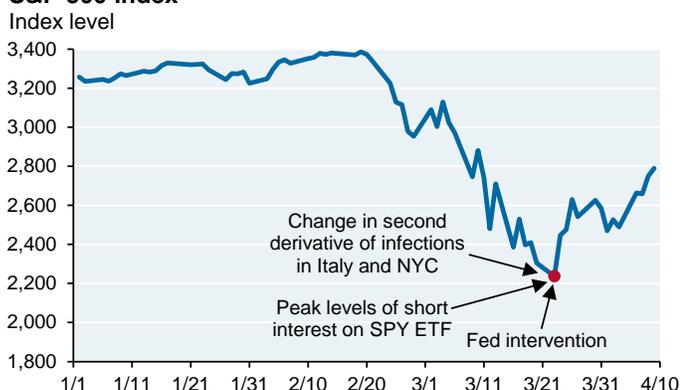




Topics: The rally since March 23; Recent antibody tests in Europe show large numbers of unreported infections, which could signal an earlier onset of herd immunity than you might think

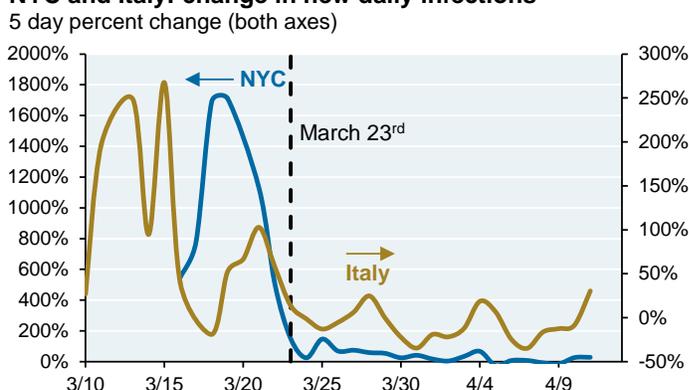
On March 20th and again on March 30th, I wrote that equity markets at prevailing lower levels were pricing in a lot of bad news (an entire decade for earnings to regain their prior peak vs historical average of usually less than three years). I also included a blizzard of charts showing the long history of markets rallying well in advance of GDP, employment and an end to bank failures, corporate defaults and consumer delinquencies. When you combine all of that with what took place around March 23 (Fed bazooka announcements, large short positions in US equity markets and a decline in the second derivative of COVID-19 infections in hotspots like Italy and NYC), you have a recipe for a sharp and sudden market rise. Now, after the rally, equity markets are pricing in a lot of good news given what still lies ahead, with P/E multiples already back at 16x 2021 consensus earnings (from a low of 13x), and even higher if you assume as I do that 2021 earnings projections will come down. Equity advances probably get slower and less one-directional from here; the fastest gains generally occur when everyone thinks the only path is down.

S&P 500 index



Source: Bloomberg. April 9, 2020.

NYC and Italy: change in new daily infections



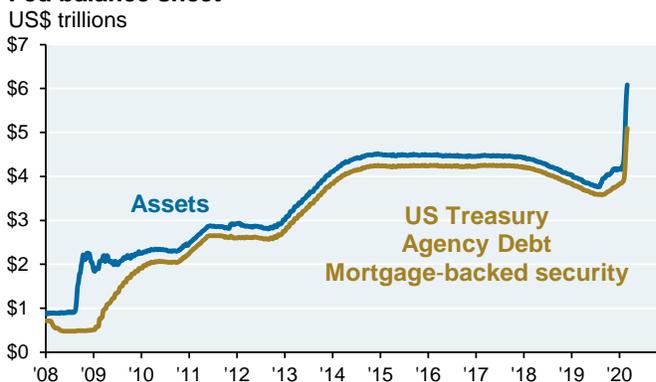
Source: Johns Hopkins University. April 11, 2020.

Quantity-On-Loan of the SPY US ETF



Source: JPM Global Markets Strategy Flows & Liquidity. April 7, 2020.

Fed balance sheet



Source: Federal Reserve Board. April 08, 2020.

March 23rd Fed bazooka announcements:

- Primary Market Corporate Credit Facility (PMCCF) for new bond and loan issuance.
- Secondary Market Corporate Credit Facility (SMCCF) to provide liquidity for outstanding corporate bonds.
- Term Asset-Backed Securities Loan Facility (TALF), to support student loans, auto loans, credit card loans, loans guaranteed by the Small Business Administration (SBA), and certain other assets.
- Expand the Money Market Mutual Fund Liquidity Facility (MMLF) to include a wider range of securities, including municipal variable rate demand notes (VRDNs) and bank certificates of deposit.
- Expand the Commercial Paper Funding Facility (CPFF) to include high-quality, tax-exempt commercial paper.

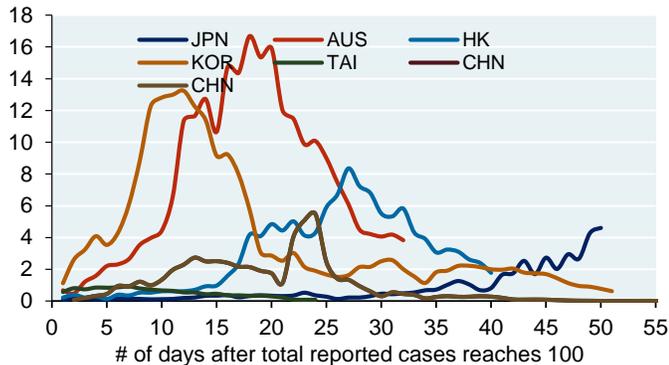


After the first wave: getting back to “normal”, and the importance of virus/antibody testing

How will countries try and get back to normal after the first COVID infection wave has subsided? This is an issue that several countries in Asia are already facing (although there has been a recent and worrisome spike in Singapore), and which countries like Austria and Norway may be facing soon.

New daily infections per 1 million people

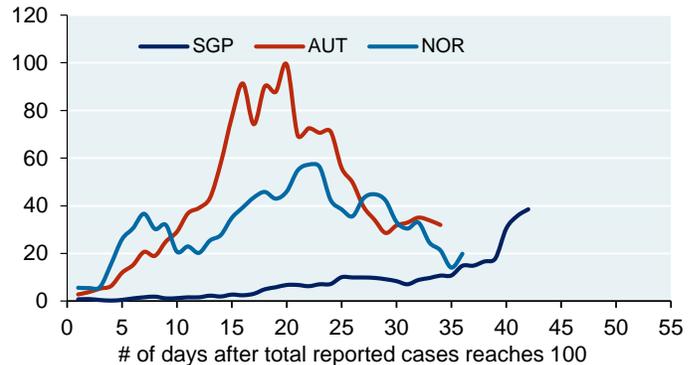
Linear scale, 3 day trailing average



Source: Johns Hopkins University, IMF, JPMAM. April 11, 2020

New daily infections per 1 million people

Linear scale, 3 day trailing average



Source: Johns Hopkins University, IMF, JPMAM. April 11, 2020

At the risk of over-simplification, there are three main approaches a country could take after the first COVID-19 wave subsides (and in each case, restrictions on international travel will be required to prevent importation of new cases):

- **Keep flattening the curve and gradually let people go back to work as infection levels drop.** The problem with this approach: it only takes a small number of infectious people wandering around to ignite a second infection wave without a healthcare system that can track down and isolate new clusters¹. It is still unclear if seasonal changes (sunlight/heat/humidity) will materially change the virus dynamics, and even if they did, a new wave could appear in the fall
- **Relax lockdowns, and use a swat-team approach to identify any new clusters.** Immediately isolate and quarantine new clusters as well as their contacts via contact tracing². Life gets back to normal faster, but this approach works best when combined with an **extremely well organized healthcare system**, a compliant population that obeys social distancing rules, a legal system that allows the government to use a wide variety of tracking approaches (credit card receipts, cell phones, close circuit television, GPS, etc) to monitor the population and enforce rules; and **when the run rate of new daily infections is low enough to handle the influx of new cases**. I consider this scenario to be the most likely in many countries
- **Through serological testing, identify people who have been exposed to the disease, possess the antibodies to prevent them from infecting others or getting sick again, and let them get back to work.** Biggest challenge: requires herd immunity for maximum impact, which we discuss on the next 2 pages

¹ Best illustrated via a [visualization](#) from Grant Sanderson at 3 Blue 1 Brown

² This approach can be thought of as a real-life version of “Code 2319” in the movie *Monsters Inc*, when a swat team descends on anyone infected by a human article of clothing, and then quarantines and decontaminates them.



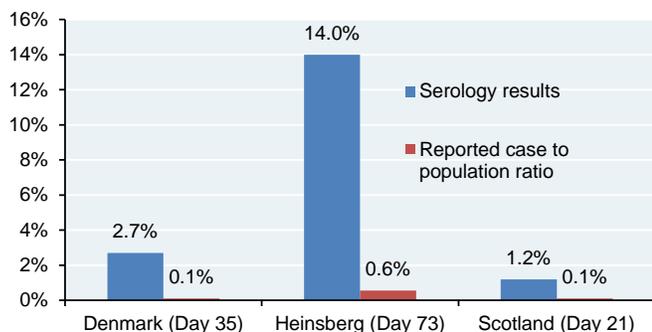
The latest antibody test results in Europe, and what they might indicate for herd immunity

Over the last 3-4 days, a small number of research institutions and hospital systems in Europe have released the results of random serological tests for COVID-19 antibodies. There are only a few so far:

- Denmark³, where 2.7% of 1,500 people tested antibody-positive 34 days after its outbreak
- Heinsberg, Germany where 14% of 509 people tested antibody-positive 73 days after its outbreak
- Scotland, where 1.2% of 500 people tested antibody-positive 21 days after its outbreak

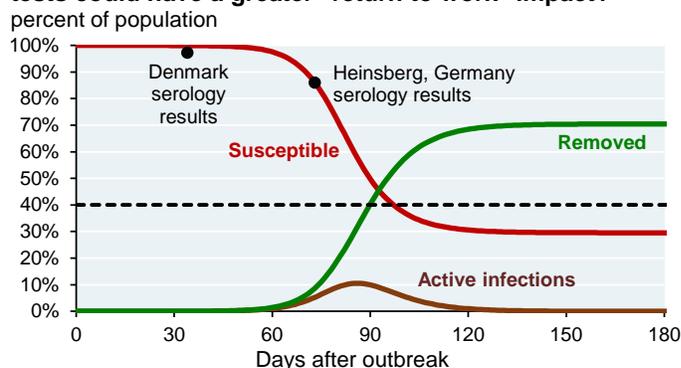
These results indicate *much* higher levels of COVID-19 exposure than by simply looking at reported case to population ratios for each region (chart below, left), which are at least one order of magnitude smaller. In simpler terms, serology results indicate that there's **a large number of unreported infections** due to people who couldn't get tested, only had mild symptoms, were asymptomatic, etc. And since antibodies show up with a lag, current infection levels are likely to be even higher than serology results indicate.

How widespread is COVID-19? Serology test results vs reported cases as a % of population



Source: Bonn University Medical Center, Rigshospitalet (Copenhagen), Evolutionary Ecology of Infectious Disease (UK), JHU. April 2020.

When might herd immunity occur, after which serology tests could have a greater "return to work" impact?



Source: Bonn University Medical Center, Rigshospitalet (Copenhagen). 2020.

Now let's get to the next and even more important question: how long until herd immunity might arrive simply through passage of time? Antibody presence of 2.7% and 14% might seem small, and it *would* be if viruses evolved linearly. But viruses only attack susceptible hosts, and as they progress, the susceptible population shrinks. An epidemiologist contact at the University of Toronto was pleased to see the Denmark and Heinsberg results, and suggested we look at them through the lens of our "SIR" model⁴ to see why, using serology results as a better measure of "true" infection rates. Here's what we found: **herd immunity, estimated as 60% population exposure⁵, might be closer than you think.** Following each serological observation along the red curve to the dotted line in the 2nd chart, much greater levels of immunity could be one month away in Heinsberg, and two months away in Denmark.

³ The best studies, like the Danish one, will conduct "ELISA" tests and then cross check them with a more specific test called a viral neutralization assay to make sure the tests are right.

⁴ "SIR" models are used to track the distribution of a population exposed to a virus over time into three categories: "susceptible", "infected" and "removed" (recovered or deceased). The susceptible population declines rapidly once the pool of potential hosts migrates into the removed category. However, the susceptible population does not decline to zero since immune individuals act as "fire-breaks" who buffer susceptible individuals from infection.

⁵ Herd immunity requires at least 60% exposure since the effective reproductive number must fall below 1.0x. Assuming an initial reproductive number of 2.5, that would require a 60% decline in the susceptible population.



To be clear, there are a lot of uncertainties: these models are highly sensitive to input parameters (particularly the timing of outbreak and serology test results); serology tests for COVID-19 may involve false positives (unclear how large an issue this might be), as well as people who test positive with “insufficient” antibodies⁶; sample populations might not be representative of the whole; and they may not be applicable across countries. **Furthermore,** even if herd immunity were reached, the virus would still spread, but at a more manageable rate involving smaller clusters that are dealt with independently.

Even with all these caveats, the projections on the prior page are helpful in illustrating the evolution of the virus and its antibody aftermath, and **provide a rationale for serological testing as part of a “back to work” plan in the summer or fall (under the presumption that a society can organize itself to do it).** We will update the chart above as new serological observations emerge.

Serology tests: who’s using them, who’s making them and what the CDC has to say about it

The CDC and private companies are scrambling to produce serology tests; the UK has ordered 3.5 million, Germany may use them to issue immunity certificates to survivors, and China and Singapore are using them to measure more accurate infection rates. On top of that, the US FDA is allowing doctors to use serology tests to identify recovered patients whose antibodies could treat emergency cases of the disease. There are now over 50 companies that have informed the FDA of their intention to sell serology testing kits in the US, many of which are already available. However, to be clear, these kits are self-validated, and the FDA requires that the following disclosures be included:

- The tests have not been reviewed by the FDA
- Negative results do not rule out SARS-CoV-2 infection. Follow-up testing with a molecular diagnostic should be considered to rule out infection
- Results from antibody testing should not be used as the sole basis to diagnose or exclude SARS-CoV-2 infection or to inform infection status
- Positive results may be due to past or present infection with non-SARS-CoV-2 coronavirus strains

These are strongly worded caveats, which some counties already appear prepared to disregard, or at least acknowledge as “acceptable” risk as the world focuses on getting back to work.

Sources:

“Neutralizing antibody responses to SARS-CoV-2 in a COVID-19 recovered patient cohort and their implications”, Fan Wu et al, Shanghai Public Health Clinical Center, Fudan University, March 30, 2020

“Preliminary results and conclusions of the COVID-19 case cluster study”, Bonn University Hospital, March 2020

“Serological analysis of 1000 Scottish blood donor samples for anti-SARS-COV-2 antibodies collected in March 2020”, Oxford Immunology Consortium, Scottish National Blood Transfusion Service and University of Kent

“Blood banks will test whether donors have had coronavirus”, SN.DK, April 4, 2020

⁶ A recent paper from Fudan University reported that one third of recovered patients in a 175-person cohort did not possess high levels of COVID-19 antibodies normally associated with disease recovery. They concluded that the low-antibody patients might have recovered since their T-cells, cytokines or other parts of their immune systems defeated the virus instead. Whether low-antibody patients are still susceptible to the disease remains to be determined.

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