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Modelling market risk for pandemics

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Flash back a century, to the Spanish flu

The raging Covid-19 pandemic has whetted researchers' interest in pandemic modelling.

The interest is partly because modelling multiple factors that link the pandemic to market performance is challenging. Usually, researchers have to also contend with uncertainty over the quantum and timing of policy interventions. Moreover, pandemic effects are linked to health system responses, immunity that people might develop over a period, and the possibility of a vaccine. These reactionary measures are uncertain, with no dependency on the past actions, and hence challenging to model.

In this paper, we address some of the challenges around modelling market risk factors and compare market situations between the two pandemics.

Of all the pandemics in the past century, Covid-19 has striking parallels with the Spanish flu (1918-1920), not just on the health and epidemiological side, but also in how financial markets have reacted to the two pandemics. Therefore, we have tried to identify risk comparison metrics – for use in market risk and stress-testing practices – for evaluating the severity of Covid-19, using the Spanish flu as a frame of reference.

Given the similarities and differences between the two, it is important to compare market behaviour during these pandemics to understand the factors present at the time better.

Only a few indicators were available during the Spanish flu to indicate market performance and reaction. If we look at the foreign exchange asset class, forex rates were fixed for most currencies during the Spanish flu, making any comparison inherently flawed. Prices prior to 1957, when the Commodity Research Bureau index – a representative indicator of global commodity markets was launched – are unreliable.

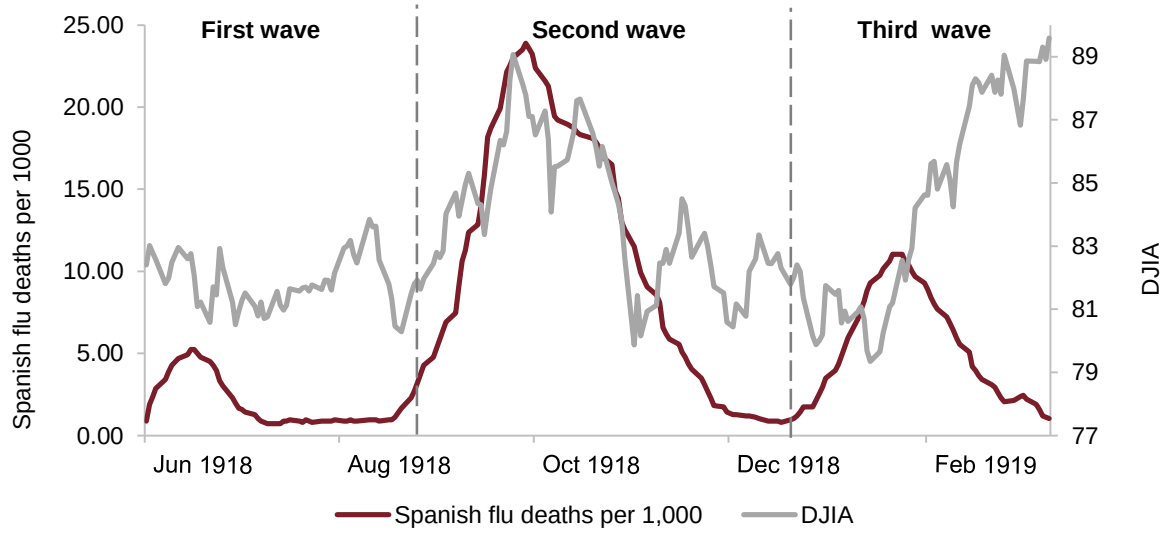
However, the Dow Jones Industrial Average (DJIA), which was trading at the time of the Spanish flu, does provide a reliable indicator, and we use this as a central measure of comparative performance between the two periods. As such, equity is typically the quickest to react to pandemics compared with other asset classes.

We use statistical parameters such as annualised volatility over 30 days, peak-to-trough fall, peak volatility, and correlation checks to compare the two pandemics. These parameters provide a comprehensive overview of index performance during pandemics, because they capture multiple parameters to gauge the indicator performance, e.g. uncertainty over a period, market correction, uncertainty during the peak of a flu, maximum drawdown of the DJIA index, and correlation between the death rate and index performance.

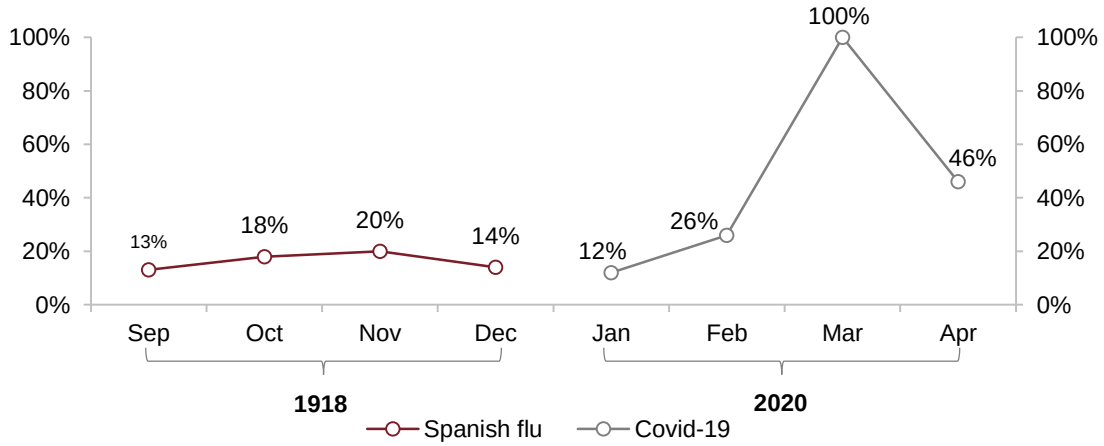
How Covid-19 compares on different counts

- **Volatility comparison in the DJIA index:** During Covid-19, the market reacted with a significant jump in volatility, as panic selling was seen among traders. Increased trading volumes of volatility-linked products, rapid central bank intervention, and algorithmic trading also led to increased market volatility. During the Spanish flu, there were three waves of the virus outbreak, which resulted in three virus peaks. The DJIA's behaviour and performance during each of these three peaks were notably different. We have considered the largest Spanish flu wave that manifested during September to December 1918.

Spanish flu – the three waves (1918-1919)



Annualised volatility over 30-day periods during the two pandemics

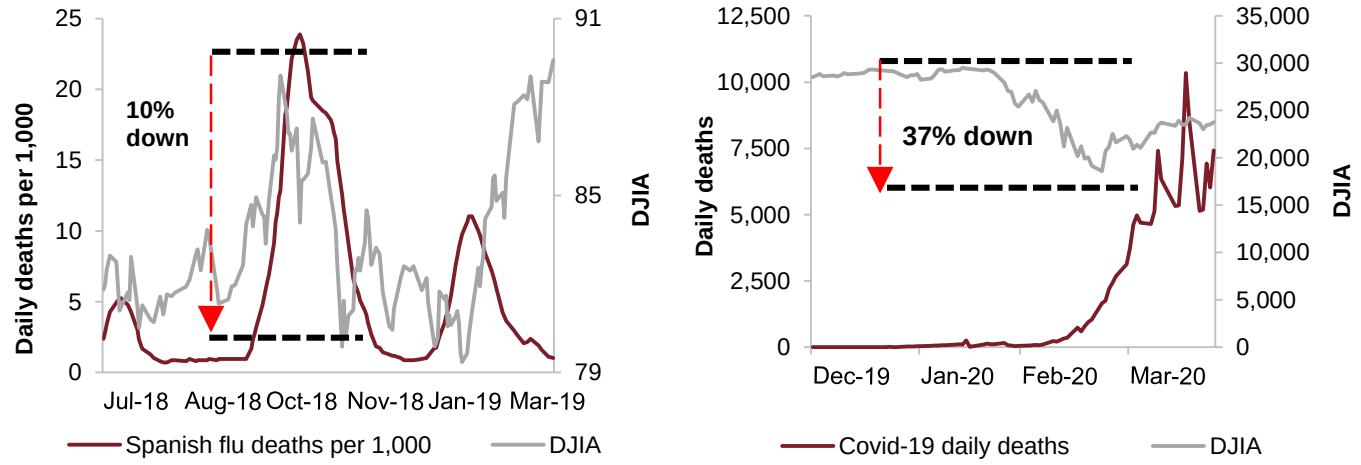


We see that the volatility in the DJIA during Covid-19 months is more than 5x higher than that observed during the Spanish flu period. This is specifically attributed to increased interconnectedness of global supply chains, higher speed of communication, and a more voluminous (and hence liquid) stock market[1].

- **Peak-to-trough fall:** The Spanish flu pandemic peaked during the second wave (September-November 1918), leading to a very high mortality rate. This was also coupled with the post-world war recession. During this period, the DJIA initially increased, but declined after October 1918. During this virus peak, the peak-to-trough fall was 10%. For Covid-19, we are not certain when the virus peak will be reached, though estimates[2] suggest the peak could be over in certain countries. The peaks are expected at different time periods in different countries. Between December 2019 and April 23, 2020, the DJIA had a peak-to-trough fall of 37%. This is about 4 times higher compared with that during the Spanish flu pandemic. Since April, 10, 2020, the DJIA has been flat and has not seen much movement.

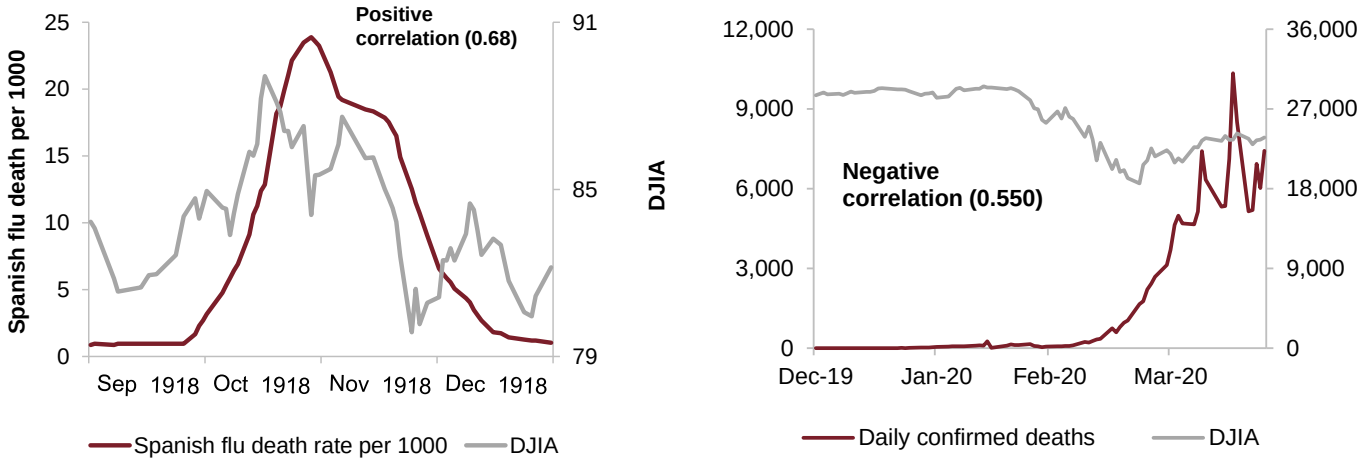
[1] Source: https://insight.kellogg.northwestern.edu/article/what-explains-the-unprecedented-stock-market-reaction-to-Covid-19
[2] Source: https://www.theguardian.com/world/2020/may/06/global-report-several-asia-pacific-nations-pass-Covid-19-peak-and-plot-return-to-work

Peak-to-trough fall during Spanish flu and Covid-19 (%)



- **Volatility during the second peak of Spanish flu:** The Spanish flu peak for the second wave occurred around November 1918. If we look at the volatility metric one month prior to the peak (i.e., over a 30-day period), it was 0.18 on an annualised basis. If we look at the Covid-19 data, the annualised volatility over a 30-day period (March 23 to April 23, 2020) is 0.62. This higher volatility could be attributed to uncertainty over when the Covid-19 curve would flatten and lack of clarity on policy intervention at that time.
- **Correlation check:** As per our calculations, the correlation coefficient between Spanish flu deaths and DJIA data series was found to be 0.68. Despite this, it is difficult to establish a correlation between the data series. During the first wave, World War I had a major impact on stock prices; the world war had ended during the second wave, and the Spanish flu impact was largely offset by euphoria about war conclusion. For Covid-19, the correlation coefficient between Covid-19 deaths and the corresponding DJIA series is -0.55, implying they are negatively correlated, which is on expected lines.

Correlation comparison between the pandemics and DJIA



Tail effect: The Spanish flu hit the countries when stock prices were low. As per researchers, the Spanish flu had a mild impact on the aggregate US economy, and much of the impact on the economy was due to the world war [3]. The economic recovery is linked to increased output, which was witnessed a few months after the pandemic ended.

On the contrary, Covid-19 hit the economy when equity indices were already booming and the cyclical impact was waiting to hit, as some economies had already moved into a slowdown phase. Abysmally low GDP estimates have worsened further, and the unemployment rate is likely to soar in the coming quarters as Covid-19 continues to spread.

Due to Covid-19, the impact on equity prices was more than 30%, and this is comparably reasonable given higher liquidity, better information flow, and a higher number of participants in the market today. But at the end of the day, we should not forget that Covid-19 deaths are not anywhere close to the Spanish flu deaths, and the equity markets have already recovered to an extent.

The 1918 pandemic was associated with sizeable declines in the real rate of return on stocks and short-term bills. This could be attributed to the high inflation rate during the pandemic. Primarily, it was due to the timing of the flu with respect to the economic and financial cycles. In the case of Covid-19, we expect the inflation to rise in the post-recovery period, when governments plan for fiscal stimulus in their respective economies.

The implications for market-risk management

Higher volatility may mean higher capital charges due to market risk: High volatility could lead to a spike in capital requirement related to market risk. The increased value at risk (VaR) is likely to force banks to keep more capital, at a time when regulators want banks to continue to give out loans as much as possible to keep lending to the real economy.

Pandemic might mask model deficiencies: Covid-19-related volatility has resulted in a significant increase in the trading books' capital requirement. Volatility has led to a higher number of VaR back-testing exceptions for banks and the usage of a VaR multiplier to cover model deviations. Capital calculation has been impacted, as several banks have seen actual or hypothetical P&L movements compared with their model-predicted VaR estimates. Under the current regime, it is difficult to point out model deficiency, as the impact is due to extreme volatility and not due to model deficiency. This has led to VaR multiplier becoming pro-cyclical in nature and putting pressure on capital requirement. Such pro-cyclical nature of the VaR multiplier has led to all banks being gauged on the same scale, while model deficiencies differ from bank to bank. Pro-cyclical market-risk capital measures give banks less leeway to act as intermediaries, hindering firms from accessing financing and risk-management services they need.

Scenarios for stress testing: It will be a herculean task for banks to consider all the potential Covid-19 scenarios to model market risk. However, they should consider a good number of possible scenarios, ensuring that extreme situations and intermediate expectations are modelled, while modelling pandemic impact on their capital requirement based on market risk.

An effective approach for banks would be to divide their analysis over short, medium, and long term.

[3] Source: https://voxeu.org/article/1918-influenza-did-not-kill-us-economy

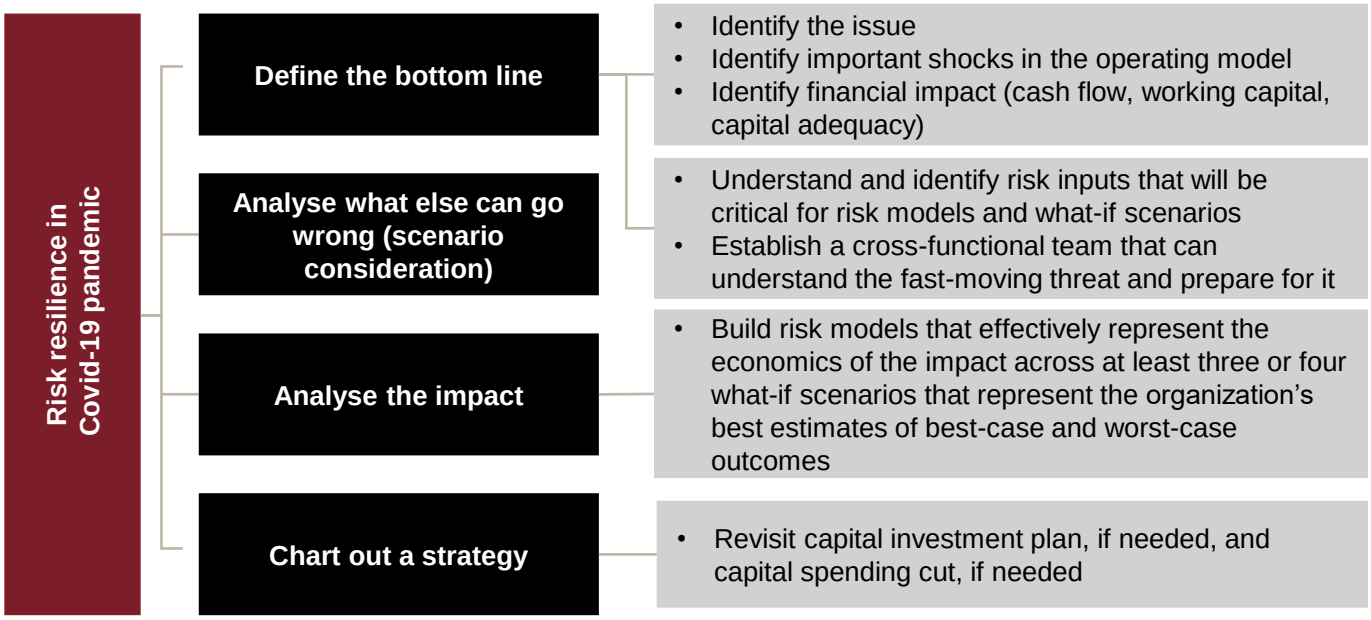
Time horizon	Stress scenario parameters
Short term	• Performance of highly impacted sectors should be considered. These include hospitality, oil and gas, travel and tourism and supply chain shocks. • How does MTM movement impact capital requirement • Number of times VaR estimate is breached • Sentiment analysis • Short-term policy responses (e.g. fiscal stimulus) • Post-pandemic market response • Covid-19 mortality rate
Medium term	• Scenario analysis based on macroeconomic parameter projections, such as GDP growth and purchasing managers' index (PMI) • Sentiment analysis • Medium-term policy responses • Inflation, unemployment rates
Long term	• Long-term policy responses • Operational risk from Covid-19 • Failure of banks triggered by the pandemic

Each of these parameters can be considered under multiple scenarios.

Scenarios	Global mortality rate	Global GDP drop	Market crash since December 2019 (%)	Global unemployment rate	Worst-hit sectors	Sovereign default, haircut
Baseline	1–1.5%	-3%	-23%	5%	Aviation, tourism	NA
Medium impact	2–2.5%	-5.5%	-35%	6.5%	Aviation, tourism, automotive, oil and gas, real estate/infrastructure, MSMEs	5% (countries impacted: Italy, Greece)
Severe impact	3–3.5%	-7%	-38%	8%	Aviation, tourism, automotive, oil and gas housing/infrastructure, MSMEs, retail loan portfolios	15% (countries impacted: Italy, Spain, Greece)

Market-risk model changes: Increased volatility in interest rates and FX may lead to MTM losses for banks. Banks might need to reassess their market-risk models and update them to include Covid-19 scenarios. Scenario analysis for a change in the interest rates and credit spreads is needed for banking books. Given the high volatility, there should be a reallocation of limits on trading-book sensitivities. For the calculation of stressed VaR, a reassessment of the stress period is required. Banks should communicate to their regulators if the market-risk capital is adversely affected due to Covid-19 implications and differs much from market-risk models.

Pandemic risk resiliency plan: Pandemics call for a resiliency plan to sustain financial institutions' assets. The below chart can be helpful in charting out a strategy for a risk-resiliency plan.



Closing thoughts

The market impact of a pandemic is mostly a knee-jerk reaction, which then gets shaped by policy responses, outbreak propagation velocity, and multiple other policy factors.

The two pandemics discussed here have a high degree of similarity and impact on banks from a market-risk perspective. But while the Spanish flu did not result in widespread pandemic modelling at banks, the situation in 2020 is quite different.

Pandemic scenario modelling indicates how a pandemic affects the assets of banks and helps institutions prepare through limited planning for future pandemics.

Banks and regulators are likely to incorporate pandemic modelling as part of their planning process, and we have presented a few indicators that might be useful from a market-risk perspective. CRISIL's team of experts has assisted several banks in their stress-testing programs, and we are witnessing an ever-increasing demand for pandemic and non-financial scenario modelling from our clients.

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