Prescient Models

Stress Testing for Pandemics:
Lessons from the Hong Kong SARS Recession

by Joseph L. Breeden

20 February 2020

Stress Testing for Pandemics

By Joseph L. Breeden, CEO, Prescient Models LLC

Given the unfortunate global headlines about coronavirus, managers are starting to ask about stress testing the financial impacts of possible pandemics. For some, that is dusting off old plans. For others, it is devising new plans. For the author, it has elements of reliving the past.

Severe Acute Respiratory Syndrome (SARS) is being used as a benchmark for the new coronavirus (COVID-19). Of course, COVID-19 is a much greater global health risk that what SARS turned into, but our past work around SARS does have some lessons for how to prepare. Epidemiologists say that SARS is the best analogue for COVID-19, because they are the closest genetically, having 80% DNA equivalence. In banking, the Hong Kong SARS recession of 2002-2003 is the only disease led recession within our data, so we will start there.

The author was doing real-time portfolio forecasting for a major lender in Hong Kong during and after the 2002-2003 SARS recession. A retrospective analysis of the Hong Kong SARS recession is given in his book[i]. This article will revisit some of the lessons there and some additional insights from the experience. This article will conclude with a discussion of possible COVID-19 stress scenarios for the US.

Revisiting SARS

In late 2002, Severe Acute Respiratory Syndrome spread from civets to humans, eventually affecting 8,000 people in southern China and Hong Kong. With 774 deaths, the fatality rate was 9.6%[ii]. The virus itself did not affect a large percentage of the population of Hong Kong (only 1,755 in total), but the resulting fear and control measures caused a measurable shock to the Hong Kong economy.

Figure 1 shows historical changes in GDP for Hong Kong with significant downturns highlighted. In order of severity, we see the 1997-1998 Asian Economic Crisis, the 2009 Global Financial Crisis, the 2001 Global Recession, and the 2003 Hong Kong SARS Recession. Each recession below is followed by a growth rebound, except for the 2001 Global Recession, the expansion was interrupted by the SARS Recession. Lasting only one quarter, 2003 was not a recession by most official definitions. Most interesting is the magnitude of the economic rebound following the end of the SARS epidemic.

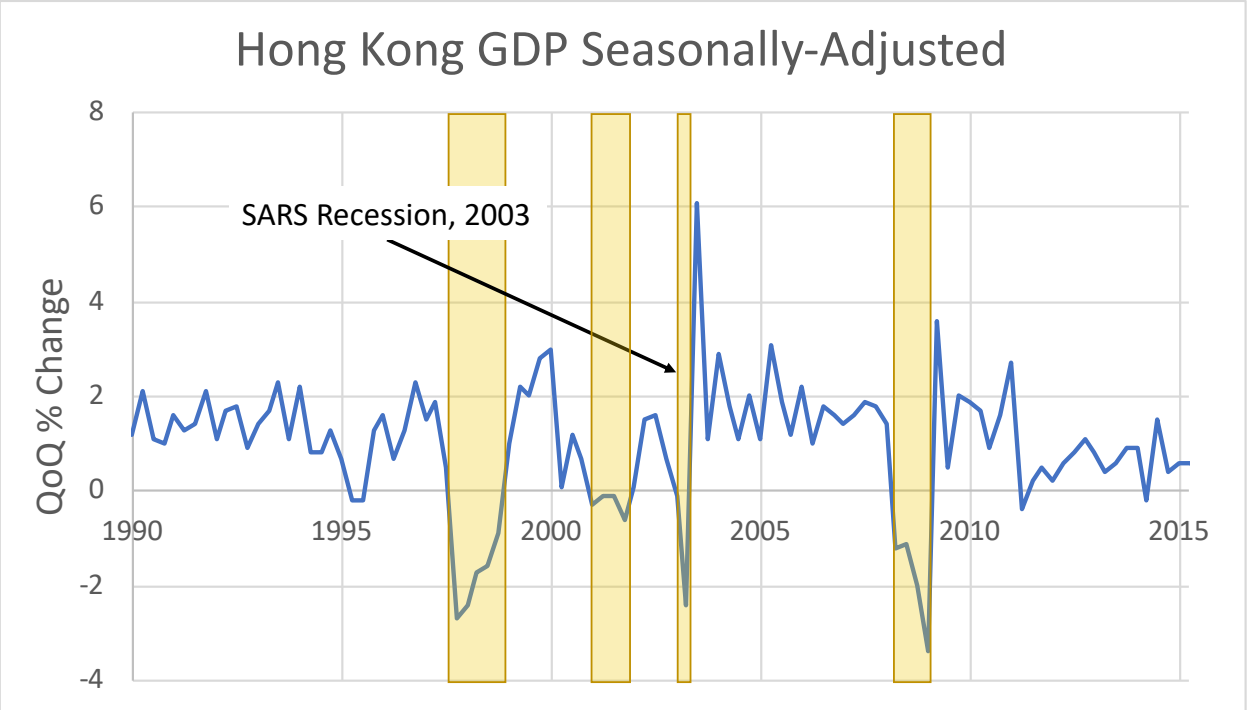

Figure 1: Quarterly change in GDP for Hong Kong. Data from Census and Statistics Department, The Government of the Hong Kong Special Administrative Region, https://www.censtatd.gov.hk/hkstat/sub/sp250.jsp?productCode=B1030001.

At the time of the outbreak, the author was working with a large Hong Kong financial institution on loss forecasting, remotely. Attempting to create forecasts in real-time through the crisis, the first thing tried was to correlate losses through the crisis to the number of people infected monthly. Indeed, such a model could explain the sudden reversal from the 2002 economic recovery.

However, any model that correlates the number of cases of disease with economic or financial impact will be specific to only that event. The extra loan defaults experienced by a financial institution are not literally because those people were sick. Rather it is an economic contagion effect caused by fear of the disease. The multiplier between number of sick people and economic impact is a function of how much the disease is feared.

Therefore, the best approach is to model defaults using traditional macroeconomic factors such as GDP, unemployment, and residential property values. In Hong Kong, all of these were affected by the fear of SARS. Consumers did not go shopping, so businesses laid-off workers. Property values fell and fell especially hard in areas with outbreaks. Rather than creating a model of the disease, we created a model of recessions and would translate future epidemics into scenarios of impact on typical macroeconomic factors.

Some years later, working for the same client, we had an opportunity to create a stress test model that included both the 2001 Global Recession and the 2003 SARS Recession. Table 1 shows the coefficients estimated for the model and Figure 2 shows the history and in-sample fit of the model. The y-axis here is the change in log-odds of default for consumer loans due to

calendar-date impacts. As can be seen, a model using unemployment rate and residential price index fits reasonably well to both recessions and the later expansion. Our work also included modeling EAD and LGD, both using typical macroeconomic factors and with similar results.

Table 1: xxx

Variable	Coefficient	Std Err	Standardized Coefficient	p-value
Intercept	7.28	0.34		2.20E-30
Unemployment Rate	6.03	0.29	0.87	1.06E-29
Residential Price Index	-1.32	0.34	-0.17	2.09E-04

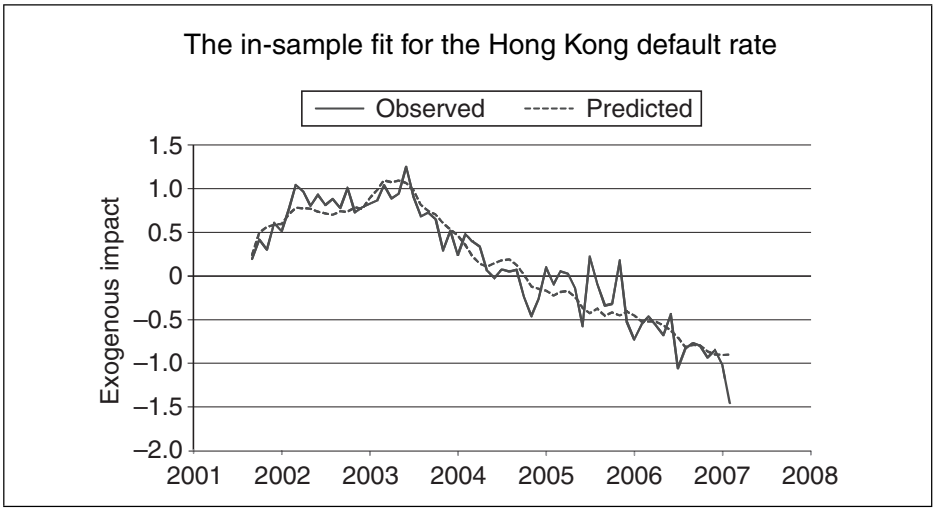

Figure 2: Macroeconomic impacts on consumer loan defaults in Hong Kong for a large financial institution.

The lesson from this exercise was that to stress test for pandemics, FIs do not need to create custom stress test models. Don't bother implementing the model in Table 1. Rather, use your existing stress test model but focus on creating scenarios for how a pandemic could affect the economy and therefore portfolio performance.

Considering COVID-19

Even though we don't intend to model COVID-19 directly, understanding the virus is necessary to understand what consumer, business, and government responses might be. That said, we currently know quite a lot and not enough. The genome of COVID-19 has been sequenced and we know that it is 96% similar to a certain bat species[iii]. The SARS virus is the closest human pathogen. Several labs are rushing candidate vaccines into testing.

What we don't know is how many people are infected. Statistics on the number of confirmed cases say nothing about how many people have the virus but are showing only minor symptoms and therefore not seeking help. In the Hubei province of China, the number of reported cases is biased by the selection of those who were tested and the availability of test kits. For example,

in the hospital where the virus appeared, a study of the first 138 cases contracted there noted that not everyone in the hospital was tested – only those showing clear symptoms[iv]. As a result, we do not know the transmission rate, but it is estimated to be between 3 for SARS and 2 for pandemic flu. We do not know the fatality rate, because we do not have accurate measures of either numerator or denominator, but it is thought to be significantly less than SARS and significantly more than seasonal flu. In fact, a literature search will show that we have large uncertainties knowing such measures on many of the diseases that are endemic globally.

The biggest difference between SARS and COVID-19 is that SARS was contained. The last SARS case appeared in 2004[v]. COVID-19 appeared in a very different place at a different time. A disease outbreak in Wuhan, China would be similar to having an outbreak in Dallas or Chicago. Wuhan is a transport hub in the center of China with connectivity to many countries. Simulations of air travel following the outbreak but before suspension suggest that many countries could already have outbreaks of COVID-19 underway[vi]. Given the possibility of slow appearance, limited symptoms in many, and limited testing ability in many locations, we may not know the full extent of the virus for some time.

The above information could change significantly by the time this article is published, but it is enough to begin creating scenarios.

Stress scenarios for a US COVID-19 recession

Honestly, no one knows what will happen with COVID-19. Therefore, we stress test it.

In China, the government has moved aggressively to restrict the spread of the disease and has promised equally aggressive economic stimulus, but these are opposing policies. Restricting the spread of the virus has meant dramatically suspending travel and even local mobility. In a number of large cities, restaurants and bars are closed and only food delivery is available. Although factories are attempting to reopen, such restrictions keep many of them understaffed or shuttered. Many schools are closed or attempting to switch to online teaching.

US companies are beginning to report supply chain constraints and drops in sales within China. The longer China must keep these controls in place, the more severely the global supply chain will be disrupted. Even if the disease does not reach the US, the economic slowdown will.

For our stress test scenario, we will take the more severe approach of assuming that the disease is not contained and does spread globally with outbreaks in major US cities by summer. COVID-19 has shown that it can spread in Singapore, an equatorial country without winter. Therefore, we have no reason to assume that summer would end the outbreak the way it does with seasonal flu.

Epidemiologists have said that COVID-19 will probably have the impact of a very, very bad flu season. If the 2017 flu season is a guide with 61,000 US fatalities[vii], we might assume twice that many for COVID-19. Although a large number, do you remember the 2017 flu season?

Government health services issues warnings and aggressively promoted flu shots, but there were no school or business closures. Economic impacts were significant, but not the kind that trigger a downturn. The reason is that there was no public fear curtailing activities.

In some ways the 2009 H1N1 (swine flu) pandemic is a better guide. In the US there were 12,500 fatalities from 10% to 20% of the population contracting the illness[viii]. Even though the fatalities were less than in 2017, this was a disease that was tracked in the news, and concentrated outbreaks forced the closure of many schools. Although preparations were made for more dramatic action, none was needed in 2010.

From a data modeling perspective, H1N1 doesn't offer much in the US. This occurred during the peak of the 2009 recession and any impacts are indistinguishable. The only useful information is in how schools, businesses, and governments were prepared to act. In light of this, we make the following assumptions for a COVID-19 Stress scenario:

- The US government would not be able to take the dramatic steps taken in China.
- Airlines could prevent travel for those with fevers. Fear of travel would also cause a dramatic reduction for airlines, hotels, and related businesses.
- Storefront retail sales would drop dramatically as consumers limit public exposure to essentials.
- Service industries would suffer with closure of some small businesses, but health care would expand.
- Overall, hours worked per week for employees would decline first, followed by rising unemployment.
- Online shopping would boom, but only if US companies have goods to sell, considering supply chain disruptions.
- The Federal Reserve would act aggressively to stimulate the economy, but to little effect until the fear of contagion had passed.

Our AI-driven macroeconomic forecasting models already predicted a slow-down in Q1 and Q2 of 2020, where the recession that would-have-been has been avoided by the Fed's stimulus in 2019. GDP growth would have been on the order of 1.5% annualized with more aggressive growth in Q3 and Q4 as the Fed's stimulus has full effect. The COVID-19 shock would override that growth, causing a sudden drop in GDP to -3.5% by Q3.

By year end, the virus will have peaked and the consumer-led rebound will begin, but supply chain disruptions cause the rebound to be more muted than was observed in Hong Kong and spread over a period of time. Figure 3 shows this scenario compared to the 2020 DFAST Severe scenario. DFAST scenarios are always unrealistically abrupt and therefore begins even more quickly than our COVID-19 Stress scenario.

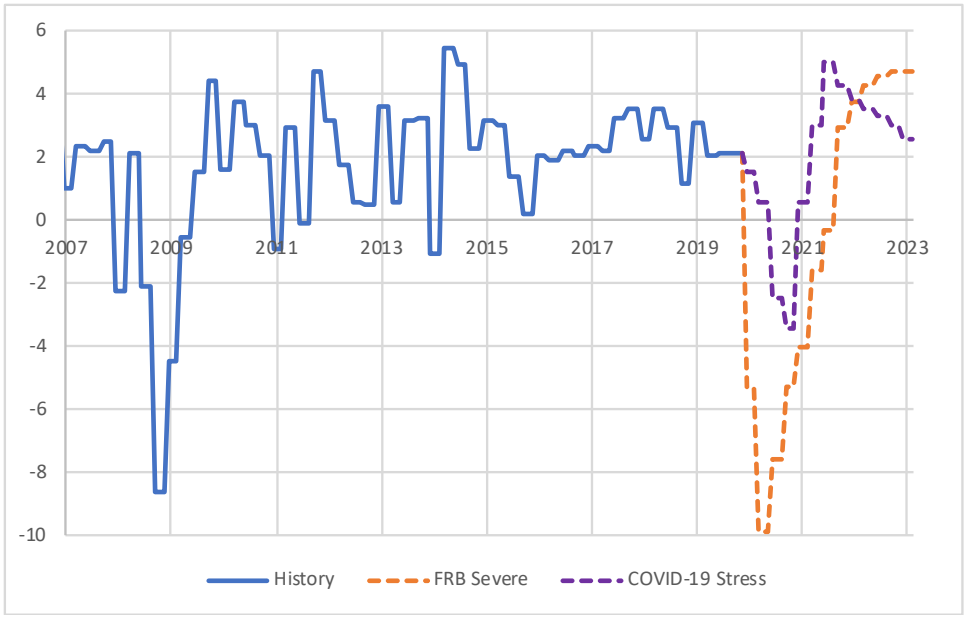

Figure 3: Annualized quarterly change in Real Gross Domestic Product (RGDP). The COVID-19 Stress scenario is compared to the FRB DFAST Severe scenario.

Figure 4 shows a corresponding unemployment rate for the COVID-19 Stress scenario and is again compared to the FRB DFAST Severe scenario. The unemployment rate scenario assumes that layoffs begin more quickly than is typical in a recession because of the abrupt drop in retail sales and services. Hiring is assumed to happen fairly quickly, especially in services. The COVID-19 Stress scenario looks somewhat similar to the 2001 recession.

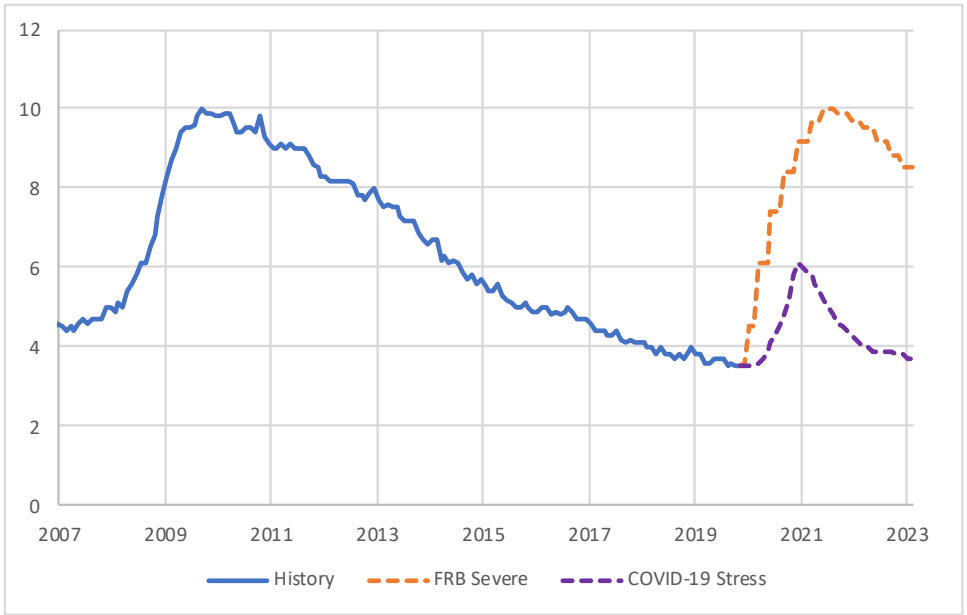

Figure 4: Monthly unemployment rate. The COVID-19 Stress scenario is compared to the FRB DFAST Severe scenario.

Nationwide, we expect house prices and commercial real estate prices to go flat as the supply of available properties drops. Markets with newsworthy virus outbreaks would see dramatic short-term drops in prices.

Some experts say that a COVID-19 recession scenario would be milder. Others say that it could be worse. One mitigating factor for the recession could be that the recession globally would be asynchronous. As China brings the virus under control and their economy starts to recover, other countries such as the US would hit peak impact.

The scenario described here is only that. The point is to follow an exercise like this to think through possible impacts of a pandemic to the public and the economy. As current conditions evolve, the scenarios can be revised and rerun to identify potential weaknesses for the FI.

Economic factors like GDP are always reported too late to be an indicator of when the stress scenario should become the base case. Instead, we will look for the spread of the disease, news coverage, and company-specific reports of drops in travel and tourism, retail sales, and small business closures and bankruptcy filings.

Immunizing the portfolio

As with any stress test, the results of the forecast must be translated into an action plan. What would you do in anticipation of the stress? What would you do during the stress?

Since the recession is expected to be short in duration, the greatest default risk will be in short duration loans. Fortunately, that means FIs can wait to make changes in underwriting or pricing until closer to the recession. The greatest risk would be loans with around a one-year term made a couple months before a recession was apparent. It's the worst case of (1) lack of visibility when pricing and (2) risk from a short-duration recession.

More so than a typical recession, FIs will need to carefully consider the reputation risk of certain actions. Collections in particular may want to allow grace periods to avoid being in the news for attempting to collect debts from those who are sick. Being prepared for proactive policy changes can turn these issues into a customer service advantage.

Preparing for a COVID-19 is more like preparing for a natural disaster than a typical recession. Use the stress test models already in place. Design appropriate macroeconomic scenarios and revise as events change. Plan in advance for corresponding portfolio management changes. As with all natural disasters, hope that this is nothing more than a training exercise.

---

[i] Breeden, J.L. *Reinventing Retail Lending Analytics: Forecasting, Stress Testing, Capital, and Scoring for a World of Crises – Second Impression*, Riskbooks, March 2014.

[ii] Smith, Richard D (2006). "Responding to global infectious disease outbreaks: Lessons from SARS on the role of risk perception, communication and management". *Social Science & Medicine*. **63** (12): 3113–23.

[iii] Zhou, P., Yang, X., Wang, X. *et al.* A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature*(2020). https://doi.org/10.1038/s41586-020-2012-7

[iv] Wang D, Hu B, Hu C, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China. *JAMA.* Published online February 07, 2020. doi:10.1001/jama.2020.1585

[v] World Health Organization, https://www.who.int/csr/sars/country/en/

[vi] De Salazar, P.M., Niehus, R., Taylor, A., Buckee, C.O. and Lipsitch, M., 2020. Using predicted imports of 2019-nCoV cases to determine locations that may not be identifying all imported cases. *medRxiv*.
[vii] Centers for Disease Control and Prevention, https://www.cdc.gov/flu/about/burden/index.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fflu%2Fabout%2Fdisease%2Fburden.htm
[viii] https://en.wikipedia.org/wiki/2009_flu_pandemic

Prescient Models

www.prescientmodels.com | sales@prescientmodels.com | +1-505-670-7670
1600 Lena St., Suite E3 Santa Fe, NM 87505