

### Box 3

#### Regime shifts in stock market volatility: a historical perspective on the US market

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**After a period of about two years with fairly steady price increases and persistently low volatility, global stock markets experienced a notable price and volatility correction in early February 2018.** Before this correction, policy authorities had become concerned about the benign volatility conditions, since low volatility may lead market participants to take on excessive risk and thereby create risks to financial stability (the “volatility paradox”).<sup>16</sup> Against this background, a return to conditions of higher volatility could, on the one hand, be regarded as a welcome normalisation.

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<sup>16</sup> Such risks are discussed in more depth in Andersson, M., Hermans, L. and Kostka, T., “Higher future financial market volatility: potential triggers and amplifiers”, *Financial Stability Review*, ECB, November 2017, pp. 172-182.

On the other hand, a “disorderly” stock market correction with sharp price declines and large price fluctuations might itself pose risks to financial and economic stability.

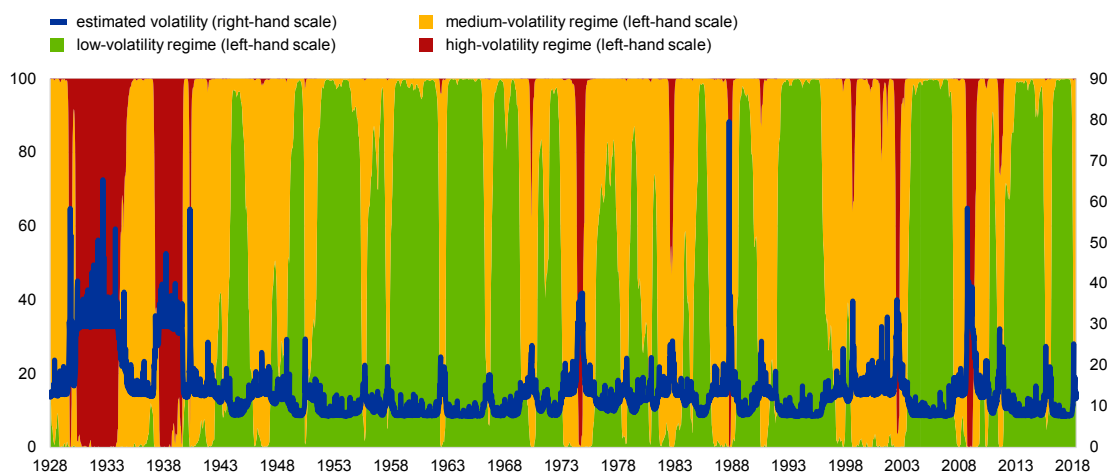
**To put recent developments into a historical perspective, this box analyses stylised facts of stock market volatility derived from 90 years of US data.** For this purpose, a model of weekly returns of the S&P 500 price index is estimated that allows for abrupt switches between three regimes in the volatility dynamics during the period from January 1928 to mid-May 2018 (low, medium and high-volatility regimes).<sup>17</sup> Such regime-switching models are able to capture two well-known stylised facts of stock market volatility, namely that volatility can jump sharply upwards in a short amount of time, and that such jumps are followed by fairly rapid reversion to lower levels which, in turn, can vary over time.<sup>18</sup>

### Chart A

Stock market volatility regimes are quite persistent historically

#### Estimated stock returns volatility and stacked regime probabilities

(Jan. 1928 – May 2018, weekly data; regime probabilities in percentages, annualised volatility in percentages)



Sources: Federal Reserve Economic Data (FRED) and ECB calculations.

Notes: The low, medium and high-volatility regime probability series are stacked onto each other such that they add up to 100%. The volatility series are computed as the square root of the probability-weighted average of regime-specific annualised conditional variances.

**The model suggests that stock market volatility indeed tends to cluster around low, medium or very high levels.** Chart A shows the estimated volatility of weekly S&P 500 returns (the blue series) along with the stacked probabilities of being in any of the three regimes (represented by the areas shaded in green, orange and red). Average volatility amounts to 9% in the low-volatility regime, 14% in the medium-volatility regime and 31% in the high-volatility regime. The estimated probability of staying in the same regime over the next period is high for all three regimes, but particularly so for the low and medium-volatility regimes. Accordingly, the expected duration for those two regimes is quite long at about 80 and 50 weeks, respectively. Historically, periods of low and medium volatility are the most common, occurring in 45% of all weeks in both cases. High-

<sup>17</sup> A regime-switching autoregressive conditional heteroscedasticity (SWARCH) model is employed, as originally proposed in Hamilton, J.D. and Susmel, R., “Autoregressive conditional heteroskedasticity and changes in regime”, *Journal of Econometrics*, Vol. 64, 1994, pp. 307-333. In the conditional variance part, the model allows for three different regime levels and includes a leverage effect. The model errors are assumed to come from a Student’s *t*-distribution.

<sup>18</sup> See, for example, Dueker, M.J., “Markov Switching in GARCH Processes and Mean-Reverting Stock-Market Volatility”, *Journal of Business & Economic Statistics*, Vol. 15, No 1, 1997, pp. 26-34.

volatility regimes, by contrast, tend to be much less frequent (10%) and much less persistent, apart from two episodes in the 1930s, the first of which was related to the Great Depression.

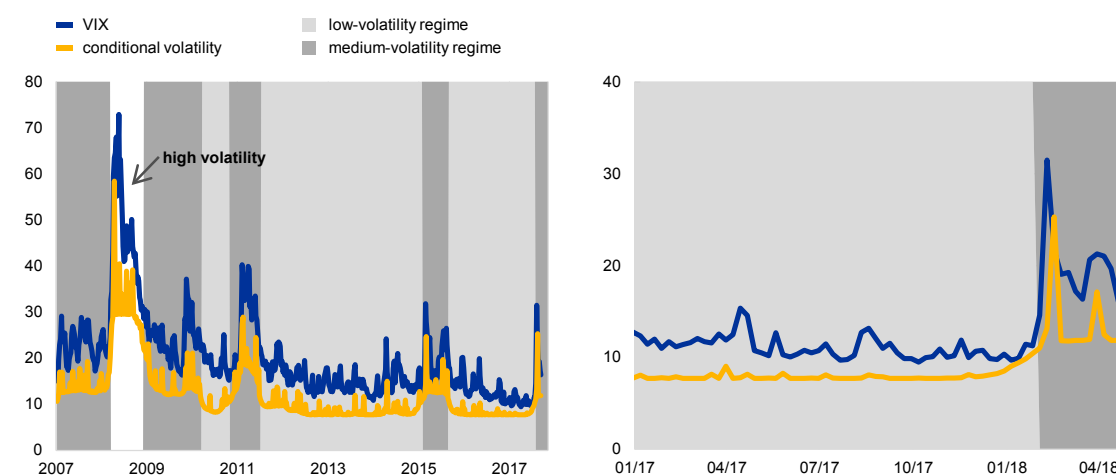
**The stock market turbulence in early February 2018 interrupted a protracted, though not unusually long, period of low volatility.** Growing uncertainty among market participants about the future course of monetary, fiscal and foreign trade policy in the United States may have been among the main drivers of recent spikes in estimated and expected market volatility, the latter represented by the options price-based Volatility Index (VIX) (see Chart B). While US stock prices fell by about 6.5% in one week, estimated volatility and the VIX surged to levels of 25% and 32%, respectively. However, volatility receded quickly, dropping to levels of around 12% for estimated volatility and 14% for the VIX at the end of the review period.

### Chart B

Is the market heading towards a period of sustained higher volatility?

#### Estimated stock returns volatility and the VIX during different volatility regimes

(Jan. 2007 – May 2018, weekly data; annualised volatilities in percentages; regimes with the highest probability shaded)



Sources: Federal Reserve Economic Data (FRED) and ECB calculations.

Note: The estimated volatility series is computed as the square root of the probability-weighted average of regime-specific annualised conditional variances.

**The regime-switching model suggests that the recent bout of turbulence did not bring about a shift towards a high-volatility regime.** This notwithstanding, the turbulence caused a shift from a regime of low volatility to one of medium volatility. Accordingly, the probability of a medium-volatility regime increased from below 1% at the end of November 2017 to around 75% from early February 2018 onwards. The increased likelihood of a medium-volatility regime also raised the odds of extreme market turmoil, from practically zero at the end of 2017 to close to 1% by mid-May 2018. All in all, this box suggests, when taking a long-term historical perspective, that the most recent gyrations in US stock market volatility did not bring about a clear shift towards a regime of extremely high volatility, but they may still indicate heightened risks of higher volatility going forward in the United States and elsewhere in the world. From a financial stability perspective, a move to only moderately higher average volatility can be considered as a welcome normalisation.