

Black swans and fat tails

PERSPECTIVES

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Economists use the terms *black swans* and *fat-tailed distributions* to describe rare, but high-impact events in areas ranging from the financial markets to climate change. We would do well to take such phenomena into account – including in medicine.



Illustration: Tiril Haug Johne

Until a black swan was discovered in Western Australia in 1697, it was an established truth that all swans were white. Nassim Nicholas Taleb, a mathematician and philosopher whose career includes a stint as a hedge fund manager, uses *black swans* as a term to describe rare events and their relevance to the financial market [\(1\)](#). According to Taleb, black swans are rare events that are i) difficult to predict on the basis of existing historical knowledge; ii) difficult to understand because of their low probability of occurring; and iii) difficult to accept because we have mental blocks against such rare events.

Black swan events can also be visualised as the extremes in distributions with a *fat tail* of possible (extreme) outcomes. In other words, they are not as rare as we might think [\(1\)](#). Black swans and fat tails are important phenomena in areas such as economics, history and biology. The fat tails encompass rare, but often quite important events that could drastically shape our reality. Black swans and fat tails are also relevant in medical science, because many important medical outcomes are not normally distributed.

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Fat-tailed distributions

Body height and weight are examples of variables that are well described by the normal distribution curve. In a normal distribution, the possible outcomes are distributed symmetrically around the mean value, and only a small proportion

of the outcomes are encompassed by the two tails of the distribution. A normal distribution curve will therefore not be a good description of phenomena that have more frequent extreme outcomes or asymmetrical deviations from the mean. Such distributions with a greater proportion of extreme outcomes are said to have fat tails.

One cause of fat tails is skewed distributions, where relatively more events are found at one end of the distribution (Figure 1). An example of a skewed distribution is the distribution of wealth in Norway, where a few individuals own the lion's share of the total amount of private assets. Even symmetrical distributions can have fat tails, including the distribution of extreme weather, rain and drought. For example, many are familiar with Student's *t*-distribution, where a greater proportion of the outcomes are found in the tails of the distribution than in a normal distribution (Figure 1).

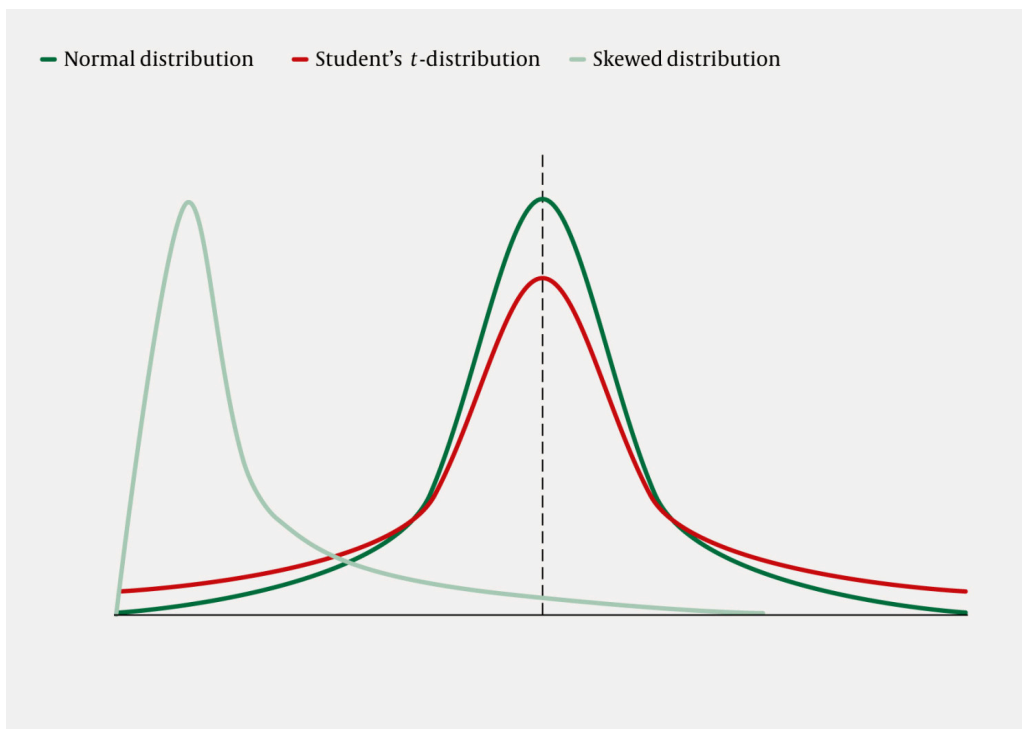


Figure 1 The relationship between a normal distribution, a distribution with symmetrical fat tails (here Student's *t*-distribution) and a skewed distribution with an asymmetrical fat tail. The dotted vertical line shows the mean value.

Black swans can produce fat tails

Black swan events can have an enormous impact on the world we live in. Well-known examples include the personal computer, the outbreak of World War I and the COVID-19 pandemic (at least the effect of the ongoing pandemic). These events tend to be identified only after they have occurred, and in their wake it is common to collect data and circumstantial evidence that would have confirmed that a black swan event was coming – with the benefit of hindsight. The dilemma lies in the likelihood of a black swan event occurring, in other words, the fatness of the tail(s) of the distribution of the phenomenon. Irrespective of whether it is global climate change, a global financial crisis or a new pandemic, the risk tends to be lower the more serious the disaster is

expected to be. For decision-makers, the crucial issue is how much the likelihood can be reduced, measured against the seriousness of the disaster if it should occur – a race which is of vital importance in black swan situations. In other words, decision-makers face the dilemma of balancing the amount of resources they want to use to limit the damage caused by an event that will probably never occur against the huge losses we might suffer should the event actually occur.

Black swans and fat tails in medicine

In medicine, we also have a strong aversion to risk and therefore often implement systems that include, for example, checklists to minimise the risk of adverse events [\(2\)](#). However, unlikely black swan events also occur in medicine, where they can have an enormous impact. We therefore seek to guard against them.

Fat tails are essential for most investment decisions in the health services, associated with localisation, structural design, capacity, reserves, specialisation and skills. Fat tails mean that extreme outcomes are more likely. To avoid disastrous consequences, it might therefore be sensible and rational to build up spare capacity to handle relevant extreme outcomes. As a rule, the best possible decisions made under circumstances of such real uncertainty produce 'cost efficiency through necessary overcapacity' as a result. This is the only way to achieve a minimum standard in healthcare provision at the lowest possible cost.

«Structural uncertainty requires us to take better account of unlikely events that may occur»

In a complex hospital setting with acutely ill patients or sudden catastrophic events during surgery, time is short and the information is often limited and incomplete [\(3\)](#). Our approach to black swan events is crucial for the way in which we organise ourselves and for how we interpret uncommon events and their consequences. After a black swan event, evidence of how this event could have been predicted and averted is often collected. Often, this is a misguided approach. Adverse events occur because they are neither easy to predict, nor easy to prevent. Structural uncertainty requires us to take better account of unlikely events that may occur in our daily clinical work and when major changes to the health services are being planned.

Taleb argues that the future will be more uncertain and even harder to predict, even though our total knowledge is increasing [\(1\)](#). Perhaps a heightened awareness of black swans and fat tails could help us encounter future challenges in medicine? It is crucial that decision-makers share the uncertainty in their decisions with the community and do not behave like armchair generals. By doing so, their decisions are likely to be less fraught with risk [\(4\)](#). The ongoing COVID-19 pandemic provides a good illustration of how a black

swan event (it is debatable whether the pandemic is a black swan) can change the rules of the game in society, and of how difficult it is to predict when and with what effect such an event will occur [\(5\)](#).

In discussions on the construction and location of hospitals, and the organisation of health trusts, it is important that we recognise that black swan events occur with unpredictable regularity. Nor can we predict how and how much such events will affect us – perhaps more than we want. We would therefore do well to acknowledge their existence when we make strategic decisions in the health services.

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