A Quant View Of The Wuhan Virus

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Most of the time—indeed almost all of the time—investors in financial markets can comfortably dismiss day to day fluctuations in the incoming flow of data as irrelevant noise. But today is one of the extremely rare occasions when the ups and downs in daily data are not just relevant, but immensely informative. The reason is the rapid spread of the Wuhan coronavirus, which has cascaded through global financial markets over the last two weeks.

Epidemics are, first and foremost, human tragedies. But they are also catalysts of economic risk—and as with other economic risks, a quantitative approach to the analysis of their characteristics and effects can be illuminating.

Two decades of quantitative research into risk has taught that shocks in any complex system usually cluster into two types: exogenous and endogenous. Exogenous shocks typically trigger abrupt crises, followed by quick recoveries. Endogenous shocks are far unhealthier; they take more time to develop, and longer to cure.

Exogenous and endogenous

Epidemics may appear exogenous, but they trigger endogenous-type cascades...

Epidemics are a third case. They combine exogenous properties—economic stress provoked by an outside agent—with endogenous properties—the ability of the stressor to trigger a cascade effect in the economic system. Therefore, the economic outcome of an epidemic may, at random, either be limited, or to the contrary, be disastrous.

From 282 confirmed cases reported by the World Health Organization on January 21, the number of Wuhan viral infections has ballooned to 20,630 across all 31 Chinese provinces and 26 other territories around the world.

The total number of people infected is still small compared with the infection rate of seasonal influenza viruses, which in an average year sicken almost 30mn people in the US alone. Nonetheless, the Wuhan virus merits close quantitative examination for two reasons: first, its rapid rate of human to human transmission, and second, its relatively high mortality rate, which so far is some 15 times higher than that of the average influenza outbreak.

Initial haze

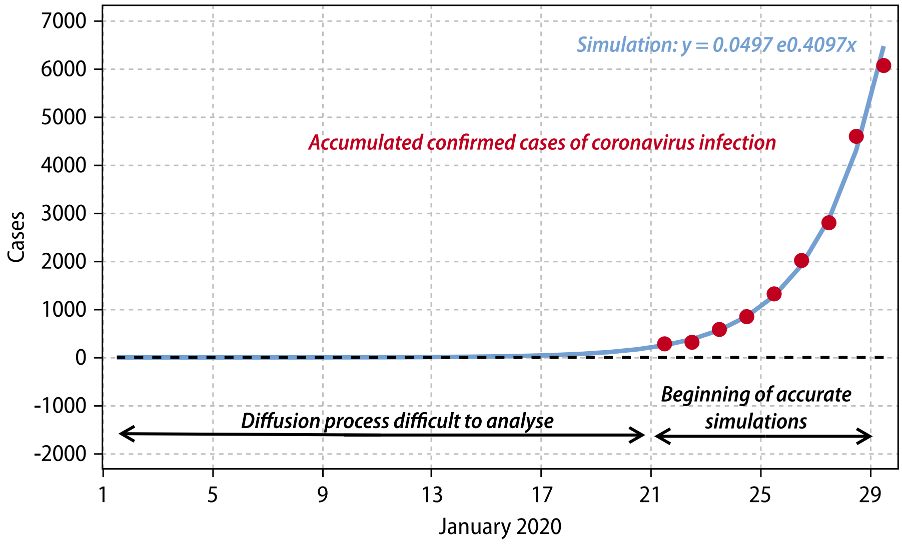
...which can lead to an exponential increase in measurable catastrophic risk

Like avalanches, epidemics are "cascade" events, which create exponential diffusions of risk. But while exponential impacts multiply much faster than linear ones, the nature of an outbreak is seldom clear in its early days. As a result, at the beginning of an epidemic, it can be difficult to asses the probability that it poses a catastrophic risk.

For example, in 2009 the French Health Ministry purchased 94mn doses of vaccine against the H1N1 swine flu virus. This €1bn of spending turned out to be largely unnecessary. In the event, the outbreak proved considerably less severe than an average seasonal flu outbreak.

Initial projections of the corona virus spread were extremely alarming

Reported cases of coronavirus infections up to January 29



WHO, Gavekal Intelligence Software, Gavekal Data/Macrobond

The chart above shows the early diffusion of the coronavirus, as reported by the WHO. No useful statistical information can be gleaned at the very beginning of the outbreak. But as the spread of the disease accelerates, there is sufficient data to allow a curve to be fitted to the infection rate.

Cause for alarm?

At its inital rate of acceleration, the Wuhan virus would have infected half the world...

The projections of this exponential fit look extremely alarming. If the diffusion process were to continue to follow the same curve, by the end of February half of humanity would be infected. The Wuhan coronavirus outbreak would be on the same order of magnitude as the 1918-20 Spanish flu pandemic, which infected 500mn people, or a third of the world's population at the time.

Thankfully, such a catastrophic scenario looks highly improbable, largely because the diffusion process has already started to fade.

...but the rate of acceleration is slowing

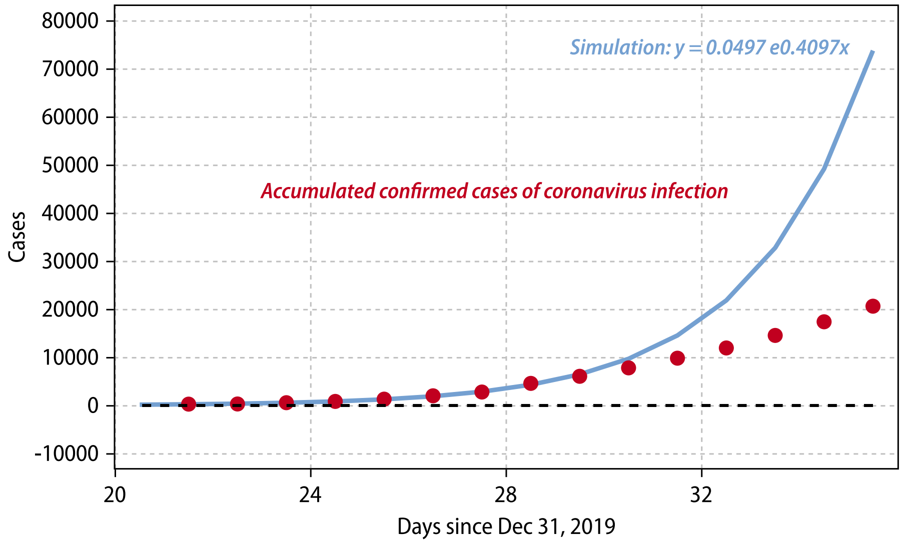
The dynamic of acceleration is measured by its derivative (that is, the second derivative of velocity), which mathematicians call the "jolt" (and physicists the "jerk"). As the upper chart overleaf illustrates, while the spread of the Wuhan virus continues to accelerate, it is now accelerating at a lower rate than last week. If the jolt continues to decrease in line with the fitting function shown in the lower chart overleaf, by the end of February the Wuhan virus will have infected a total of some 230,000 people around the world. After that the rate of new infections will begin to diminish.

This curve fitting model is unsophisticated, but it does provide a top-down view of the catastrophic pandemic risk. For complex processes, such top-down views can often prove more robust than bottom-up analyses. It also provides a yardstick with which to assess the day by day evolution of the outbreak, as tracked by the WHO and China's National Health Commission.

Keep a weather eye on the "jolt", the first derivative of acceleration...

Don't get hung up on the accelerating spread, watch the "jolt"...

Reported coronavirus infections up to February 4

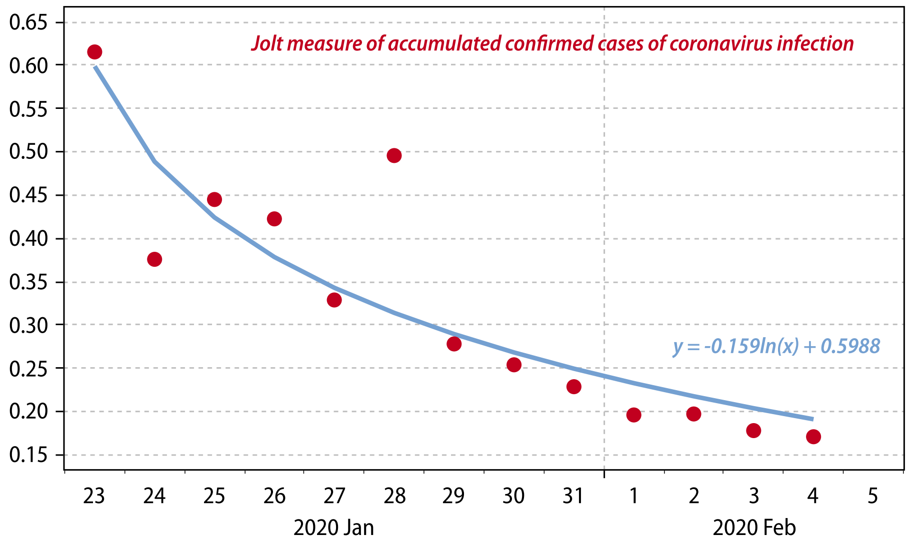


WHO, Gavekal Intelligence Software, Gavekal Data/Macrobond

...which gives some cause for optimism...

...and the jolt shows that the acceleration is now slowing

Reported coronavirus infections up to February 4



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...that the number of new infections will peak early in March, if not before

If the number of accumulated confirmed cases increases at a lower rate than the simulation in the table overleaf, the Wuhan flu will likely peak within the next couple of weeks, and then fade rapidly away. If the number of new cases increases in line with the simulation, and the rate at which patients are discharged as cured rises in line with expectations, the number of patients infected with the disease at each moment in time will evolve in line with the curve in the chart overleaf, peaking in early March.

The jolt model is a yardstick for assessing daily reports of infections

Accumulated confirmed cases of coronavirus infection

Date	Projected cases	Confirmed cases
February 2, 2020	14,557	14,557
February 3, 2020	17,688	17,391
February 4, 2020	21,809	20,630
February 5, 2020	26,559	
February 6, 2020	31,973	
February 7, 2020	38,082	
February 8, 2020	44,907	
February 9, 2020	52,460	

Source: World Health Organization, Gavekal Intelligence Software

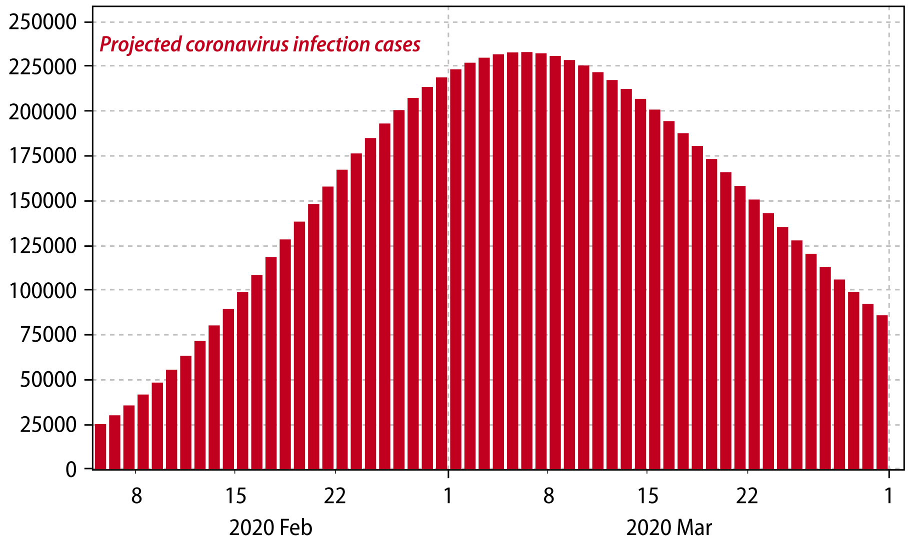
Conclusion

Watch carefully the accumulated number of cases over the coming days

The last 11 days of coronavirus data mitigate the risk of a catastrophic global pandemic. Epidemics, however, must be tracked day by day, unlike standard macroeconomic evolutions. For once, portfolio managers should temporarily forget about inflation, growth, liquidity, tariffs and so on, and focus each day on estimating catastrophic risk. If the total number of accumulated infections exceeds 52,000 by Sunday February 9, which appears unlikely, this systemic risk estimation will be reassessed and scaled up significantly.

In the jolt model, the number of infected patients peaks in early March

Assuming a 'Jolt' decrease in line with y = -0.159ln(x) + 0.5988



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