# D Higher future financial market volatility: potential triggers and amplifiers

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*The reduction in asset price volatility in recent years has taken place in tandem with investors lowering the premia required for lower-rated assets. The current favourable market sentiment could however change abruptly if, for instance, investors were to reassess the outlook for growth or monetary policy. Potential surges in asset price volatility could be amplified by: (i) investors selling off assets perceived as overvalued; (ii) the high levels of corporate leverage; and/or (iii) a rapid unwinding of market positions that benefit from low volatility. Low volatility in financial markets is therefore being closely monitored by financial stability authorities, as it may mask an underpricing of risks and a build-up of financial imbalances.*

## Introduction

**Asset price volatility stands at historically low levels.** One of the most prominent broad-based measures of global asset price volatility is the VIX index, which is a gauge of expected volatility of the US S&P 500 index. This metric, sometimes dubbed the "fear gauge", has been fluctuating at historically low levels in recent quarters. The low volatility extends beyond US stock markets, as asset price gyrations have been subdued across most asset classes and economies. This is consistent with the assessment that the drivers of lower volatility in recent years have also been global in nature, related to business cycle developments and very accommodative monetary policies across advanced economies (see also **Section 2**).

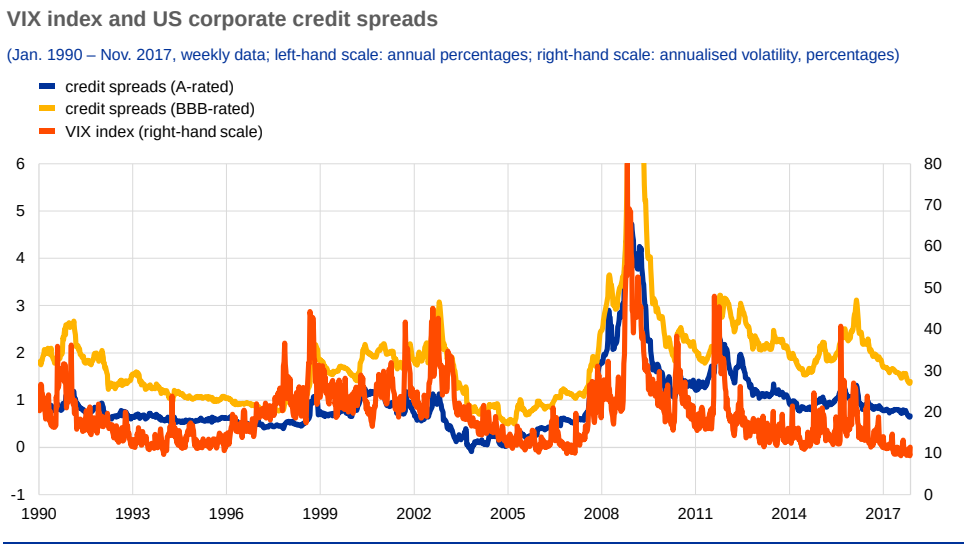
**Low financial market volatility can harbour risks to financial stability.** Low volatility in financial markets has materialised in an environment in which investors' search-for-yield behaviour has driven credit spreads down, particularly for assets with lower ratings (see **Chart D.1**). This environment may generate incentives for investors to engage in excessive risk-taking. Low financial market volatility may cause a rise in vulnerabilities stemming from financial institutions' risk management, given their widespread use of various value-at-risk (VaR) methods (a methodology which puts a high weight on the most recent observations). According to this risk metric, low financial market volatility reduces the expected loss over a given period, which may have further spurred risk-taking in the recent past. Low volatility may also encourage the build-up of leverage, synthetic or real. Furthermore, the low volatility observed for most global asset price indices has been driven by reduced correlations across the individual assets included in the indices. Investors may become overly complacent in such an environment, believing that their portfolios are adequately diversified. This may lead to further risk-taking and, potentially, large losses in the event of a sudden increase in volatility (and assets becoming more correlated).[196]

[196] For further discussion, see "The Volatility Paradox: Tranquil Markets May Harbor Hidden Risks", *Financial Markets Monitor*, Second Quarter 2017, Office of Financial Research, August 2017.

More generally, a sudden spike in volatility could trigger a demand for higher premia on riskier assets and thereby lead to mark-to-market losses and prompt outflows from riskier asset classes and regions. Moreover, if credit spreads and equity risk premia were to rise, funding costs for non-financial firms would increase, which would pose liquidity and solvency risks for the more vulnerable firms, possibly amplifying the initial sell-off.

**Chart D.1**

Close co-movement between stock market volatility and credit spreads




Sources: Bank of America Merrill Lynch and Thomson Reuters Datastream.

**This special feature describes some of the main triggers and amplifiers which could contribute to a potential ratcheting-up of volatility.** One way to conceptualise prospective increases in asset price volatility is to identify potential triggers and vulnerabilities that could amplify volatility cycles. The special feature starts by discussing whether elevated market volatility could be triggered by a worsening growth outlook (or greater uncertainty surrounding growth) or by an abrupt change in market expectations about the timing of monetary policy normalisation. As discussed in the second part, should any of these (or other possible) triggers materialise, volatility may rise sharply on account of elevated corporate leverage, high valuations or a rapid unwinding of market positions. An indicator approach is employed to illustrate the relevant issues. While the focus is largely on the US stock market, owing to its prominence in market discussions, the assessment of financial stability risks and vulnerabilities holds for most advanced economies, including the euro area.

## The macro environment and its impact on market volatility

**Aggregate asset price developments are closely linked to macroeconomic performance.** Thus, one plausible explanation for the low level of market volatility

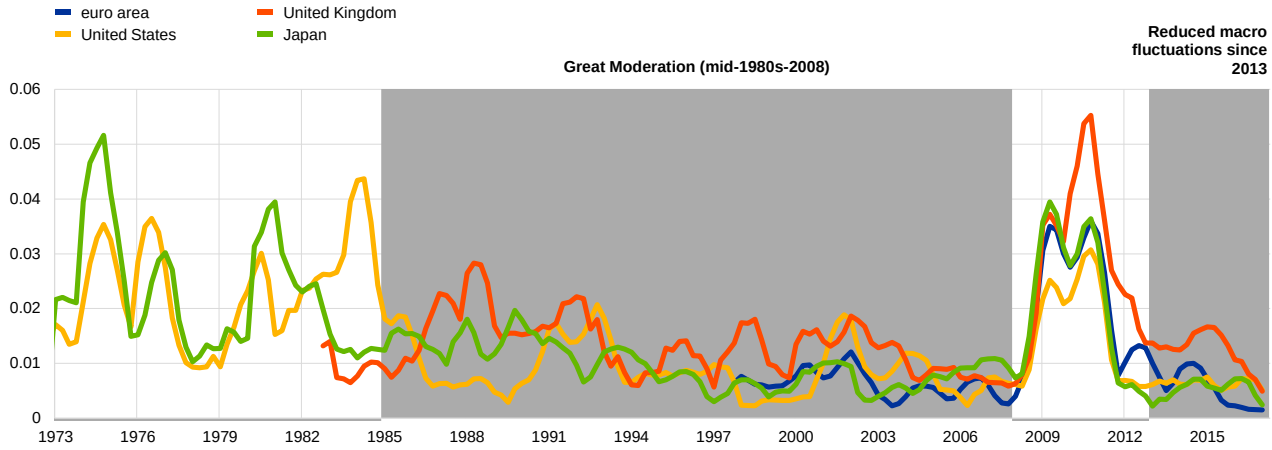
could be that the macro environment has become more stable.[197] If so, greater uncertainty in the future about the business cycle could contribute to elevated volatility in markets.

**Chart D.2**

Volatility of real GDP growth has returned to pre-crisis levels

**Real GDP volatility for the United States, the euro area, the United Kingdom and Japan**

(Q1 1973 – Q1 2017, quarterly data, standard deviation of year-on-year changes in real GDP, eight-quarter moving window)




Sources: Haver Analytics and ECB calculations.
Note: The grey shaded areas indicate periods of low business cycle fluctuations.

**The amplitude of business cycle fluctuations has receded across the globe.** Taking a broad perspective, **Chart D.2** displays long time series of real GDP volatility in four advanced economies. During the period from the mid-1980s until the outbreak of the financial crisis in 2008, business cycle fluctuations in advanced economies remained at relatively low levels, a phenomenon that has been dubbed the "Great Moderation".[198] After the ratcheting-up of volatility during the global financial crisis, macro volatility has recently fallen below the levels observed before the crisis across all four economies.

197 In theory, stock prices are a function of current and expected future dividends, discounted by a risk-free rate and an equity risk premium (the latter being compensation for perceived uncertainty regarding future cash flows). Dividends are usually paid out as a function of firms' earnings. Taking a macro perspective, corporate earnings and aggregate economic activity should be expected to develop broadly in line with each other over the long term. Empirical studies have indeed found a positive relationship between the two, although earnings cycles tend to display larger amplitudes. See, for instance, the box entitled "The relationship between listed companies' earnings growth and output growth in the economy as a whole", *Monthly Bulletin*, ECB, September 2007.

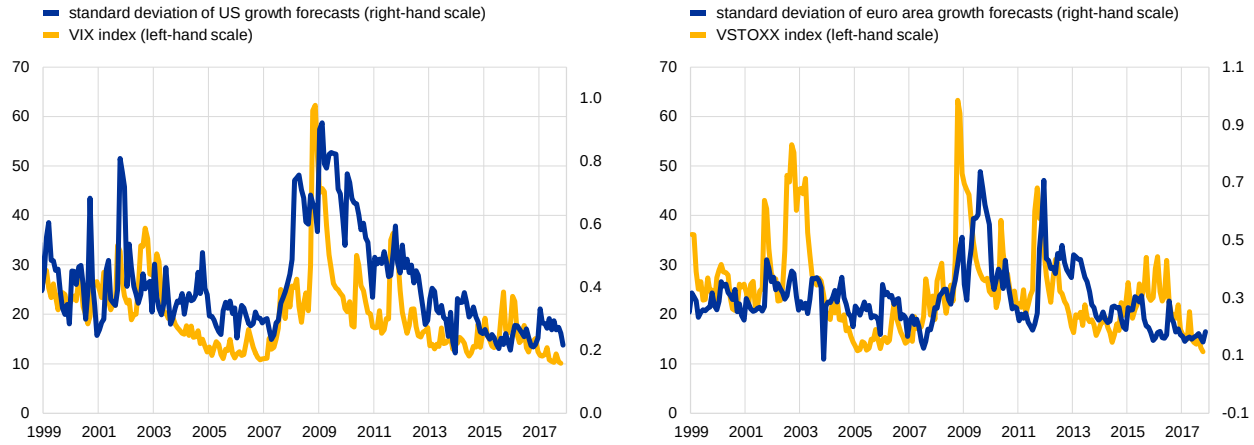
198 Several possible reasons why macro volatility remained low over this period have been suggested. First, many central banks moved towards an inflation target as their main objective. More systematic monetary policies may have contributed to dampening macro fluctuations. Second, the economic structure gradually shifted away from manufacturing to services (an industry which is more predictable and less volatile). Third, the adoption of more efficient inventory practices such as "just-in-time" may also have contributed to the more stable macro environment. For an overview, see Bernanke, B., "The Great Moderation", remarks at the meeting of the Eastern Economic Association, Washington, DC, February 2004.

**Chart D.3**

More aligned business cycle expectations among analysts may have also contributed to lower market volatility

**Standard deviation of analysts' one-year-ahead real GDP growth expectations and the VIX index (left panel) and the VSTOXX index (right panel)**

(Jan. 1999 – Nov. 2017, monthly data; left-hand scale: annualised volatility, percentages; right-hand scale: standard deviation)




Sources: Consensus Economics, Bloomberg and ECB calculations.

**As GDP growth volatility has declined, analysts' business cycle predictions have converged. Chart D.3** shows the cross-sectional standard deviations of one-year-ahead US and euro area real GDP expectations provided by individual analysts. These measures of the degree of disagreement across analysts regarding US and euro area growth performance have gradually declined in recent years and have developed broadly in line with stock market volatility in the two economies. The combined effect of reduced actual business cycle fluctuations and more agreement among analysts about the economic outlook may have dampened the fluctuations in the equity risk premium component used in asset valuations and is thus likely to have contributed to lower stock market volatility.

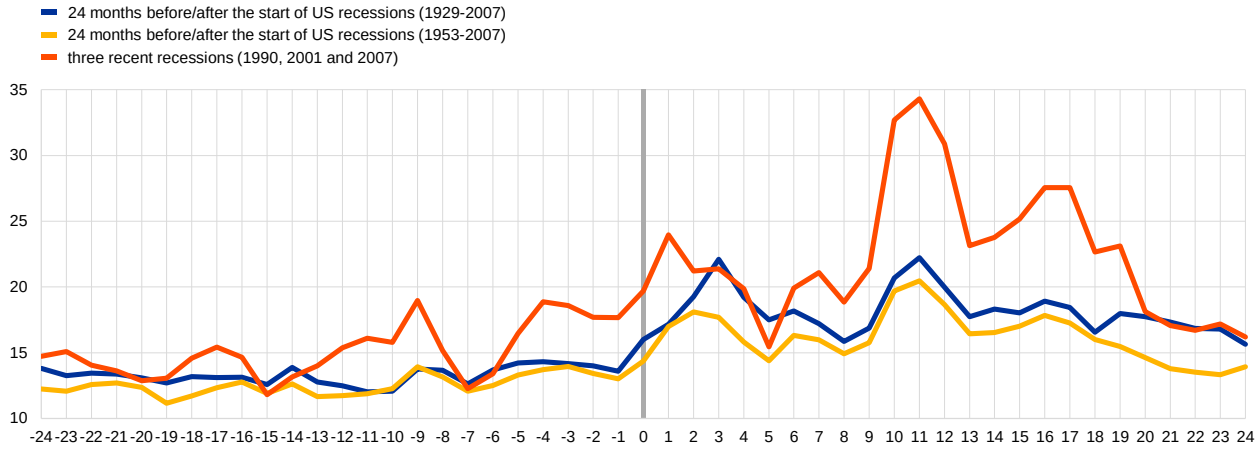
**A worsening macro outlook may push volatility higher.** A deteriorating growth outlook would reduce firms' earnings prospects, triggering lower stock prices. This, in turn, could lead to higher volatility in markets, as investors' views about future cash flows from financial assets may diverge. This can be seen, for example, in the United States, where since 1929 stock market volatility has increased sharply at the start of recessions and then remained elevated for an extended period (see **Chart D.4**). As seen in the chart, the pattern of elevated volatility after the outbreak of recessions is consistent across various sub-samples.

**Chart D.4**

US stock market volatility remains elevated after the outbreak of recessions

**US stock market volatility around the starting dates of US recessions since 1929**

(monthly data, annualised average US stock market volatility 24 months before and after US recessions)




Sources: Haver Analytics and ECB calculations.

## Revised expectations regarding the future path of monetary policy could trigger an increase in volatility

**An abrupt reassessment of the expected pace of monetary policy normalisation could raise the level of asset price volatility.** Monetary policy actions can have a large and broad-based impact on both the level and the volatility of asset prices. As all asset prices are inherently forward looking, policy actions not fully anticipated by investors tend to have a particularly marked impact.[199] For example, an examination of all Federal Open Market Committee (FOMC) meetings since 1990 shows that monetary policy meetings that were perceived as unexpectedly hawkish (judging by the daily move in exchange rates or bond yields) led to elevated equity market volatility, while loosening monetary policy shocks had the opposite effect (see **Chart D.5**). The VIX index stood on average approximately 15% higher 20 trading days after a monetary tightening event. Thus, a faster than expected removal of the accommodative monetary policy stance in the United States and other advanced economies could trigger increases in asset price volatility.

**Shocks to volatility might also become more persistent as monetary policy tightens.** During the years when various unconventional monetary policy measures were being introduced, surges in both US and euro area stock market volatility have tended to reverse more quickly to moderate or lower levels; in other words, they

[199] See, for instance, Gürkaynak, R., Sack, B. and Swanson, E., "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements", *International Journal of Central Banking*, May 2005; and Andersson, M., "Using Intraday Data to Gauge Financial Market Responses to Federal Reserve and ECB Monetary Policy Decisions", *International Journal of Central Banking*, June 2010.

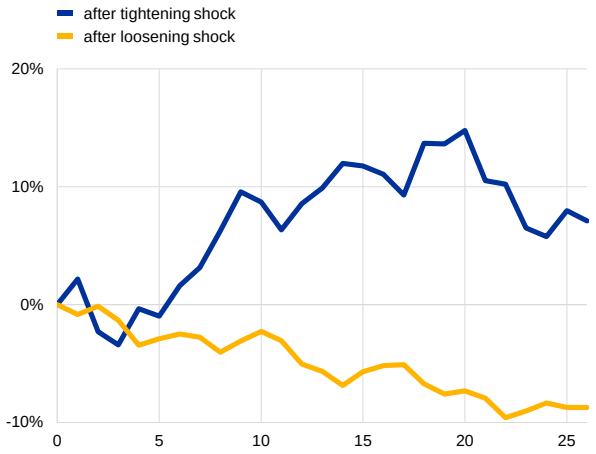
became less persistent (see, e.g., **Chart D.6** regarding the United States).[200] This pattern may have reflected a growing perception among financial market participants that, in the event of high market stress, central banks would be ready to step in to normalise conditions. Conversely, again looking at US data, volatility persistence began to increase after these policies ended. Taking the US evidence as a blueprint, as growth in advanced economies gradually improves and monetary policies become gradually less accommodative, market participants may consider it less likely that central banks would need to step in and intervene, which, in turn, could increase the duration of elevated financial market volatility episodes.

**Chart D.5**

US stock market volatility edges up after monetary policy tightening shocks

**Evolution of the VIX index over 25 days following tightening/loosening monetary policy shocks**

(1990-2017, daily data, average volatility, percentages, index normalised to zero on the day before the monetary policy shock)



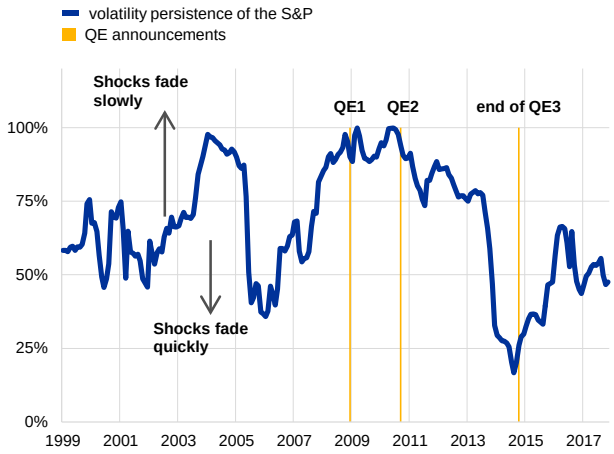

Sources: Haver Analytics and ECB calculations.
Notes: Monetary policy shocks are derived in a manner similar to Rogers, J., Scotti, C. and Wright, J., "Evaluating asset-market effects of unconventional monetary policy: a multi-country review", *Economic Policy*, Vol. 29(80), October 2014, pp. 749-799. A tightening (loosening) shock is assumed if the narrow measure of the nominal effective exchange rate of the dollar appreciates (depreciates) by more than one standard deviation on the day of the FOMC meeting. The two lines track the average response in the log level of the VIX index following a tightening (loosening) shock over a 25 trading day horizon. The axis value of zero corresponds to the day before the FOMC meeting. The sample includes all FOMC meetings since January 1990. The methodology is robust to the use of other metrics to identify the shock (e.g. one-year or ten-year Treasury bond yield).

**Chart D.6**

Tighter monetary policy may contribute to greater persistence of equity market volatility

**Time-varying estimates of persistence implied in GARCH(1,1) stock market volatility in the United States**

(Jan. 1999 – Nov. 2017, share of shock to volatility persisting beyond ten trading days, percentages)




Sources: Bloomberg and ECB calculations.
Notes: The y-axis shows the percentage share of a shock to stock market volatility, derived from the impulse response function of a GARCH(1,1) model for the respective stock index, estimated over a one-year rolling window of daily information. The vertical yellow lines mark the dates of quantitative easing (QE) announcements by the Federal Reserve System.

## A rapid unwinding of market positions and elevated leverage could amplify an increase in volatility

**A sudden increase in volatility may be amplified by a number of looming vulnerabilities.** Excessive risk-taking in a very tranquil market environment can potentially lead to a build-up of a number of vulnerabilities, such as asset mispricing, increased leverage or an increasing prevalence of one-directional position-taking

[200] See the box entitled "Have global uncertainty shocks become less persistent?", *Financial Stability Review*, ECB, November 2016.

that relies on continued low volatility. Should conditions in markets eventually deteriorate, investors may respond by selling assets perceived as overvalued, overly discriminating against sectors with high leverage and embarking on large-scale unwinding of previously profitable positions. Taken together, these vulnerabilities have the potential to amplify any initial increase in volatility.

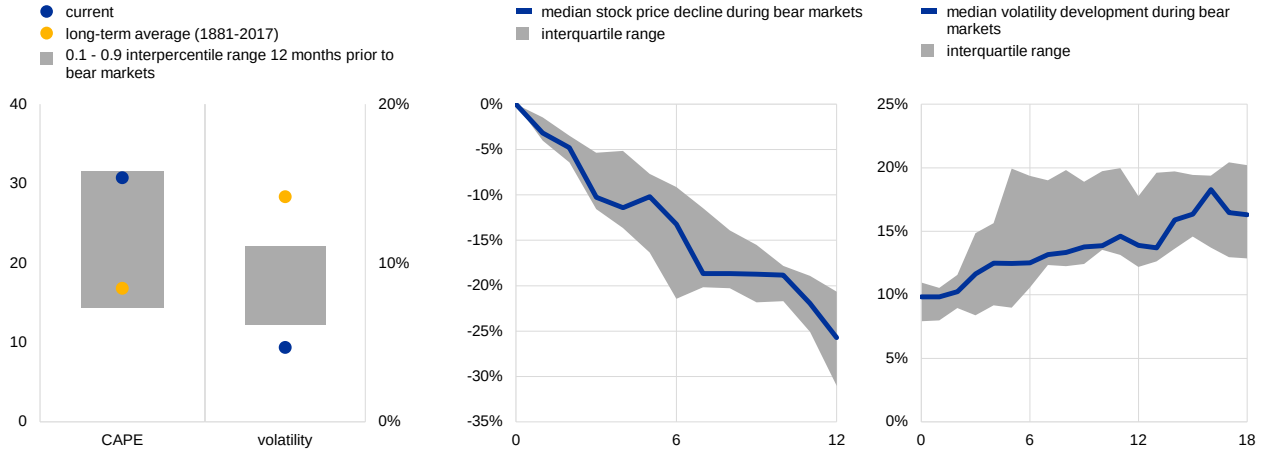
**High valuations and low volatility have, in the past, been harbingers of future bear markets and elevated volatility.** One of the potential side effects of prolonged periods of low volatility is that investors may engage in excessive risk-taking. One indication of such behaviour is that financial asset prices start to decouple from underlying fundamentals. Looking back at historical episodes in US stock markets, in the year preceding the 13 strongest bear markets observed since 1881, levels of volatility were low and valuations elevated (as measured by cyclically adjusted price/earnings (CAPE) ratios) relative to the historical average (see left panel of **Chart D.7**). As stock markets subsequently corrected (see middle panel of **Chart D.7**), volatility increased sharply (see right panel of **Chart D.7**). The current valuation/volatility environment looks exceptional, even compared with the situations preceding the historical sharp corrections in US stock markets.

**Chart D.7**

Periods of low stock market volatility may incentivise higher risk-taking; stock market corrections and elevated volatility may follow

**Stock market valuations and volatility levels in the year preceding 13 US bear markets since 1881 (left panel); stock price developments and volatility movements during the 13 bear markets (middle and right panels)**

(left panel: US CAPE ratio levels and annualised stock market volatility; middle panel: 12-month cumulative US stock price developments in percentages; right panel: 18-month development in US stock market volatility, annualised volatility)




Sources: R. Shiller's homepage and ECB calculations.
Notes: The 13 bear markets identified by Shiller are: 1892, 1895, 1902, 1906, 1916, 1929, 1934, 1937, 1946, 1961, 1987, 2000 and 2007 (for details, see R. Shiller's 22 September 2017 column). The dataset only allows for monthly computations. Thus, the volatilities shown in the left and right panels are computed based on the (annualised) standard deviation of monthly returns over a one-year period. This is the reason why the right panel has been extended to 18 months compared with 12 months for the middle panel.

**Alternative measures derived from options markets indicate that some investors currently see an increased likelihood of stock price corrections.** Along with the low volatility and signs of overheated US stock prices, it appears that an increasing number of investors have engaged in trades to protect their portfolios from, or to speculate on, a correction in stock prices. In fact, the skewness of the future equity return distribution implied by S&P 500 options at different strike prices

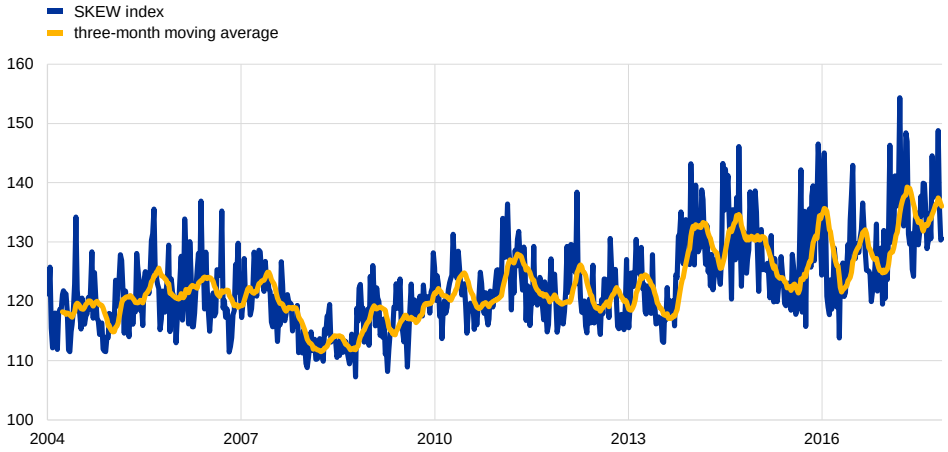
has increased in recent quarters (see **Chart D.8**). This suggests that investors are bidding up the prices of out-of-the-money put options – a trade which would benefit from falling stock prices.

**Chart D.8**

Information derived from out-of-the-money options indicates higher risks of future stock price corrections

**SKEW index derived from options on the S&P 500 index**

(Jan. 2004 – Nov. 2017, weekly data, level of SKEW index)




Sources: Bloomberg.
Note: SKEW values generally range from 100 to 150; the higher the value, the higher the perceived tail risk.

**High indebtedness among firms may amplify the speed and magnitude of a potential correction of asset price volatility.**[201] As the leverage of firms increases, they become more risky, which – in principle – should justify higher stock market volatility. US aggregate data provide historical evidence of such a relationship (see **Chart D.9**, left panel). Since 2011, however, indebtedness of US firms has gradually increased without any corresponding increase in volatility. Should this relationship be reinstated in the event of an initial increase in stock price volatility, it would act as an amplifier and fuel further stock market gyrations.

**The time-series evidence is corroborated by firm-level data.** The right panel in **Chart D.9** presents the history of the cross-sectional correlation of individual firms' leverage ratios and stock price volatility (based on the firms in the current panel of the Dow Jones 65 Composite Average). Historically, a positive correlation between the two metrics can be observed for a majority of firms. As seen with the time-series evidence, since 2011 this relationship has broken down, although it tentatively re-emerged in 2016. In sum, the micro and macro evidence presented here suggests

[201] This is closely related to the "leverage effect" described by Black (1976), which suggests a causal relationship between stock returns and volatility changes. When equity prices of companies fall, their leverage increases, since the value of their debt rises relative to that of their equity. As a result, stocks traded in the markets become riskier, and hence more volatile. In other words, stock market volatility should increase/fall when leverage goes up/down. The empirical literature has, however, found mixed evidence regarding the existence of a leverage effect. See Black, F., "Studies of Stock Price Volatility Changes", proceedings of the 1976 meeting of the Business and Economics Statistics Section, American Statistical Association, 1976, pp. 177-181; and Hasanhodzic, J. and Lo, A., "Black's Leverage Effect Is Not Due To Leverage", February 2011.

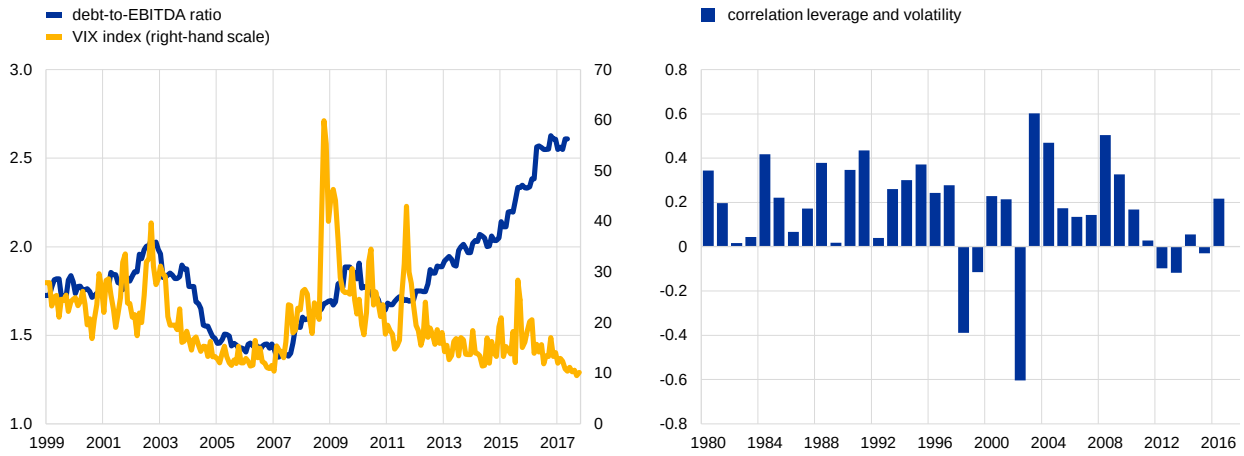
that, should equity prices suffer a correction, the high leverage levels evident in US listed companies may act as a further accelerator of the pick-up in equity price volatility.

**Chart D.9**

Decoupling between stock market volatility and firms' leverage in the United States

**US gross debt-to-EBITDA ratio and the VIX index (left panel) and average annual correlation between the leverage and volatility of individual firms included in the Dow Jones 65 Composite Average index (right panel)**

(left panel: Jan. 1999 – Oct. 2017, median debt-to-EBITDA ratio; right panel: 1980-2017, average annual correlation)




Sources: Bloomberg and ECB calculations.
Notes: EBITDA stands for earnings before interest, taxes, depreciation and amortisation. Leverage for firms included in the S&P 500 index.

**Finally, an increase in volatility could be exacerbated by investors winding down short volatility positions.** Non-commercial investors have held increasing numbers of short positions in VIX futures and options. The classification of non-commercial investors is usually done to identify traders using the derivatives markets for speculative purposes (including hedge funds, asset managers and individual investors).[202] Such investors often use leverage to boost potential profits and therefore their losses could have more systemic implications for the financial sector at large.[203] The short positions in the VIX are a bet that volatility will remain low – a strategy that has been highly profitable in the last two years (see left panel of **Chart D.10**). The source of these profits can be derived from the slope of the VIX futures curve. If the level of the VIX index is low, futures prices tend to predict a gradual increase in the VIX over the coming months towards more normal volatility

[202] Speculative, or non-commercial, investors tend to be characterised by their engagement in directional bets on the underlying of the derivative (the VIX index, in this case). The opposite positions tend to be held by dealers, who match the demand of the speculative investors against a premium. Dealers typically hedge their positions, as they do not engage in directional bets. This notwithstanding, this simplified distinction should be treated with some caution. There may also be non-commercial investors with non-speculative motives.

[203] According to more granular data from the Commodity Futures Trading Commission, hedge funds' net short positions in short VIX futures contracts have accounted for approximately 97% of total speculative net short positions in futures and options in 2017.

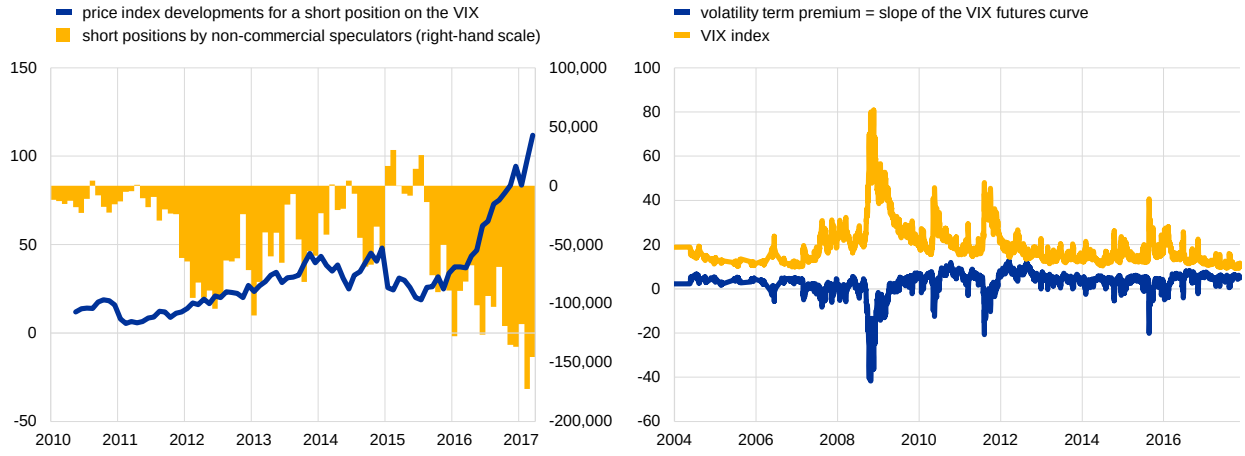
levels (see right panel of **Chart D.10**).[204] As VIX futures prices are in this case higher than the "spot" VIX, a short position in a VIX future is profitable if the VIX index remains broadly stable or declines. A significant increase in volatility, on the other hand, has two adverse effects on this "carry trade". First, current short positions give rise to losses as the VIX rises above its futures price. Second, short positions in the VIX will, in general, remain unprofitable while the VIX is high; the slope of the futures curve typically turns negative during periods of elevated volatility, as the VIX is then expected to decline towards more moderate levels. As a result, as volatility picks up, these short, potentially leveraged, positions can be expected to be unwound rapidly, possibly aggravating the initial rise in asset price volatility.

**Chart D.10**

Low-volatility trades have been highly profitable in the recent past

**Price index for a short-positioned VIX trade (XIV, blue line) and non-commercial speculators' net short positions in VIX futures (left panel), and the VIX index and the slope of the VIX futures curve (right panel)**

(left panel: Jan. 2010 – Oct. 2017, monthly data; left-hand scale: price index; right-hand scale: number of net short contracts; right panel: Jan. 2004 – Nov. 2017, daily data, VIX index points)




Sources: Bloomberg, Commodity Futures Trading Commission and ECB calculations.
Notes: The blue line in the left panel refers to developments in the VelocityShares Daily Inverse VIX Short-Term ETN (XIV). This is an exchange-traded note (ETN) which provides investors with a cash payment at the scheduled maturity or early redemption based on the inverse performance of the underlying index (i.e. the VIX index). The yellow bars in the left panel indicate the number of long VIX futures contracts minus short VIX futures contracts purchased by non-commercial (i.e. speculative) investors. The blue line in the right panel corresponds to the difference between the price of a VIX future with a six-month residual maturity and the "spot" VIX index.

## Conclusions

**This special feature has documented a number of triggers and amplifiers that could lead to higher financial market volatility in the future.** Looking back, the reduction in global market volatility in recent years can be linked in part to fundamentals. In particular, reduced business cycle uncertainty and predictable

[204] The fair value of VIX futures differs from other "plain vanilla" futures (which are derived from the cost-of carry relationship between the futures and the underlying asset). Since there is no carry between the VIX and a position in VIX futures, the fair value of VIX futures cannot be derived by a similar relationship. Instead, an estimate of the VIX futures price entails modelling the process for the VIX and estimating the parameters of the model from historical values of the VIX and VIX futures prices. This implies some degree of mean reversion where very low levels of the actual VIX index tend to correspond with higher VIX futures levels. For more details of the features of VIX futures, see the Chicago Board Options Exchange website.

accommodative monetary policies have probably contributed to dampening asset price fluctuations around the globe. However, this environment may change over the FSR risk horizon of 24 months. Volatility is likely to increase – possibly in an abrupt manner – should macroeconomic conditions deteriorate or should markets abruptly revise their expectations regarding the phasing-out of accommodative monetary policy conditions. In addition, a number of vulnerabilities have the potential to amplify any initial increase in volatility. Investors may respond to an increase in financial market volatility by selling assets perceived as overvalued. Moreover, the volatility of assets linked to firms and sectors with high leverage may increase disproportionately. Finally, a large-scale unwinding of previously profitable low-volatility strategies may occur. Regarding the latter point, although the low-volatility risk is widely recognised by financial market analysts, investor positioning suggests that many investors may still be too complacent about this risk. In the euro area, the implications of a possible sharp increase in volatility would be partly mitigated by the accommodative monetary policy, as well as by the limited signs that asset prices are stretched relative to fundamentals. Nevertheless, investors need to ensure that they have sufficient buffers to withstand higher market volatility in the future and possible adverse repercussions, such as falling financial asset prices and wider credit spreads.