, having incurred large trading losses in the wake of the crisis, many banks came under pressure from shareholders and creditors to rapidly deleverage and de-risk their balance sheets<sup>38</sup> (e.g. through scaling down/withdrawing from proprietary trading) and improve risk management. An analysis conducted by the BIS found that reductions in net trading positions were associated with higher regulatory capital ratios, with European banks that had suffered large trading losses in 2008 among those carrying out the biggest adjustments to both measures (T1 regulatory capital and net trading securities). At the same time, the low interest-rate environment is depressing both facilitation revenues (by keeping bid-offer spreads tight) and profits realised on dealer inventories (by compressing yields), and therefore also the “carry” of bond holdings. Against this backdrop and given economies-of-scale effects (it only makes sense to engage in low-margin business if sufficient volumes can be executed) as well as competitive pressures (which could prevent banks from passing on increased costs to the market), the risk-return trade-off of market-making is being reassessed by many banks as they adapt business models to the many structural and cyclical changes affecting the functioning of markets. In addition, the willingness of dealers to hold inventories also depends on their ability to hedge the risk, the relative mispricing of very similar bonds (“buy cheap-sell expensive”) and their views on future interest rates.

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<sup>38</sup> This is connected to the effects produced by regulatory requirements and supervisory exercises, but possibly starting at an earlier time, soon after the onset of the crisis.



## Annex 6

### The risks linked to the use of the euro as a funding currency for carry trade activity

Strictly speaking, carry trades seek to profit from the interest rate differentials between two currencies by funding investments in high-yield currencies with borrowing in low-yield currencies. In particular, borrowing in Japanese yen and Swiss francs has been known to fund investments in emerging currency assets. Carry trades are generally unhedged, leading to exchange rate and credit risks, and are highly leveraged (Curcuro et al. (2010)).

Carry trades link domestic and international markets on the basis of exchange rates and through capital flows, leading to contagion and exchange rate misalignments when the flows are reversed. For example, the Swiss franc experienced a bout of appreciation in 2011 due to a risk-on episode that was independent of its domestic situation, but which notably affected its domestic financial markets. Accordingly, between 1 July 2011 and 10 August 2011 the Swiss franc rallied by almost 16% against the euro, while the SMI equity index fell by 23% (Chart 1).

In a low interest rate environment the euro is likely to be used as a funding currency for carry trades. The resulting risks were highlighted in the ESRB (2011) report:

- “Low interest rates [...] have an international dimension: they play a role in promoting cross border carry trade activity, and can cause exchange rate misalignments”
- “The risks associated with carry trade strategies include not only the excessive exchange rate volatility, but also asset price volatility and large losses following defaults of banking book exposures to unhedged borrowers”

Chart 6.1  
EUR/CHF and SMI equity index



Source: Bloomberg.

Meanwhile, the recent divergence of monetary policies on the two sides of the Atlantic has increased the euro's attractiveness as a funding currency, raising financial stability risks in the event of a reversal. The share of the euro in international debt issuance increased from 20% in 2014Q1 to 29.2% in 2015Q1 (ECB (2015b)), possibly reflecting a rise in carry trade activity.

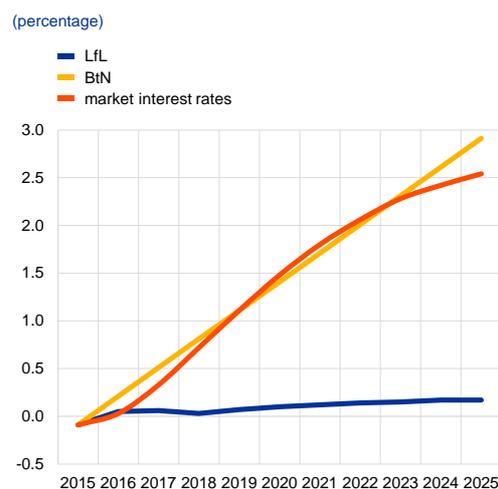
In a prolonged period of low interest rates, the build-up of carry trade positions funded in euros could trigger a progressive depreciation of the exchange rate to below its equilibrium level. An abrupt unwinding of carry trade positions could result in a rapid appreciation of the euro, possibly spreading to the broader financial system through increased asset price volatility, defaults on leveraged positions and an impact on international trade.



## Annex 7

### Demographics and asset prices

Chart 7.1  
Implied 1Y forward interest rates in the two scenarios and in the data (Dec. 2015)



Market expectations concerning the future path of interest rates, as indicated by forward yields (see Chart 2), appear, after an initial delay, to point to a steeper increase in implied 1Y-forward interest rates over the coming years than the linear normalisation paths used as input for the model simulations presented in Section A of this technical documentation.<sup>39</sup>

This difference might imply more erratic adjustments to bond and asset prices along the path of adjustment to new long-run equilibria, as predicted by the scenarios used in this report. In addition, market rates appear to factor in a fairly high probability of back-to-normal style scenarios. Thus, according to market rates, ancillary risks are mainly seen around the readjustment path to higher levels of interest rates.

#### Low for long

If low interest rates were to persist for a considerable period of time, all scenarios would imply negative real interest rates and/or low or negative risk premia. This would sustain elements of speculative demand in asset markets and would tend to support further price increases in bond markets. Modest expected growth rates in per capita income and currently observable trends towards higher income concentration would generally support demand for fixed income products, further reinforcing search-for-yield behaviour, which appears to be sustained in these scenarios. Real short-term interest rates below expected GDP growth rates encourage borrowing, even if it is unsustainable in the long run. Consequent asset prices misalignments would distort the efficiency of the aggregate investment portfolio.

Declines in population growth are among the drivers of such trends, as less investment is needed to provide a slower-growing labour force with new capital, thereby moderating demand for credit and the supply of debt securities, and lowering long-run interest rates.<sup>40</sup> In addition, lower population growth is likely to moderate productivity by reducing incentives to incur the fixed costs of R&D and innovation, implying fewer economies of scale in the generation of new knowledge, and a

<sup>39</sup> Cf. Technical Documentation: Section A, p.18, Fig. 4.1.

<sup>40</sup> Executive Office of the President of the United States (2015), "Long-term interest rates: a survey". p.35.



slowdown in the adoption of productivity-enhancing innovations.<sup>41</sup> Moderate technological progress would also mute marginal returns on capital, further lowering interest rate levels.

However, a breakdown of projected real interest rates under the “low for long” scenario into population growth, technological progress and capital depreciation<sup>42</sup> implies a depreciation rate of below 2%, markedly lower than that suggested by the empirical literature.<sup>43</sup> Adjusting this upwards would increase real interest rates and reduce the prices of fixed-income assets, thereby qualifying current valuation assessments to some degree.

Given a flat path for interest rates, real equity prices are expected to fall in the EU over the next ten years. Demographic trends support this drift, as the life-cycle theory of saving and portfolio choice suggests that with an ageing population and increasing dependency ratios, preferences for riskier asset classes tend to weaken. In order to address increased longevity and risk aversion, investors may move from equities to long-term bonds, potentially depressing share prices and flattening the yield curve further.<sup>44</sup> A 2012 Credit Suisse analysis for the US, forecasting massive decreases in the P/E ratios of US stocks due to a projected decline in the ratio of the middle-aged to the older population, delivers additional support for the argument.<sup>45</sup>

Structural export surpluses might soften the asset price impact of demographic changes through capital imports, potentially supporting equity and other asset prices. Countries experiencing longer life expectancies, however, tend to increase their net foreign positions, thereby effectively exporting capital and compensating for the downward pressure on interest rates. In addition, patterns of demographic change are qualitatively similar in most advanced and major emerging markets, reducing the pool of sources of potential capital imports around the globe. Nevertheless, as also discussed in Backus et al. (2014)<sup>46</sup>, heterogeneity in the timing and size of demographic trends, combined with the relative openness of mature economies, could allow international capital flows to act as a buffer, moderating the otherwise stronger impact on the net demand for assets driven by internal forces. Cross-jurisdictional evidence for the EU shows that members with a lower capital account surplus typically forecast more moderate increases in dependency ratios over the next ten years, adding further weight to the argument.

## Back to normal

Various “back to normal” scenarios show considerable variations in possible short-term interest rate paths over the next ten years. EU average short-term interest rates in 2025 are expected to be in the range of -1% to 2.7%. This range would imply real term spreads of between 1% and 5%,

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<sup>41</sup> See Romer, D. (2011), "Endogenous Growth", Advanced Macroeconomics (Fourth ed.), New York McGraw-Hill.

<sup>42</sup> This is the decomposition of interest rates at the Golden Rule level for capital accumulation of an augmented Solow model or, more generally, of an augmented Cass-Koopmann model, where the rate of time preference is positive, e.g. as implied by a discount factor below 1.

<sup>43</sup> Depreciation rates suggested for EU members exceed 2% except for one estimate for Greece, according to different sources. Some estimates exceed 4% and, in particular, estimates for Germany are close to 10%. Goerzig, Bernd (2007), Depreciation in EU Member States: Empirical and Methodological Differences. DIW. IMF (2015), Investment in the Euro Area: Why Has It Been Weak? IMF Working Paper 15/32.

<sup>44</sup> Ageing and pension system reform: implications for financial markets and economic policies, G10 report, September 2005, [G10 report](#)

<sup>45</sup> Credit Suisse (2012): How demographics affect asset prices. Global Demographics and pensions research.

<sup>46</sup> Backus, David, Cooley, Thomas and Henriksen, Espen (2014): Demography and low-frequency capital flows. Journal of International Economics 92 Supplement, pp. 94-102.



leaving ample room for the reestablishment of risk, maturity and liquidity premia, possibly driven by demographic trends since older investors tend to be relatively risk averse.

Considerable uncertainties therefore remain over the projected path of the interest rate adjustments, and unexpected shocks or surprises are likely to occur during the transition. Search-for-yield incentives should rebalance in such an environment, implying a stronger appetite for equity and lower increases in the demand for fixed-income instruments at the longer end of the spectrum.

However, reflecting foreseeable public budget constraints within the EU, due to negative population growth and a change in the demographic structure, it is reasonable to expect that the supply of sovereign debt will continue to increase with the rising cost of public pension schemes and social systems, including health care. Anticipating changes to the structure of asset demand across the maturity and risk spectrum, sovereign issuers might favour short-term debt in order to lock in low – or even negative – funding costs as long as these are available. Given that such incentives are pronounced for jurisdictions with less robust budgets, search-for-yield could be temporarily cemented into sovereign debt markets.

In line with market expectations, therefore, interest rates may, after plateauing initially at low levels, deviate from the path implied by the BTN scenario, generating lower price levels for debt securities as well as high price volatility, potentially accompanied by a temporary increase in the amount of short-term relative to long-term debt. Temporarily elevated volatility could have a negative effect on economic growth, particularly if adverse selection gears investors' portfolio choices towards safe-haven assets, thereby potentially crowding out private investment and limiting the paths of TFP growth and aggregate demand. Such effects may speed up the exit from search-for-yield strategies, with a negative impact on private investment demand and macroeconomic performance.

Decomposing real interest rates into population growth, technological progress and depreciation, interest rates might be expected to exceed the rates assumed under the "back to normal" scenario, mitigating the perceptible downward bias deriving from the unrealistically low assumptions for depreciation rates detailed above.

With expected real returns of between 0% and 3.6% on average in the EU, equities appear to be outperforming real short-term interest rates, although not necessarily long-term interest rates. This would imply the presence of substantial risk premia on equity, compatible with demographic trends.<sup>47</sup> Correcting, however, for underestimated depreciation rates, would erode this differential and make equities less attractive than short and long-term fixed income products. Thus, concerns over the profitability of financial entities could be reinforced insofar as their attractiveness depends exclusively on the performance of their assets.

Given a persistently ageing population and low factor productivity, the pressure on public budgets would be expected to increase if interest rates were to rise. This could mitigate the existing excess demand for assets in secondary markets and the performance of affected asset classes, in particular for many western EU members. Economic growth, generated by additional public spending could, however, partially compensate for this effect given higher disposable income and an associated increase in demand for financial assets.

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<sup>47</sup> The positive relation between the dependency ratio and the risk premium as a measure of risk aversion, however, appears to be driven by US evidence. For some EU countries, and even for shorter estimation samples for the US, the relation becomes a negative one. In addition, factors such as the presence of social security systems and the depth of the financial system appear to be involved, with the negative relationship between risk premium and the change in the proportion of the population over 65 being even more pronounced in countries with higher social benefits for this population group and less pronounced for countries with a deeper financial system. Cf. Ang, Maddaloni (2005), "Do demographic changes affect risk premiums? Evidence from international data", *Journal of Business* pp. 78-1.



## Annex 8

# Financial stability risks from investment funds in a low interest rate environment

### Redemption risk

Large-scale redemptions from investment funds may occur due to (i) the withdrawal of funds as a result of investors' rational reassessment of the outlook for asset prices or changes in their risk aversion; (ii) runs on funds driven by self-fulfilling panic (Diamond and Dybvig (1983)); or (iii) negative externalities (Chen, Goldstein, Jiang (2010)). The current EU regulatory framework provides asset managers with tools to manage larger-than-normal redemptions, and that are likely to remove any potential "first-mover" advantage. However, these tools might not be able to deal with large, concurrent and uncoordinated withdrawals from funds if asset valuations were to fall following a rapid and unexpected rise in rates, or if risk premia were to increase sharply for a significant period of time. The preliminary results of an ESRB market liquidity stress test of the European asset management sector show that, under the worst-case scenario modelled, HY, ABS and some IG bond markets could face problems absorbing larger redemptions. It remains unclear how markets would cope if several groups of investors were to act in a similar manner, and especially if market liquidity were scarce. As such, it remains unclear what set of necessary/sufficient conditions would render this risk a threat to financial stability (scope/scale), or which national jurisdictions have the macroprudential tools needed to deal with large redemptions.

### Leverage

Highly leveraged entities could pose a risk to financial stability if they are large and/or highly interconnected. Leverage can be either financial (through cash) or synthetic (through derivatives). Measuring synthetic leverage continues to be challenging and it is, therefore, difficult to assess to what extent the low interest rate environment has affected synthetic leverage. As a result, both financial and synthetic leverage need to be more closely monitored. With regard to financial leverage, in a low interest rate environment lower funding costs allow credit providers (such as prime brokers) to offer leverage at a lower cost. However, in the current environment, suppliers of leverage are also credit constrained by new regulations governing liquidity and capital. Moreover, it is unclear whether the demand for leverage has increased (we note that levels of financial leverage utilisation are rising but are still not particularly high). Additionally, current regulation provides tools for regulators to control leverage (UCITS limits and AIFMD macro tools). On the other hand, especially under the "low for long" scenario, conditions could develop whereby the supply and demand curves move to a higher utilisation of leverage.

### Interconnectedness

Search for yield fostered by a low interest rate environment could incentivise agents to invest/operate in markets/asset classes they are not used to, creating new links across markets and their operators. In this respect, the current need for extra yield (due to low interest rates) may be pushing asset managers to expand operations that could create new links among operators and sectors in the financial system, potentially increasing vulnerability to contagion effects. In particular, asset managers may lend securities more actively and, in fact, we have seen an increase in volumes of securities lending in the EU. It is unclear, however, to what extent this rise is down to regulation (in some cases securities lending is preferable to repos from a balance sheet point of view), on the need to obtain "term", on short-selling, or on search for yield.



### Money market funds

The current low interest rate environment is making it increasingly difficult for MMFs to deliver non-negative returns. While MMFs have so far been able to cope with negative rates, it is uncertain whether they could continue to operate in a negative interest environment in the long term if investors decided to withdraw their money. This could, in turn, have negative consequences for money markets, which are an important source of short-term funding (e.g. banks) and financing (e.g. trade, large conglomerates).



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