



Turbulence

When the Bubble Bursts

Extreme value theory can help us understand extreme events in financial markets.

By François Longin



Author

In Holland in the 1630s, adjusted for inflation, a single tulip bulb could fetch as high as \$100 000 – many times the annual salary of the average skilled worker at the time. Why on earth would anyone pay so much for a single flower, an item that has relatively little value today? The answer to that question is “tulip mania”.

In finance circles, we like to think of tulip mania as the first example of an economic bubble, when asset prices deviate from intrinsic values to produce soaring “booms” that eventually collapse to a certain degree. Since tulip fever, history has been repeating itself.

These “boom and bust” bubbles are what we call extreme events in finance: they include the stock market crash of October 19th 1987, the stock mar-

ket crash of 1929, the breakdown of the European Monetary System in September of 1992, the turmoil in the bond market in February of 1994, the internet bubble of the year 2000, the stock market crash of 2007-2008 and the recent collapse in the Chinese stock market.

Extreme events are a critical issue for finance professionals – and particularly for those who specialize in risk management, asset management and financial regulation. Regulators are also interested in market conditions during a crisis because they are concerned with the protection of the financial system against catastrophic events which can be a source of systemic risk. As experienced during the latest crisis, problems in financial markets and the banking system tend to transmit to the real world and impact all economic actors.

When bubbles burst, it doesn't usually come as a huge surprise, as a sharp rise is bound to be followed by a fall. However, it can be very difficult to predict when exactly a fall will happen, and this question preoccupies professionals and regulators alike.

Extreme value theory

This is where extreme value theory comes in. This statistical tool allows one to understand the extreme

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observations of a random variable. In finance, extreme value theory has been applied to understand the extreme observations of the return on an investment portfolio or a trading position.

The theory is not entirely new: it was first elaborated in the 1920s, and expanded in the 1940s by three statisticians: René Maurice Fréchet (France), Emil Julius Gumbel (Germany), Boris Gnedenko (Ukraine). However, the theory was elaborated by its founding fathers from an engineering perspective. Gumbel was one of the statisticians in the 20th century who laid down the foundations of extreme value theory.

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In an applied work in hydrology, he wrote: *"It seems that the rivers know the theory. It only remains to convince engineers of the validity of this analysis."*

In the 1990s, we began to apply Gambles thinking to finance. In this case, it seems that financial markets know the theory, it only remains to convince traders, investors, risk managers, asset managers, bankers, central bankers, regulators and professors of the validity of this analysis.

In short, this theory studies the limit distribution when the number of observations tends toward infinity. It highlights the existence of an asymptotic distribution of amazing simplicity.

In my research, I've applied extreme value theory to different markets (equity, interest rate, foreign exchange rates), different geographical zones (Ame-

rica, Europe and Asia), different time-periods and different frequencies. But when I started to study extreme events in finance just after the stock market crash of October 1987, academic studies considered such events as outliers. It meant that the data associated to extreme events in financial markets were considered as abnormal and were usually discarded in empirical works.

A few decades later, financial experts are collectively realizing the critical importance of understanding extreme events in finance – ESSEC took the initiative of organizing an international conference dealing with extreme events, and to have edited a collective book on the subject.

Over the past decades, extreme value theory has shown that we're gaining a better understanding of the statistical behavior of extreme movements of financial asset prices. Moreover the understanding of the behavior of the market during extreme events is also useful to understand the whole behavior of the market both under ordinary and extraordinary conditions. In other words, it is a mistake to separate extreme events from other events. In fact, this could be a universal truth touching many aspects of society including business, politics and religion. ■