Man vs Nature: what the government can fix and what it can't (a quick read, mostly charts)

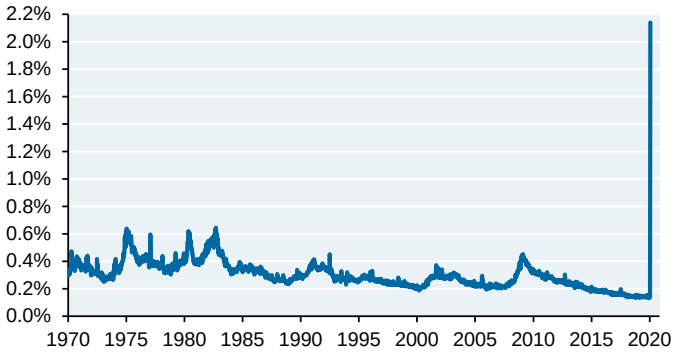
There are some things the government can try and fix during a pandemic and other things which it can't. All our coronavirus materials are updated daily here. In this note, we highlight some of what we have posted recently, and which can be divided into issues the government can fix (credit availability and cost, income loss) and things it cannot (economic activity during a lockdown, the speed of medical advances).

- Trackers of high frequency US manufacturing and consumer data
- Trackers of the Fed's ability to reduce liquidity problems in credit markets, and where we see value
- A history of markets recovering before employment
- The Chloroquine controversy and the problem with non-randomized trials
- The limited value of infection prediction models (they usually don't work until you know the answer)

An early read on high frequency US manufacturing and consumer data

By now you've seen the extraordinary measures enacted by the Fed and the Congress. I will not enumerate them here, but they are both extensive and unprecedented. Instead, as investors, we're more interested in how successful they will be in combatting the surge in jobless claims that occurred last week. Our new tracking charts appear below and are critical to our understanding of the pandemic and its market, investment and economic consequences.

US jobless claims as % of active working population (employed + looking for work)



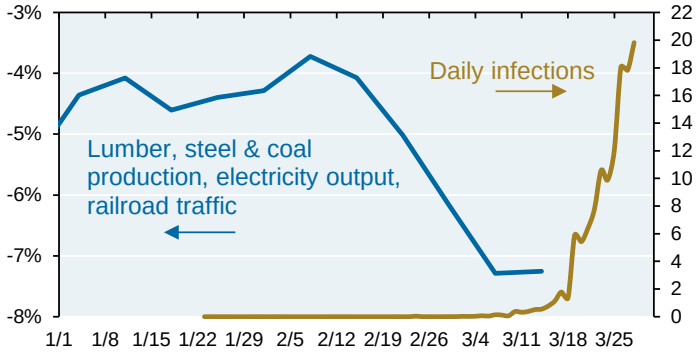
Source: Department of Labor, St. Louis Federal Reserve. March 26, 2020.

On the jobless claim number

A virus-led spike in jobless claims is not quite the same as a spike in jobless claims during a demand-led recession, given the speed with which unemployed people may go back to work once lockdown provisions are lifted, and given provisions in the $2 trillion fiscal stimulus bill designed to incentivize companies to hire them back (in which case gov't loans could become grants)

US 2020 manufacturing tracker and daily infections

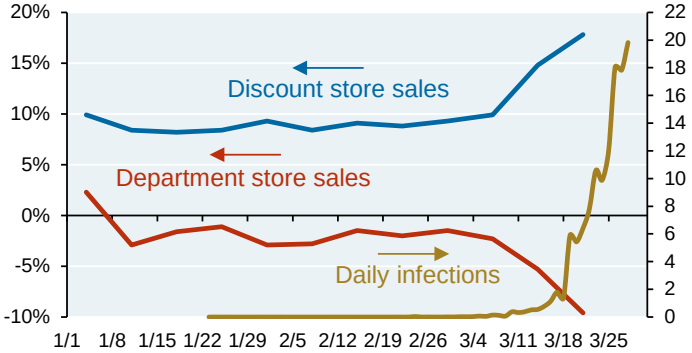
Rolling 4 week y/y % | Daily infections, thousands



Source: WWPA, EIA, AISI, AAR, EEI, Haver. JPMAM. March 28 , 2020.

US 2020 consumer tracker and daily infections

Weekly y/y % | Daily infections, thousands

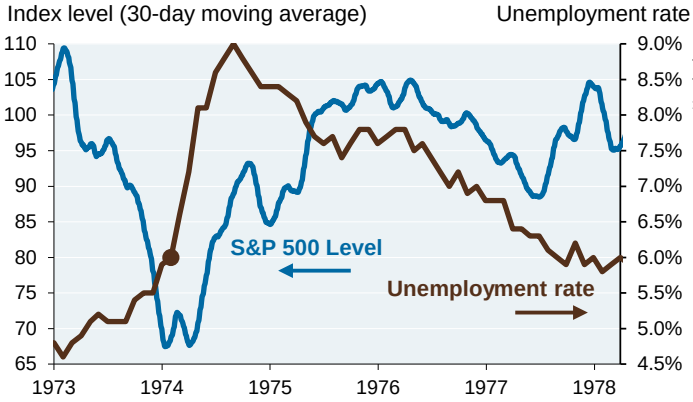


Source: Redbook Research, Johns Hopkins University. March 28, 2020.

A history of markets and unemployment

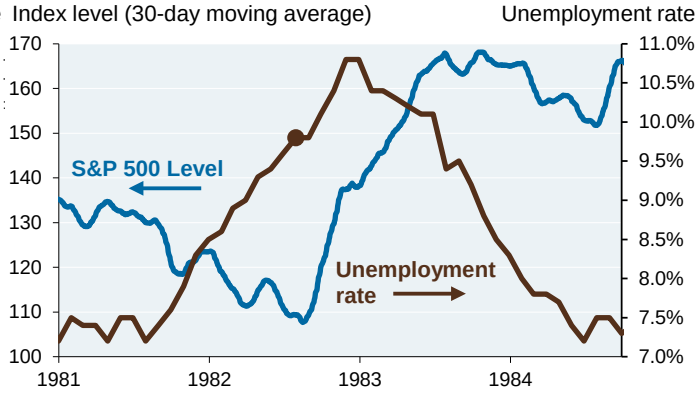
I don't know if the March 23 S&P 500 closing level of 2,237 will mark the low for this cycle, it may be too soon for that. When the bottom does occur, I expect it to be consistent with prior cycles in the US and Europe in which markets bottomed well before unemployment levels started to decline. Look at the stagflation era of the 1970's; equities bottomed when unemployment was just starting to ***rise***. The tech collapse, in which peak unemployment closely coincided with the market bottom, was the exception.

1970's stagflation crisis



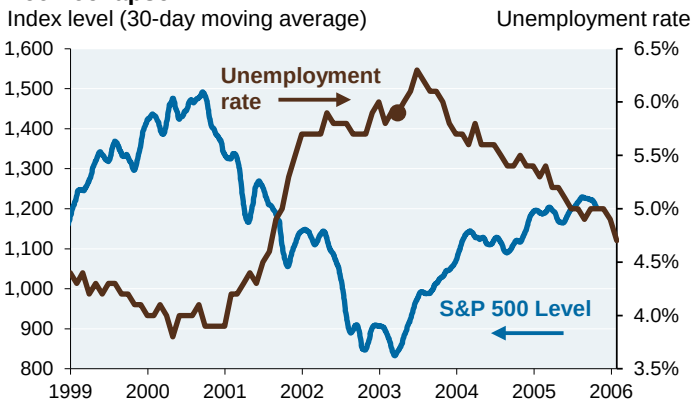
Source: Bloomberg, BLS. 2020.

1980's inflation / housing crisis



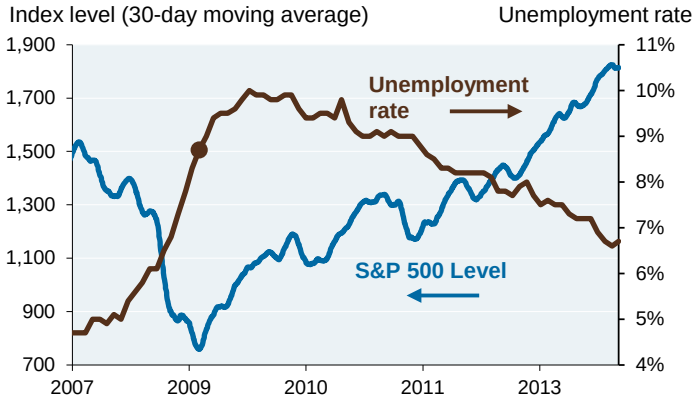
Source: Bloomberg, BLS. 2020.

Tech collapse



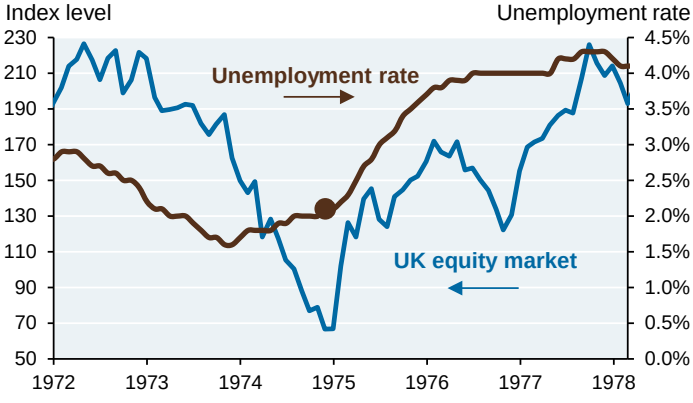
Source: Bloomberg, BLS. 2020.

Financial crisis



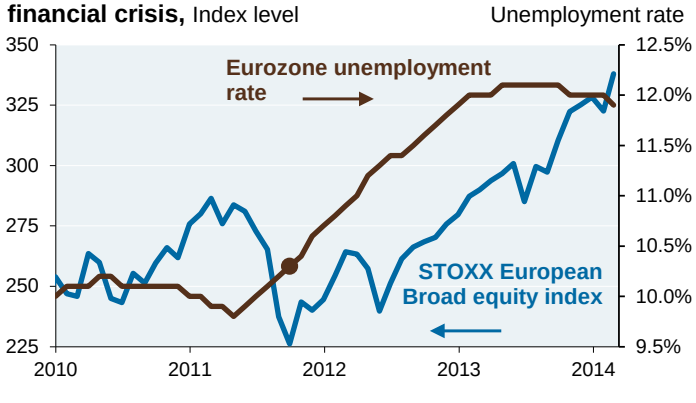
Source: Bloomberg, BLS. 2020.

UK equity market and unemployment rate in the 1970's



Source: Bloomberg, Federal Reserve Bank of St. Louis. 2020.

European equities and unemployment rate during global financial crisis, Index level



Source: STOXX, Eurostat. 2020.

Measuring the Fed's ability to alleviate a credit and liquidity crunch

Over the next few weeks, the Fed will launch a variety of credit facilities designed to alleviate pressure in credit markets. The magnitude of spread increases are in many cases much smaller than in 2008, which reflects improvements in the plumbing and capitalization of the banking sector. **Note in the 6th chart how spreads for bank debt have barely budged relative to non-bank investment grade issuers**.

The new facilities include loans, asset purchases and relaxed accounting standards for banks, all of which are designed to reduce selling pressure and improve the flow and cost of credit. We expect the benefits to show up within weeks, particularly at the short end of the curve. We see value in investment grade credit, select municipal issuers and upper tier non-energy high yield. These charts are all in our online coronavirus portal and are updated frequently. Red dots indicate current levels.

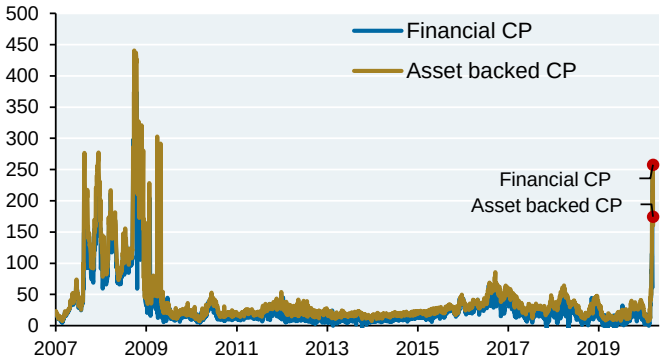
3 month LIBOR - 3 month forward Fed Funds rate
basis points

Source: Bloomberg. March 27, 2020.

US 3 month Libor - 3 month Treasury (TED spread)
basis points

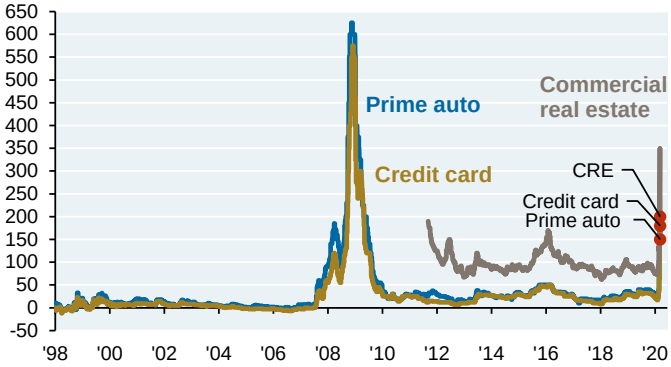
Source: Bloomberg. March 27, 2020.

US commercial paper - 3 month Treasury
basis points



Source: Bloomberg. March 26, 2020.

AAA asset backed securities spreads
basis points, spread versus Treasury



Source: J.P. Morgan. March 27, 2020.

US investment grade corporate bond spreads
JULI index spread versus Treasury, basis points

Source: Bloomberg, J.P. Morgan. March 27, 2020.

Financial - Non financial investment grade bond spreads
JULI index spread difference, basis points, banks vs non banks

Source: Bloomberg. March 27, 2020.

30 year fixed rate mortgage - 10 year Treasury
basis points

Source: Bloomberg, J.P. Morgan. March 27, 2020.

US high yield corporate bond spreads
JPDFHYI index spread versus Treasury, basis points

Source: Bloomberg, J.P. Morgan HY Team. March 27, 2020.

Fixed rate preferred securities option adjusted spread
P0P1 index, basis points

Source: Bloomberg, J.P. Morgan. March 27, 2020.

Emerging markets dollar denominated bonds
Spread vs US Treasuries, basis points

Source: Bloomberg, J.P. Morgan. March 27, 2020.

S&P 500 leveraged loan price index
SPBDALB index

Source: Bloomberg. March 27, 2020.

Fed facilities

Money market lending facility
Fed purchases of US Treasuries
Commercial paper funding facility for municipals
Fed purchases of mortgage back securities
Term asset backed securities loan facility
Commercial paper funding facility for corporates
Primary investment grade credit funding facility (direct lending)
Secondary corporate credit funding facility (asset purchases)
Fed lending to Exchange Stabilization Fund (Main Street lending fund)

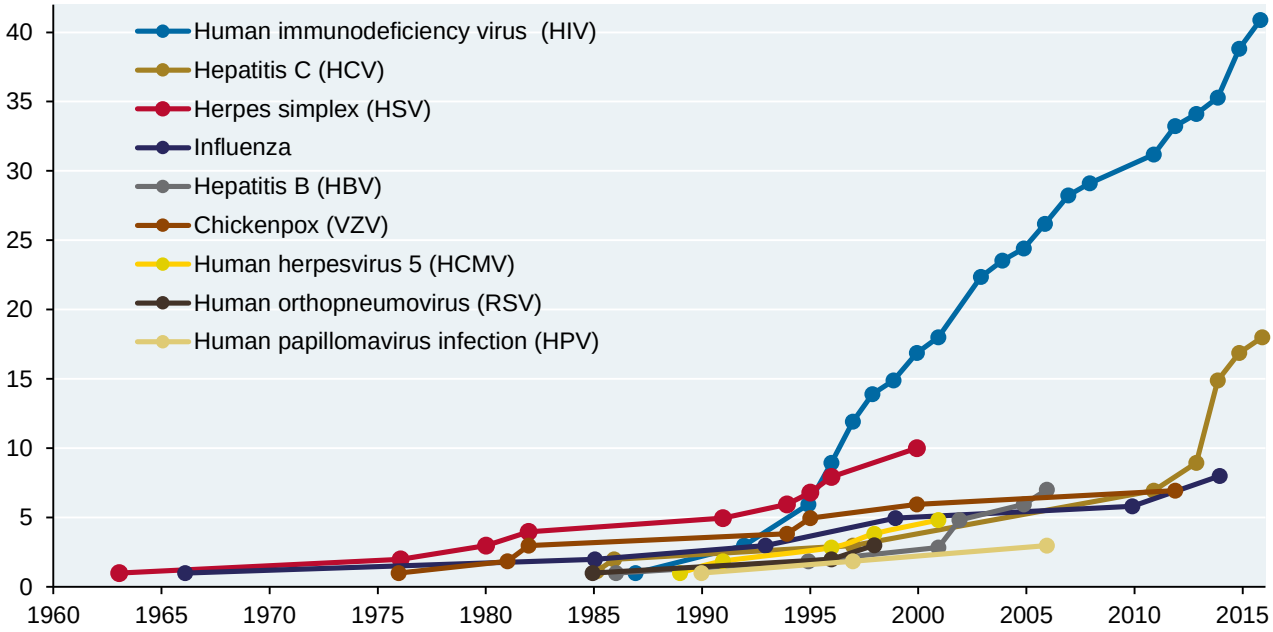
The Chloroquine controversy

The development of anti-viral medications and vaccines is typically a lengthy and complex process involving randomized trials, control groups, large population sets and a variety of steps designed to demonstrate both efficacy and safety for broad public use. **Most anti-viral studies reported in the press so far and which are cited on the following pages meet few of these qualifications**, and have been conducted in "wartime" conditions in China and elsewhere posing great risk to doctors and other healthcare providers. While some of these drugs may eventually be used to combat the disease, it would be premature based on non-randomized trials of twenty or thirty people to draw concrete inferences about their effectiveness.

As a reminder of how complex anti-viral development can be, consider this: from 1963 to 2016, **of the thousands of anti-viral inhibitors proposed in scientific literature, only 90 were approved for final use**. Another reminder: numerous therapies were tested against Ebola, including chloroquine, favipiravir, brincidofovir, monoclonal antibodies, antisense RNA and convalescent plasma. Ultimately, none proved to be effective or safe as proven via randomized clinical trial.

History of antiviral drug development

Number of approved drugs

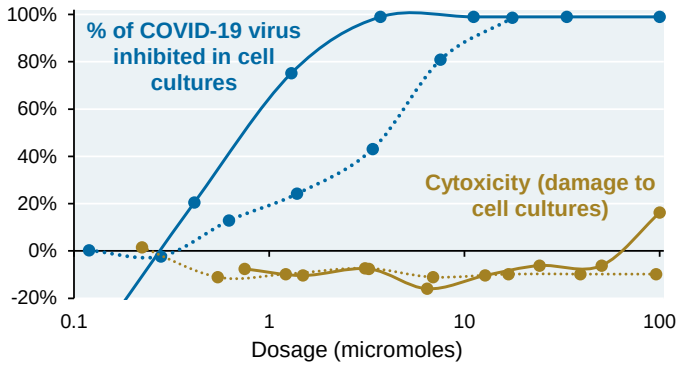


Source: De Clercg and Li, *"Approved anti-viral drugs over the past 50 years"*, Clinical Microbiology Reviews. June 2016.

Anti-virals and the Chloroquine controversy

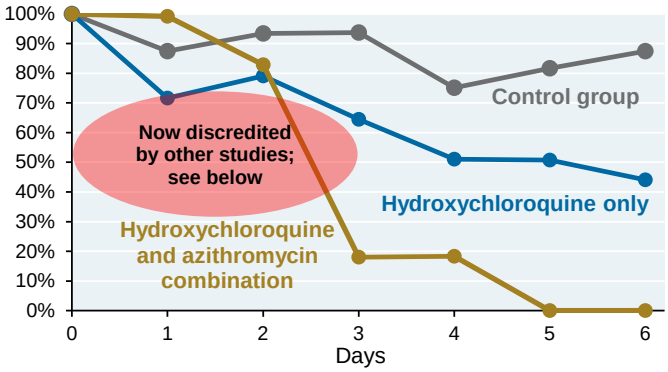
Gilead's **Remdesivir** and Bayer AG's **Chloroquine** have reportedly shown promise in field tests to treat patients that have already contracted COVID-19, but there are some very important caveats to be aware of. Remdesivir and Chloroquine (a widely-used anti-malarial and autoimmune drug) reduced viral loads in cell cultures with low levels of toxicity to the cell. That's what is shown in the next chart on the left; but remember, these are **cell cultures** and not live trials, there are no successful vaccines against *any* of the coronaviruses, and there are numerous drugs that were promising in vitro for other infectious diseases and **which failed in clinical studies**.

Remdesivir (solid) and Chloroquine (dotted) test results
percent



Source: Wuhan Institute of Virology. February 4, 2020.

Treatment results of patients with COVID-19
% of patients that test positive for infection



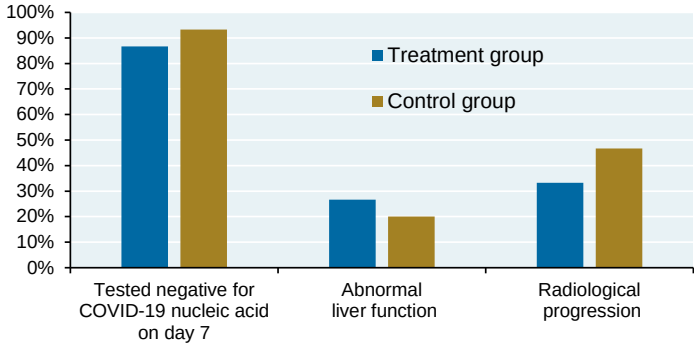
Source: Gautret et al, IHU-Méditerranée Infection. March 2020.

The **controversy on Chloroquine** deepened with widespread media reports of positive results from a March study from France that combined chloroquine and azithromycin (a "Z-pack"). The chart above (right) made the rounds on the internet very quickly. **However**, it is now clear that this French study:

- was a non-randomized trial with only 36 patients, and had no discussion of outcomes
- excluded 6 recipients that were not discussed, some of whom required ventilation and/or died
- started out with higher viral loads in the control group than in the infected patients, which could explain why the control group showed higher infected rates at the conclusion of the study
- imputed more than 1/3 of the control group virus tests rather than measuring them
- sourced its treatment group (unlike the control group) from a single medical center

The Chloroquine outlook was muddied further by the Shanghai Public Health Clinical Center which found **no benefits at all** from Chloroquine when comparing the control group vs the treatment group:

Results of small 30-patient study using hydroxychloroquine for COVID-19, % of patients experiencing indicated result



Source: Chen Jun et al, Shanghai Public Health Clinical Center. March 2020.

All of these uncertainties led to strongly worded caveats in a paper published on March 30 in the American College of Physicians "Annals of Internal Medicine", which concluded as follows on the subject of hydroxychloroquine (HCQ):

> "There is enough rationale to justify the continued investigation of the efficacy and safety of HCQ in hospitalized COVID-19 patients. It is critical to reiterate that while viral clearance is important, clinical outcomes are much more relevant to patients. **There currently are no data to recommend the use of HCQ as a prophylactic for COVID-19, although we eagerly await data from trials underway.** Thus, we discourage its off-label use until justified and supply is bolstered. The HCQ shortage will not only limit availability to COVID-19 infected patients if efficacy is truly established, but also represents a real risk to patients with rheumatic diseases who depend on HCQ for their survival."
>
> Alfred Kim (Washington University School of Medicine) and Jeffrey Sparks (Harvard Medical School) in "*Rush to Judgment*"

Another example of unclear results: a study on Lopinavir-Ritonavir involving a randomized trial of 199 people in Wuhan. The 28-day mortality was 19.2% in the treatment group and 25.0% in the placebo group, which are not meaningfully different outcomes. Other anti-virals in clinical trials include the immunomodulator tocilizumab, which showed positive results in a small 20-patient study in China that Genentech is now expanding into a Phase III study under the brand name Actemra.

All things considered, we should probably all stop flocking to front-line studies of 20-50 patients. Single-group studies without concurrent controls are very unlikely to lead to any definitive conclusions on efficacy or safety; the results from **randomized clinical trials are the only viable path to an anti-viral solution**:

> "With the current COVID-19 pandemic, randomized clinical trials have been launched around the world, including an adaptive trial sponsored by the NIH. This unprecedented speed from concept to implementation in just a few weeks is noteworthy and provides proof that clinical trials can be promptly initiated even in the middle of a pandemic."
>
> Andre Kalil, University of Nebraska Medical Center

Sources used in this section

"*Remdesivir and chloroquine effectively inhibit the recently emerged novel coronavirus (2019-nCoV) in vitro*", Nature Magazine, Zhihong Hu et al, February 4, 2020

"*Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial*", Gautret et al, International Journal of Antimicrobial Agents, March 2020

"*A pilot study of hydroxychloroquine in treatment of patients with common coronavirus disease-19*", Chen Jun et al, Shanghai Public Health Clinical Center/Fudan University, March 2020

"*A rush to judgment? Rapid reporting and dissemination of results and its consequences regarding the use of hydroxychloroquine for COVID-19*", Alfred Kim (Washington University School of Medicine in St Louis) and Jeff Sparks (Harvard Medical School) in the American College of Physicians' "Annals of Internal Medicine", March 30 2020

"*Treating COVID-19: Off-Label Drug Use, Compassionate Use, and Randomized Clinical Trials During Pandemics*", Andre Kalil, University of Nebraska Medical Center, March 24, 2020

Why aren't we predicting infections for COVID-19? Because by the time the models actually work, you already know the answer [Warning: only for those of you who like math]

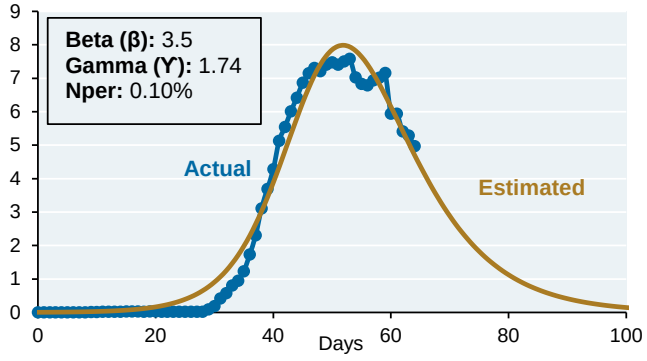
You might have seen infection prediction curves floating around for different countries. We have not found a lot of value in this exercise. The best way to explain why is with a model first applied to Korea in mid February, and then in vain to other countries[1].

Many epidemic outbreak models are based on the Kermack/McKendrick "SIR" model developed in the 1920's, which refers to "susceptible, infected and removed". The model estimates the number of active infections out of a given exposed population. Active infections rise based on new infections, and fall due to recoveries and mortalities. The three primary inputs are infectiousness (beta), removal rates (gamma) and the size of the exposed population as a % of the total population in a given region (Nper).

However, while this sounds very scientific, there's a lot of manual curve-fitting going on. One reason: it's hard to predict reported infections for a very infectious disease when large numbers of infected people are asymptomatic or for other reasons not reported, since the model will need to somehow reconcile fewer reported cases than it expects.

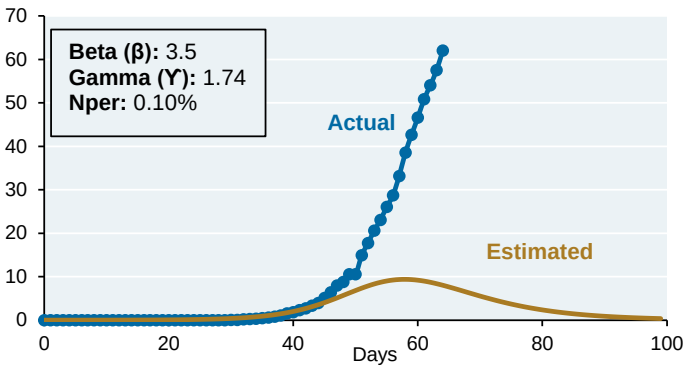
In any case, let's start with Korea. The first chart (left) shows how our model could have been applied to Korea in mid-February with a given set of assumptions. Looks great, right? Don't get too excited. While it worked for Korea, the calibrated parameters proved to be **completely useless** in forecasting infections for Italy. The second chart shows what mid-February Korea parameters would have predicted for Italy (peak active infections of 9,000), compared to what has *actually* happened (62,000 active infections so far). **This massive estimation failure is not hard to understand**; the Korea parameters were fit for a country whose policy and behavioral dynamics were completely different than Italy.

A good fit for Korea in mid-February
Active infections in Korea, thousands



Source: Johns Hopkins. J.P. Morgan Asset Management. March 26, 2020.

Korea parameters: a really, really bad fit for Italy
Active infections in Italy, thousands

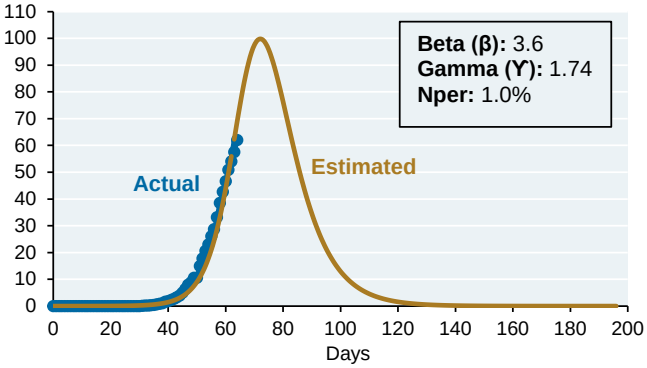


Source: Johns Hopkins. J.P. Morgan Asset Management. March 26, 2020.

[1] My son Max, who will be attending the Harvard School for Applied Computational Science in the fall, helped with this section. My models are typically written in Excel's Visual Basic. He's dismissive of VBA, so I told him that I consider VBA the programming language of the gods. His response: "yes, but it would be the programming language of gods of a society that became extinct hundreds of years ago". If you were a computer science major, you would find this exchange to be hilarious. Max writes everything in Python.

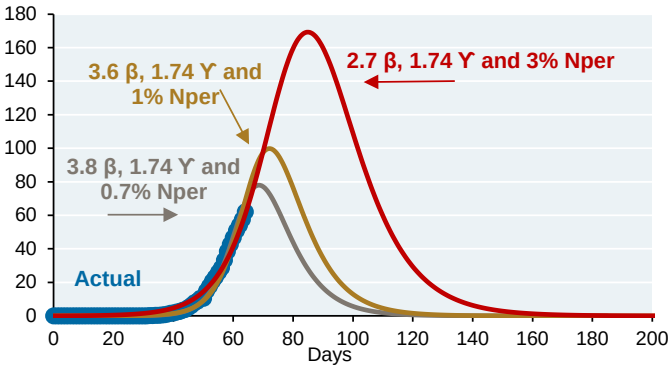
After seeing how poorly the model performed for Italy, we could have waited a couple of weeks and recalibrated its parameters to fit Italy better, which is what the next chart shows on the left. Much better fit; however, we had to increase one of the parameters by a factor of 10x (!!). **And furthermore, what good is this tail-chasing exercise**, since (a) the revised calibration may well be useless for countries other than Italy, and (b) to make matters worse, **even this new recalibrated Italy curve could be *completely* wrong too** since there are other curves with more severe infection parameters that fit the actual Italy data just as well. That's what is shown in the chart on the right; who's to say which of these curves is the right one if they all fit the actual data so far??

The model, recalibrated for Italy: 10x higher infected population, Active infections in Italy, thousands



Source: Johns Hopkins. J.P. Morgan Asset Management. March 26, 2020.

Which set of assumptions best predicts Italy? Still totally unclear, Active infections in Italy, thousands



Source: Johns Hopkins. J.P. Morgan Asset Management. March 26, 2020.

The bottom line: infection prediction models must be constantly updated to fit the observed actual infection curve in each country[2]. As a result, what you learn by fitting parameters for one country has practically no value in predicting the evolution of infections in any other country; and the predictions *within* any given country can shift wildly with the level of testing and policy changes. The best these models can do is provide a very rough estimate of potential infection trajectories for a single country assuming that public policy, testing and behaviors do not change over time, and even then, they could be totally wrong. These models are most accurate when infections are shown to have already peaked, at which point they become redundant.

[2] By the way, you don't even need a fancy SIR model to fit infection curves; we replicated the Korean infection curve with similar precision by simply using a modified version of the formula $y = \exp(-x^2)$.

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