

Orderly markets

Monitoring volatility in financial markets

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Market volatility, and its potential to undermine financial stability as well as to impose unexpected losses on investors, is a subject of concern for securities market regulators. Relatively low or high levels of volatility increase the likelihood of stress in financial markets. Low yields and low volatility characterised the two years between February 2016 and January 2018. In February 2018 equity market volatility spiked as markets globally were affected by a strong correction. The main drivers of the long period of low volatility are related to lower equity return correlation, a low interest rate environment and search-for-yield strategies, and stable macroeconomic and corporate performances. A prolonged period of low volatility may lead to a more fragile financial system, promoting increased risk-taking by market participants driven by the use of VaR models and, more recently, by the growth of volatility targeting strategies. While the AuM of these products may be considered still quite small, the number of products is sufficiently broad to become a key factor driving volatility spikes, like those that occurred in the first week of February 2018.

Introduction

In 2016 and 2017 financial markets were characterised by very low volatility, raising the question of whether volatility measures adequately reflect risks in financial markets. Volatility then spiked in February 2018, with associated pricing corrections in financial markets and losses for investors. This article explains how volatility measures can be used in financial market risk monitoring and provides explanations for the low volatility levels observed in 2016/17.

Volatility is a broad concept, and several volatility measures are used in practice. Volatility refers to the degree to which prices vary over a certain length of time. Most commonly, price volatility is defined as the standard deviation of changes in the logarithmic returns of asset prices.¹⁰⁹

Asset price volatility is unavoidable – and indeed necessary in that it reflects the process of pricing and transferring risk as market conditions change (e.g. policy changes or macroeconomic shocks) and avoids misallocation of financial resources. The greatest risks to financial stability and investor protection stem from sudden increases in volatility and not generally from periods of sustained volatility.¹¹⁰ While the value of stocks is

expected to grow over time to compensate investors for putting their capital at risk, volatility is not, and one of its most important features is its tendency to follow a mean-reverting process.¹¹¹

In principle, there are two different approaches to estimating volatility:

- historical volatility (or realised volatility): based on the historical time series of actual prices;
- implied volatility: based on the price of an option on the underlying asset. It is a parameter of an option pricing model (i.e. Black-Scholes).

The two are closely related, but historical volatilities are backward-looking and implied volatilities forward-looking. For this reason, market participants and policy makers prefer in principle to rely on the second kind, when available.

From 2016 to January 2018 equity markets were characterised by very low levels of market volatility, which began to increase again in February 2018. The next section describes market volatility trends in equity markets, building on several indicators. The following sections investigate potential drivers of low volatility in

¹⁰⁸ This article has been authored by Federico Ramella and Claudia Guagliano.

¹⁰⁹ Taylor (2007).

¹¹⁰ Danielsson et al (2016) find that the level of volatility is not a good indicator of a crisis, but that relatively high or low volatility is.

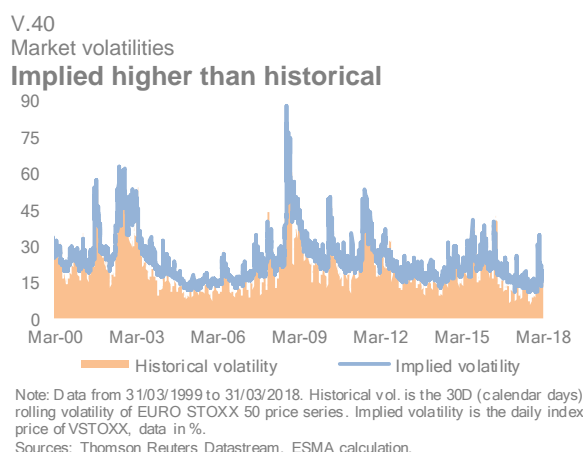
¹¹¹ Whaley (2008).

equity markets, while the final section focuses on the related potential risks.

Monitoring market volatility

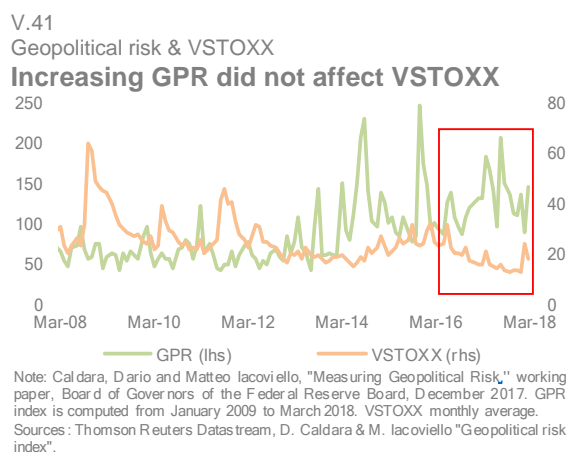
Asset price volatility characterises financial market activity. Relatively low or high levels of volatility increase the likelihood of stress in financial markets and need to be monitored. In particular, recent empirical analysis (Danielsson et al., 2016) has confirmed Minsky's (1992) instability hypothesis suggesting that economic agents interpret the presence of a low-volatility environment as an incentive to increase risk-taking, which in turn may lead to a crisis ("stability is destabilising"). Against this background, volatility developments are a fundamental topic at the core of risk assessment in financial markets.

The most commonly used volatility indices are the VIX for the US market and the VSTOXX for the European market.¹¹² The VSTOXX measures the implied volatility of near-term EuroStoxx 50 options, which are traded on the Eurex exchange.¹¹³ Similarly, the US VIX index measures the volatility of S&P 500 index options with a 30-day rolling maturity. It is calculated based on the prices of options listed on the Chicago Board Options Exchange (CBOE).¹¹⁴ Implied volatility, i.e. investors' expectations of volatility, is generally higher than realised historical volatility (V.40). This is the so-called volatility risk premium, reflecting the extra return required by investors to hold a volatile security. The difference between implied and projected realised volatility can be interpreted as a proxy for investor attitudes towards risk. When volatility spikes in stress episodes, investors' attitude towards risk usually follows, as they are less willing to hold positions in risky assets or to provide insurance against sharp asset price changes. In Europe, the long term (January 1999 - April 2018) average of historical volatility is 20.7%, while the VSTOXX average is 24.4%. The average volatility risk premium in European markets is 3.7%, i.e. the difference between implied and historical volatility. In this article we will use both measures of volatility.



Long period of low volatility in equity markets

In 2016 and 2017 financial markets worldwide experienced falling volatility. Standard deviations of the main equity indices reached extraordinarily low levels by historical standards, with VSTOXX registering its all-time lowest value of 10.7 on 18 December 2017. This was despite increasing geopolitical tensions; indeed volatility seemed to diverge from geopolitical trends as from 2H16 (V.41), with the limited exception of the Korean peninsula tensions in summer 2017,¹¹⁵ driving both VIX and VSTOXX to their highest values in 2H17 on 10 and 11 August 2017 respectively, when VIX registered 16.0 and VSTOXX 19.3.



In the US, the VIX index oscillated around 10%, less than half its long-term average of 20%, and reached its all-time lowest closing price of 9.14%

¹¹² VIX (S&P 500 volatility index) and VSTOXX (STOXX 50 volatility index) are computed on a real-time basis throughout each trading day and represent expected future market volatility over the next 30 calendar days. VIX and VSTOXX are therefore forward-looking measures.

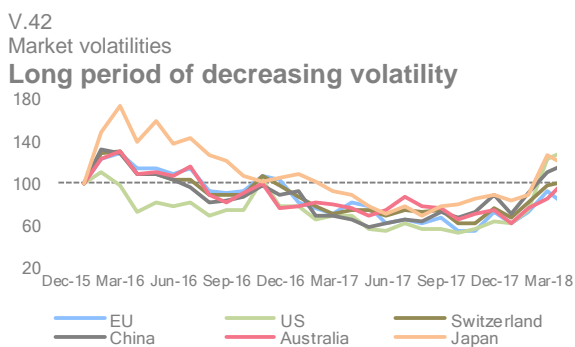
¹¹³ In total, there are 12 VSTOXX indices representing expected future market volatility over different time frames (ranging from 30 days to 360 days) and several VSTOXX

sub-indices (with maturities ranging from 1M to 24M). See https://www.stoxx.com/document/Indices/Common/Indexguide/stoxx_strategy_guide.pdf for more details.

¹¹⁴ <http://www.cboe.com/products/vix-index-volatility/vix-options-and-futures/vix-index/the-vix-index-calculation>.

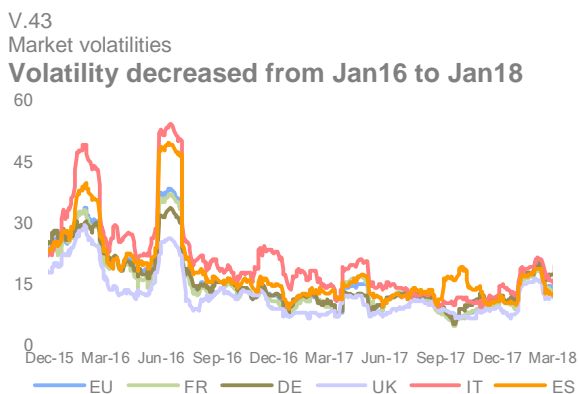
¹¹⁵ Financial Times, North Korea: A rising threat, 9 August 2017.

on 3 November 2017. At a global level, implied volatility followed the above trend starting in 2016 and continued to subside across markets. After worldwide indices had reached their minimum values in 2017, in February 2018 they spiked. In January 2018 these indices were oscillating between 60% and 82% of their January 2016 values, while in March 2018 VSTOXX and VIX were 78% and 130% of their January 2016 values respectively, showing a steeper rise in volatility in the US (V.42).



Note: Data from 31/12/2015 to 31/03/2018. All indices start from a value equal to 100, the chart shows the value of volatility indexes at the end of the corresponding month. The volatility indices used for calculations are: VSTOXX for EU, VIX for US, VSMI for Switzerland, VXFJI for China, JNIV for Japan and AXVI for Australia. Sources: Thomson Reuters Datastream, ESMA calculation.

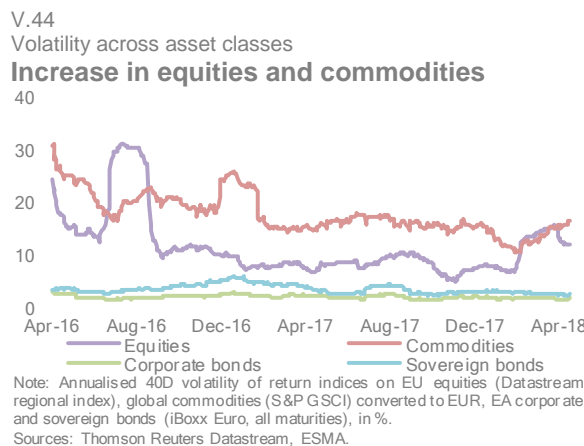
Market volatilities in European markets in January 2018 were way below their January 2016 levels and stable throughout all of 2017, but they increased across all markets in February 2018. At the European level there is a strong correlation across national equity markets, with Italy and Spain showing a higher level of volatility on average (V.43).



Note: Data from 31/12/2015 to 31/03/2018. Annualised 40D volatility for return indices of European equities, data in %. Sources: Thomson Reuters Datastream

Volatility traced a downward path across asset classes until January 2018 despite soaring volatility in equities in the summer of 2016. Commodity prices held stable through all of 2017, with no major spike in volatility. The difference in

volatility between equities and bonds decreased, reaching its lowest point in November 2017 before increasing sharply in February 2018. (V.44).



The end of low volatility?

EU equity prices rose 10% in 2017, having remained flat in 2016. The upward trend continued until the end of January 2018 when, within a period of two weeks from Friday 26 January to Friday 9 February, the Euro Stoxx 50 suffered a cumulative loss of 10.1%. The 2.5% drop in the Euro Stoxx 50 index on 6 February 2018 was the largest daily fall since 27 June 2016 (- 3.4%). On only four trading days in 2017 had Euro Stoxx 50 prices suffered a downturn by more than 1%. On 6 February 2018, VSTOXX increased to 30.18 (+62% on the previous day) and on 9 February it reached its highest value (34.74) since June 2016. As for VSTOXX, the VIX index experienced a sharp increase at the beginning of February 2018, reaching its highest closing value (37.32) since 24 August 2015.¹¹⁶ The spike in the VSTOXX index in February 2018 can be considered a consequence of market turmoil rather than political tension. Market perceptions of rising inflation, especially in the United States, and a corresponding adjustment in monetary policy expectations may have been the main drivers. The increased number of products following volatility strategies has also become a key factor in driving volatility spikes.

Markets partially recovered, but uncertainty around US trade policy triggered a renewed decline in EU and US equity markets in early March. Market volatility remained at higher levels in March 2018 before easing in April – without, however, returning to the 2017 levels.

¹¹⁶ See Securities markets section p.9.

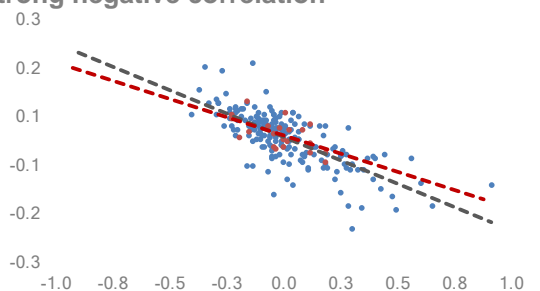
Drivers of low volatility

The very long period of low volatility has been accompanied by several trends in financial markets, such as very good equity performance, lower correlation between the different sectoral equity indices (banks, financial services, insurance and non-financial corporations), and between the constituents of the main equity indices (e.g. Euro Stoxx 50 in Europe). Other factors include the low interest rate environment and stable macroeconomic and corporate performance.

Equity return correlation

Higher levels of volatility are customarily associated with worse equity market performance.¹¹⁷ In general, the empirical evidence shows that volatility tends to decline as the stock market rises and to increase as it falls. A potential explanation attributes the negative correlation to changes in attitudes towards risk: since low volatility is associated with increased willingness to take on risk, a low-volatility environment is likely to be accompanied by rising asset valuations. Investigating this relationship in the EU equity markets with reference to the Euro Stoxx 50, we find that monthly price changes of Euro Stoxx 50 between February 1999 and March 2018 are negatively correlated with the VSTOXX monthly change (V.45). This indicates a negative relationship between equity market returns and volatility, as confirmed by the contemporaneous low volatility and strong equities performances in 2016 and 2017.

V.45
Correlation between Euro Stoxx 50 and VSTOXX
Strong negative correlation

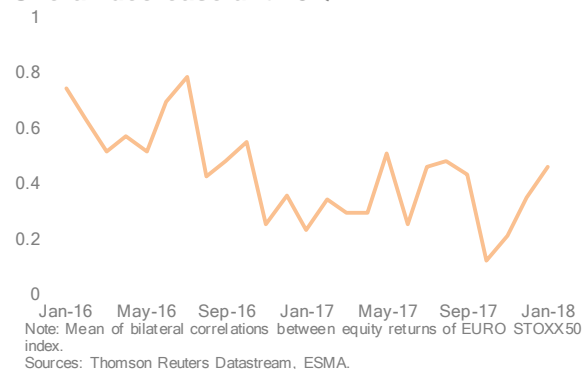


Note: Points indicate the relation between the monthly returns of the EURO STOXX 50 and the monthly change in the VSTOXX. Blue points refer to January 2001 - June 2016 while red points refer to July 2016 - March 2018, data in %.
Sources: Thomson Reuters Datastream

Low aggregate volatility may be partially explained by the decrease in equity correlations, i.e. the degree to which two different securities move together. Different reactions to events

create stronger diversification effects, reducing volatility in the aggregated picture, even when individual stock level volatility does not decrease much. Aggregate volatility is high in periods of close correlation because stocks move in the same direction at the same time and such broad-based movements are reflected in the major indices. Low correlation allows for greater equity portfolio diversification and reduces aggregate volatility at index level (V.46).

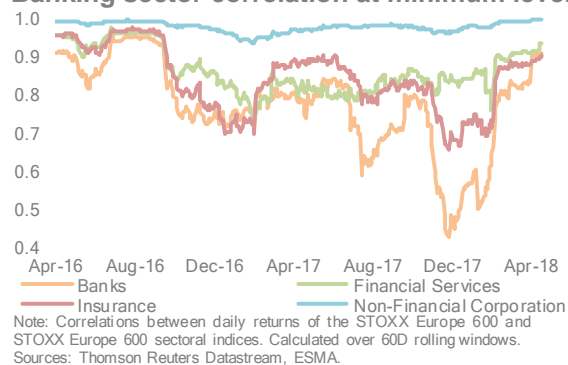
V.46
Correlation of returns
Overall decrease until 3Q17



Note: Mean of bilateral correlations between equity returns of EURO STOXX50 index.
Sources: Thomson Reuters Datastream, ESMA.

Correlation between the banking sector index and the overall equity index in Europe fell below 0.5 in 2H17, the lowest in 15 years (V.47). At the beginning of 2018, correlation increased across different sectors and between the constituents of the Euro Stoxx 50, suggesting more difficult diversification.

V.47
Correlation of sectoral indices with EURO STOXX 600
Banking sector correlation at minimum level

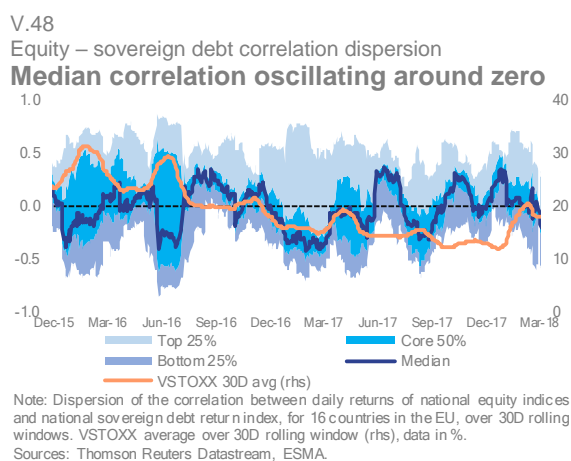


Note: Correlations between daily returns of the STOXX Europe 600 and STOXX Europe 600 sectoral indices. Calculated over 60D rolling windows.
Sources: Thomson Reuters Datastream, ESMA.

The correlation between stocks and bonds is one important input for investors in their asset allocation decisions. At the EU level this correlation tends to swing around zero (V.48). In line with the empirical literature, it does not seem

¹¹⁷ See Liu et al. (2012) for a detailed analysis of the negative relationship between equity market returns and volatility.

to be correlated with the volatility levels in both markets.



A prolonged period of a very low-interest-rate environment and generally stable monetary policies may also have contributed to the low asset price volatility. Yield compression in fixed-income markets has forced investors to make substantial portfolio adjustments. The search for yield may have boosted equity valuation globally and generally increased investors' risk appetite (A.27 and A.44).

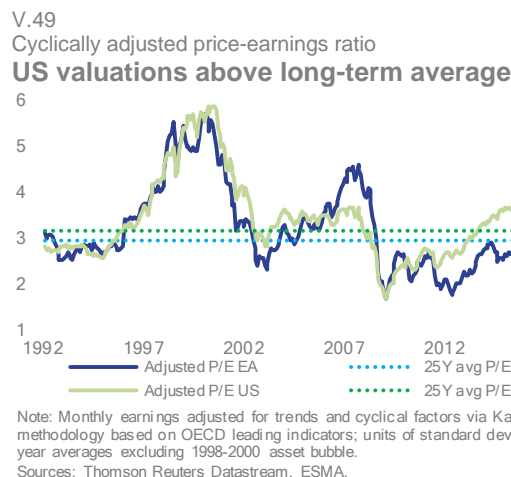
Stable macroeconomic fundamentals

Positive macroeconomic conditions at global and European level may have contributed to the strong equity market performance and low-volatility environment. Global growth in 2017 stood at 3.7% and forecasts for 2018 and 2019 are also positive, with global growth projected at 3.9% for both years.¹¹⁸ EU output growth is estimated at 2.4% in 2017 and 2.1% in 2018, driven by the cyclical recovery.¹¹⁹ Favourable financing conditions and positive economic and financial market sentiment are powering economic expansion in the Euro Area. At the same time, the non-financial private sector has continued to recover in line with the ongoing cyclical upturn of the Euro Area economy.

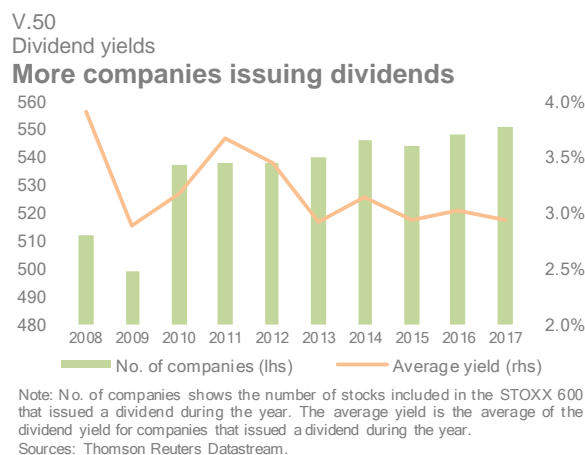
Stable corporate performances

The prolonged rally in equity prices has fuelled fears of overvaluation, especially in US equity markets, possibly contributing to the sharp equity market correction in February 2018. Price-

earnings ratios adjusted for the business cycle do indeed show that current equity valuations are high in the US relative to their long-term average. On the other hand, despite having increased to their long-term average, EA equity valuations remain below the previous peaks observed in 1998, 2000 and 2007 (V.49).



Corporates' positive performance is reflected in the increased issuance of dividends by companies composing the Euro Stoxx 600, although the average yield decreased (V.50).¹²⁰



Risks of low volatility

As already mentioned, volatility levels have not delivered any early warning of financial crises in the past. However, periods of low volatility do prompt investors to take extra risks that could lead to a more fragile financial system. This feature is called the volatility paradox.¹²¹ Low

¹¹⁸ IMF, World Economic Outlook Update, July 2018.

¹¹⁹ European Commission, Summer 2018 Interim Forecast.

¹²⁰ Another consequence of the accommodative monetary policy is the increasing phenomenon of companies' share buybacks. This driver exhibits procyclicality as the low interest rate environment enabled enterprises to borrow at low cost and use the money to buy back their own

shares. While this mechanism helped sustain equity prices, it increased the entities' leverage ratio.

¹²¹ Office of Financial Research (2017) and Danielsson et al (2015) confirm Minsky's statement that "stability is destabilising".

volatility can nudge market participants into excessive risk-taking and potentially lead to the build-up of a number of vulnerabilities, such as asset mispricing, increased leverage or an increasing prevalence of one-directional position-taking that relies on continued low volatility.¹²²

Long periods of low volatility, such as that experienced in 2016 and 2017, could therefore mask possible threats to financial stability¹²³ due to the underestimation of risks and consequent excessive risk-taking by market participants. Excessively risky behaviour and the potential capital misallocation this harbours thus remain relevant risk sources in the medium-term. In the context of a persistently low interest yield environment, abrupt increases in yields could lead to losses for investment positions and generate volatility spikes in asset prices.

An abrupt reassessment of the expected pace of monetary policy normalisation could raise the level of asset price volatility.

Value-at-Risk approach

The widespread use of Value-at-Risk (VaR) techniques in risk management may cause a rise in vulnerabilities since the methodology heavily weights the most recent observations of realised volatility. This could ultimately lead to procyclicality. A decline in realised volatility may encourage investors to increase position sizes without breaching VaR risk limits. Then, when volatility increases, investors may be forced to sell off assets to bring their portfolio back within risk limits.¹²⁴

The VaR technique is one of the three approaches for calculating investment funds' exposure in accordance with EU transparency requirements. In the EU, the VaR approach is used by UCITS funds with complex investment strategies and by AIFs. AIFs use VaR when required to do so by NCAs, and the AIFMD makes provision for NCAs to impose limits on fund leverage in order to ensure the stability and integrity of the financial system. ESMA may also issue advice to an NCA, setting out measures that it believes should be taken.¹²⁵

Volatility targeting strategies

Volatility is also a tradable market instrument in itself. Market participants can buy, or sell, volatility. Volatility trading may have a procyclical effect on market volatility. Indeed, when volatility is low, trading tends to lower the bar further. However, in stressed financial markets volatility spikes may be further amplified by volatility trading. Volatility trading is carried out by means of dynamic trading strategies involving options of varying complexity.

Market intelligence suggests that in recent years low-volatility equity strategies have become very popular. In a low interest rate environment, low-volatility strategies have generally outperformed. However, they are particularly exposed to market changes and are suspected of being highly sensitive to interest rate movements. The sensitivity of low-volatility equity strategies to interest rate movements can be broken down into two main components: industry bias towards more defensive sectors and idiosyncratic exposure due to certain stock characteristics (style, structure of their balance sheet, etc.)¹²⁶.

According to market intelligence, there has also been an increase in recent years in the use by investors (including non-banks) of strategies that sell insurance against a rise in volatility, for which they are paid a premium. These strategies may potentially amplify the increase in market volatility during periods of stress.

In Europe the AuM of funds following volatility strategies have almost doubled, increasing from EUR 22bn in December 2015 to EUR 44bn in March 2018 (V.51).¹²⁷ At the global level, in the same period AuM pursuing volatility strategies increased from EUR 402bn to EUR 461bn.¹²⁸ The AuM of EU volatility funds experienced a downturn (-3%) from January to March, following the market turmoil in the opening days of February.

¹²² IMF, Global Financial Stability Report, October 2017 and April 2018.

¹²³ ECB, Financial Stability Review, November 2017, pp 172.

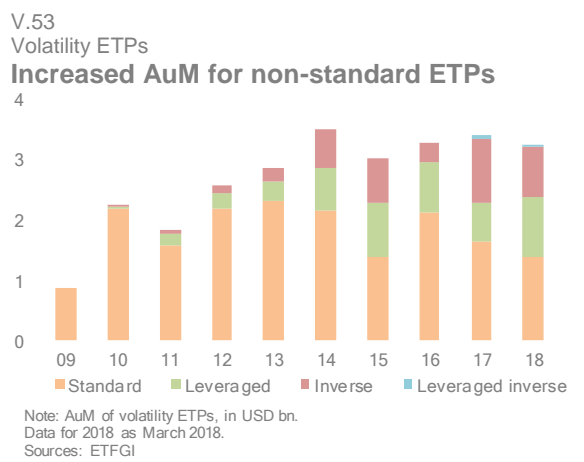
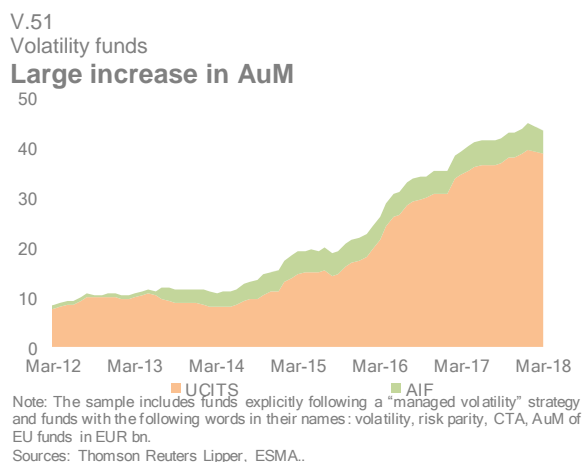
¹²⁴ Financial Times, Low volatility paradox will catch out investors and regulators, 21 November 2017.

¹²⁵ See Haquin and Mazzacurati (2016).

¹²⁶ See Stagnol and Taillardat (2017) for an empirical analysis of the exposure of low-volatility equity strategies to interest rates.

¹²⁷ The sample includes funds explicitly following a "managed volatility" strategy and funds with the following words in their names: volatility, risk parity, CTA, variable annuity.

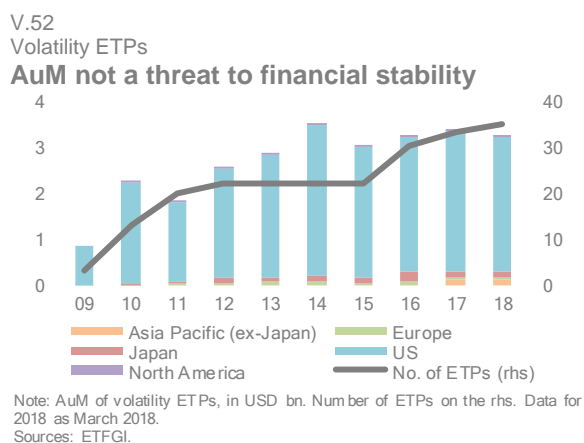
¹²⁸ The sample is non-exhaustive by nature.



Worldwide, ETFs tracking a volatility index still have limited AuM of around USD 3.2bn, too low to be considered a threat to financial stability. As of March 2018, less than 2% (USD 55mn) of these assets were held by European ETFs (V.52).

Conclusion

Volatility is unavoidable and necessary to reflect the impact of changed market conditions on the process of pricing and transferring risk. However, abrupt increases in volatility, as in the first week of February 2018, may lead to unexpected severe losses for investors and raise financial stability concerns. Against this background, financial asset price volatility is a subject of concern for securities market regulators and needs to be at the core of financial market risk assessment.



A prolonged period of low volatility, like the one characterising the two years between February 2016 and January 2018, may lead to a more fragile financial system. Promoting increased risk-taking by market participants driven by the use of VaR models, it can also pose a threat to financial stability. For a given VaR threshold, lower volatility increases the fraction of the portfolio that a financial institution may hold in risky assets. Once a spike in volatility occurs, the consequent sell-off can further amplify the volatility of the underlying assets and thus lead to procyclicality. Market participants should be aware of this risk. Finally, the growth of volatility targeting strategies and the events of February 2018 show that spikes in volatility could quickly erode the capital invested in low-volatility funds. While the AuM of this investment category may still be rather small, the number of products following volatility strategies is sufficiently broad to become a key factor driving volatility spikes like those that occurred in the first week of February 2018. The spikes in VIX and VSTOXX and the following closure of two ETNs investing in low volatility highlighted the risk of these products causing heavy losses to investors.

Although the AuM held by volatility ETPs are limited and have been constant in recent years, the use of leveraged, short and leveraged inverse strategies has increased (V.53), reaching USD 1.8bn in terms of AuM, 55% of total volatility ETF assets. Leveraged inverse strategies have been introduced in the last two years, since betting on low volatility has been profitable. While the AuM may still be considered fairly small, the number of products following volatility strategies is sufficiently broad to become a key factor driving volatility spikes like those that occurred in the first week of February 2018.¹²⁹

¹²⁹ See AMF (2018), BIS (2018) and IMF (2018) for an analysis of the 5 February 2018 volatility spike.

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