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TOP of MIND

経済再開

新型コロナウイルス感染症（COVID-19）の対応策が奏功して世界的に感染者の増加ペースは明らかに鈍化しているが、同時にこうした対策の経済的な代償は膨らむ一方である。このため、いくつかの国は経済活動の再開に向けたプランを模索しており、なかにはすでに実践している国もある。しかし、新型コロナウイルスに対する集団免疫あるいはワクチンが存在しない状況では、経済再開は感染の第2波のリスクを高めることになる。こうした点を踏まえると、安全な経済再開とはどのようなものなのか、それを実現するための状況は十分整っているのか、また経済活動の再開後、どのくらい経てば実際に景気は回復するのかが目下の「最大の関心事（Top of Mind）」である。これらの点について、ペンシルベニア大学のゼキ・エマニュエル博士、デューク大学のマーク・マクレラン博士およびハーバード大学のバリー・ブルーム博士の3人の専門家に聞いた。さらに、経済活動を再開している中国のこれまでの経緯から得られる教訓を踏まえ、米経済の回復の道筋に関する当社自身の見解も紹介する。また、効果的な検査制度、治療あるいはCOVID-19ワクチンの普及が実現して初めて完全な形での経済の正常化が可能になると考えられるなか、現在、これらの観点で実際にどの時点にあるのかについても考察する。

「これは供給サイドではなく需要サイドの（経済）問題であることを示唆する証左が存在し、その場合、レストランやショップの営業を再開しただけでは問題は解決されない。」

ゼキ・エマニュエル博士

「これまでに明らかになっているデータは、大多数の米国人がCOVID-19に対する免疫を持っていないことを示唆している。このことは、仮に正しく導入されたとしても、抗体検査は経済再開に向けた主要な解決策にはならないことを意味する。」

マーク・マクレラン博士

「経済再開を模索するにあたって鍵となるのは、症状のない人々の検査の大幅な改善である…結局のところ、いつものフレーズの繰り返しになる：検査、検査、検査。検査を行うことに尽きる。」

バリー・ブルーム博士

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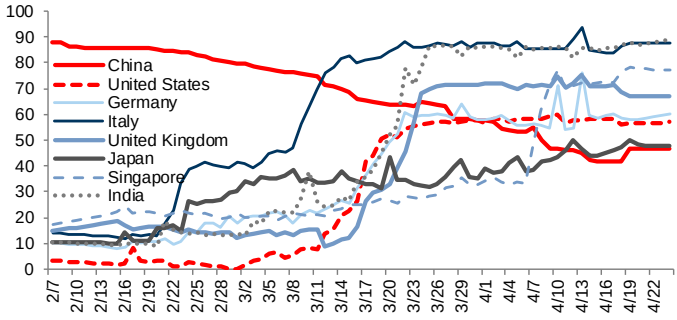
経済再開

広範にわたる休業、ソーシャル・ディスタンシング、その他の緩和措置の効果で、欧米ではCOVID-19の感染拡大に鈍化の兆しが見られる一方、これらの措置による経済的な打撃がますます顕著となっている結果、多くの国が経済再開を模索し始めており、一部にはすでに経済活動を再開している国もある。実際、中国本土に続いて、デンマーク、オーストリア、ドイツがすでに段階的な経済活動の再開に着手している。また、米国では先にトランプ政権が経済再開ガイドラインを発表しており、一部の州は独自の経済再開計画を導入し始めている（7〜8ページを参照）。

しかし、COVID-19に対する集団免疫やワクチンが存在しない限りーいずれも近く実現する可能性は低いー経済再開は感染の第2波を招くリスクが大きい。このため、安全な経済再開とはどのようなものなのか、それを実現するための状況は十分整っているのか、また経済活動の再開後、どのくらい経てば実際に景気は回復するのかが目下の「最大の関心事（Top of Mind）」である。

各国のロックダウン（都市封鎖）状況

当社の実効ロックダウン指数（ELI）；指数



出所: オックスフォード大学、グーグル、ゴールドマン・サックス証券投資調査部. (詳細はこちらを参照)

そこで、ペンシルベニア大学グローバル・イニシアチブ副学部長で、オバマ政権下で医療政策顧問を務めたゼキ・エマニュエル博士、デューク大学デューク・マルゴリス・ヘルスケア政策センター長で、G・W・ブッシュ政権下でFDA長官を務めたマーク・マクレラン博士およびハーバード大学公衆衛生大学院教授のバリー・ブルーム博士の3人の専門家に取材した。安全な経済再開のためには米国内の大半の地域における感染状況の一段の改善が必須であること（さらにそれをどのようにして判断するかが重要）、経済活動を再開するのであれば段階的にすべきであること（密接な接触を伴う非必須とされる事業活動の再開と重症化リスクの大きい人々の保護策の緩和は先送りする）、安全な再開のためには検査の拡大と感染経路の解明が不可欠であること（いずれも、パンデミックの進行過程のどの段階にあるかをより的確に判断するとともに、感染の再燃を防止/抑止するために不可欠な無症状感染者の特定・隔離を可能にするため）で、3者の見解は一致している。

当社エコノミストのダーン・ストライブンとイザベラ・ローゼンバーグによる詳細にわたる分析はこうした見方を裏付けており、公的なウイルス防止策は感染拡大の抑制に非常に大きな効果を有し、こうした対策を早計に見さかいなく緩和すると感染拡大の第2波を引き起こすリスクが高まることが確認された。また、当社ストラテジストのマイケル・カーヒルは、確かな情報に基づく経済再開計画の策定に欠くことのできない感染状況のより正確な把握に不可欠な検査の規模とその制約について理解することがいかに重要であるかを解説している。

当社中国シニアエコノミストのヒュイ・シャンは、中国の経済再開が米国をはじめ諸外国にとって有効なロードマップを提供することになるのかどうかを検証した。その結果、経済再開に際して中国が直面した感染再拡大のリスク、まだら模様の景気回復といったいくつかの課題は、（基本的に）他の国にも共通すると考えられる。しかし、中国が経済再開を概して成功させている背景にあるいくつかの重要な要因、例えば監視技術を駆使したウイルスの感染拡大の厳重な監視と管理、工場や企業に対する中央政府による圧力と支援などは、他の国には当てはまらない可能性がある。

さらにエマニュエル博士は、近々経済活動を「再開」しても、経済的な浮揚効果はそれほど得られない可能性があると警告する。博士は、現時点の経済的な打撃は休業、すなわち供給サイドの問題によるというよりも、公衆衛生に対する不安、すなわち需要サイドの問題を反映したものである可能性が高いと強調する。米国をはじめ各国がこうした不安を和らげることになる盤石な検査体制と感染経路の追跡システムを確立しない限り、入り口に「営業中」の看板を吊るしただけではこの問題は解決されない。

以上を理由に、当社米国エコノミストのデビッド・チョイとデビッド・メリクルは米国の経済再開のペースについて慎重な見方をとるが、米国企業による大量のレイオフの大半はこれまでのところ一時的な性格のものとなっているの兆候も見られる。総じて、当社エコノミストの基本的な見方に変更はなく、5月から米国の成長率は緩やかに回復し始め、2Qの極めて低い水準からとは言え3Qには前期比年率＋19%、4Qには同＋12%の成長を記録し、2020年通年の成長率は−6.0%になると予想する。

もっとも、COVID-19の集団免疫の形成、あるいは効果的な治療薬、ひいてはワクチンの開発が実現すれば、当然のことながら経済の正常化に向けた重要な転換点が訪れることになろう。そこで、ブルーム博士ならびに当社の米国バイオテクノロジー・セクター主任アナリストのサルヴィーン・リヒターに、その実現に不可欠な要件と現在どの段階にあるのかについて聞いた。

ブルーム博士は、集団免疫を近く獲得できる可能性は低いと考える理由を説明するとともに、そもそもCOVID-19に対する免疫の持続期間が依然としてわかっていないと指摘する。さらにブルーム博士は、ワクチンが開発されるのは早くても1年半後と見ている。しかし、明るい材料もある。博士によれば、それでもこのワクチン開発スケジュールはワクチン開発技術の画期的な進歩（詳細については原文22ページを参照）が貢献して記録的なスピードであることを強調しており、また今後開発されるワクチンの有効性において新型コロナウイルスの変異が問題になることもないと考える。さらに博士は、ワクチンの開発よりもはるかに早い時期ー早ければ今秋ーに有効な治療薬が開発されると確信している。現時点で最も有望な治療薬とワクチン、さらに開発の成否を知る手がかりとして向こう数週間および数ヵ月にわたって注目すべき点について、リヒターが解説する。

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Interview with Dr. Zeke Emanuel

Dr. Zeke Emanuel is Vice Provost for Global Initiatives at the University of Pennsylvania, co-host of the Endeavor Content podcast "Making the Call", and former Health Policy Adviser in the Obama White House. Below, he argues that the problem with the economy may be demand driven, and so reopening states without a testing regime that boosts public confidence may not solve the issue.

The views stated herein are those of the interviewee and do not necessarily reflect those of Goldman Sachs.

Allison Nathan: The Trump Administration recently rolled out a plan for reopening the US. Where does the plan get it right, and where does it fall short?

Dr. Zeke Emanuel: The plan gets three important things right. First, that the reopening must be phased. Second, that different kinds of nonessential businesses should reopen at different stages depending on the risk they pose in terms of spreading the coronavirus. And third, that vulnerable populations, such as people living in senior facilities, should be particularly protected, with visits to these facilities only permitted in the late phase of reopening and with strict hygiene protocols.

But the plan gets many things wrong. One is the trigger for reopening. The guidelines suggest a trigger of 14 days of declines in cases and sufficient hospital capacity. While hospital capacity seems right, I think the absolute level of infection is a more appropriate trigger. That's because you could still have a high transmission rate even as the number of cases declines, which is, in fact, what we are seeing in many places right now—basically, a plateau in cases with only a very slow decline. You can't have a very high transmission rate and reopen, so the trigger should be a low rate of infection, at around 20 new cases per million of the population.

The second problem is the grouping of heterogeneous businesses—including restaurants, sporting events and religious services—under "large venues" that can reopen with strict physical distancing protocols in the earliest phase. The problem is that these venues pose very different risks to the spread of the virus. In a restaurant, you can remove half the tables, space them out, and have people wear face masks when they're not eating. At sporting events, even if seating is spaced out, people inevitably will be crammed together at the entry gate, concession stands, and bathrooms, and cheering will certainly spew all sorts of droplets into the air; nobody gets up and shouts across a restaurant. So I think that's a bad mistake. The guidelines also make no mention of how to handle flare-ups of COVID-19 in the community once it starts to reopen. And finally, the plan is a failure when it comes to testing—the linchpin in any effort to reopen the economy.

Allison Nathan: On testing, how short are we of what we need to safely reopen, and how can we overcome this shortfall?

Dr. Zeke Emanuel: The reported numbers suggest US testing is hovering around 150k tests per day. The minimum number of required tests I've seen is about 500k a day, which seems to come from CDC guidelines that we should test people who are symptomatic. But even this minimum number of required tests is still not enough, because just testing people with symptoms is the wrong approach. The big issue in reopening the economy is the extent to which it could accelerate transmission of the virus. And to get a handle on transmission, you need to focus on a bunch of core groups, but two in particular. One is frontline people who have a lot of contact with others, including healthcare workers, grocery workers, policemen, and first responders. Those people must be tested regularly, like every week. If you just add up those groups, that's 7 million people, or 1 million tests a day.

The other group of people that must be tested in order to prevent potential flare-ups are people who are asymptomatic and could spread the virus to many other people, so-called super spreaders. We've seen the damage these super spreaders can inflict in the outbreaks at the Smithfield meat processing plant in South Dakota and the Biogen meeting in Boston. By definition, you can't find those asymptomatic people when you are only testing people with symptoms. So you need to find them by tracking contacts of symptomatic people, which requires technology, and by conducting frequent tests on a random sample of the community. When all is said and done, we estimate that all of this testing required to safely reopen the economy amounts to about 2 million tests per day—so we are very far short of what we need. How do we address this shortfall? To start, we need an acknowledgment of this shortfall. And then we need a very strict game plan, probably led by a single, competent leader.

Allison Nathan: The administration has suggested that some of the numbers on testing could be misleading because more testing is being done by private labs. Could we have less of a testing shortfall in reality than we think?

Dr. Zeke Emanuel: Maybe. But, first of all, the fact that reliable data on testing—as well as other basic COVID-19 metrics—isn't available is plain incompetence. This is knowable data that we must have to be able to efficiently move forward on reopening, treatment and other fronts. And, second, it's very unlikely that three or four times the number of reported tests—the minimum amount required—are going uncounted, let alone the 15 times more tests we think we really need. This is especially the case as labs like Quest Diagnostics are laying off people because testing outside of COVID-19 is down; I doubt Quest would be reducing their workforce if they were doing excessive testing.

Allison Nathan: What do you make of the fact that some states, like Georgia, have already begun to reopen?

Dr. Zeke Emanuel: It's strange because there's no evidence that Georgia has met any of the criteria to reopen at all—let alone businesses like tattoo parlors and salons, which are among the places already permitted to reopen. Intimate contact is difficult to avoid at these types of businesses so it will be hard not to end up with a spread situation.

Allison Nathan: Given that, is it really the right decision to defer reopening decisions to states?

Dr. Zeke Emanuel: Whether or not it's "right" is irrelevant; that's the American system, and changing it would likely require a constitutional battle. The President obviously has a lot of persuasive power, and Congress can adjust laws and provide different incentives, but this power resides with the states.

Allison Nathan: Driving the push to reopen is the massive hit to the economy. But will states just "reopening" necessarily solve our economic woes?

Dr. Zeke Emanuel: No. Many people seem to assume that the problem with the economy is a supply side one—namely, that non-essential businesses are closed. So once we reopen them, everyone will come rushing back and spend money. That may not be true. Despite the recent protests against the shutdowns, polling data shows that a large number of people are hesitant to return to work and reengage in the community because of health fears. This is consistent with data that suggests that many people reduced their mobility even before shelter-in-place and similar orders were implemented. So the evidence suggests that this may be a demand side problem, not a supply side one, which won't be solved by just opening up a restaurant or a salon. Solving it before we have effective treatments or a vaccine will instead require an effective testing regime so that people can have confidence that when they go to restaurants or other businesses, they won't get sick.

Allison Nathan: Is there anywhere in the US where you think people should feel more confident at this point?

Dr. Zeke Emanuel: I honestly haven't looked at all the data for every state, but if you look at the major places, it's clear that we've made serious advances in places like Seattle and the San Francisco area, where decision makers acted very early and concertedly to slow the spread. But even in those places where we are seeing positive signs in the disease trajectory, it's still too early at this point to feel comfortable. Very few places have met the threshold of the low absolute transmission rate that I mentioned earlier.

Allison Nathan: Once we do meet the criteria to start a phased reopening, what should reopen first?

Dr. Zeke Emanuel: Nonessential businesses like some offices, factories and restaurants, where temperatures can be taken, physical distancing can be achieved and masks can be worn are a good place to start. Reopening of schools and summer camps can also start early given that, at least so far, young people have experienced low rates of infection and only very rare cases of serious infection. That should happen on a voluntary basis, though, given the risk that children could bring the disease home to vulnerable people in the household. Denmark has recently reopened elementary schools, so we can learn from their experience. Non-essential businesses that require more intimate contact or where such contact is difficult to avoid—ranging, as I said, from salons to sporting events—should come later in the sequencing. And at the far end of it should come a relaxation of protections around vulnerable populations, like elderly people living in senior facilities.

Allison Nathan: Once we do open up, under what conditions should policymakers re-impose mitigation measures?

Dr. Zeke Emanuel: Even a slight uptick in new cases should prompt action. It's critical for the public to understand that the number of cases you see today reflects what happened 14 or more days ago. So if you're seeing an increase today, that means the virus has already been spreading in the community for two or more weeks, and exponential increases are not far behind. For that reason, you don't want to wait for that exponential growth to show up in the numbers before re-imposing some restrictions. At the beginning of this thing, we waited until we saw exponential growth to do anything, and we were too late. That's why it's essential to monitor the situation very closely on a daily basis through a careful testing regime and to quickly employ contact tracing to keep each and every new case from spreading further.

Allison Nathan: Given that, how likely is it that we see a period of start-stop economic activity over the next 18 months, or more, until we actually get a vaccine?

Dr. Zeke Emanuel: That depends upon responses. We've learned over the last six weeks that our response matters. We can materially change the course of this illness. If we actually adhere to physical distancing guidelines, don't overcrowd restaurants and stores, diligently wear face masks and wash our hands, can we skate through a phased reopening with no resurgence? No; Singapore's experience with resurgence suggests that's unlikely. But could we have only one or two, or maybe three isolated resurgences over the next 18 months? Yes, I think that's possible if the population is adherent.

Allison Nathan: Overall, how do you weigh the health risk versus the economic risk in thinking about the right way to reopen?

Dr. Zeke Emanuel: The whole point of a phased reopening is to minimize both these risks to the extent possible; we'll never get rid of either risk until we have a vaccine. Like everyone else, it pains me to see 26 million people unemployed and food lines longer than we've ever seen before. That's outrageous, and we must do everything we can to provide sufficient support for those people during this period. But data from the 1918 pandemic and other models show that places that intervened earlier and more aggressively had faster economic growth after the pandemic. And, again, if the problem in our economy is demand driven, as the evidence suggests it is, you can reopen every business, but the economy won't come back until people feel confident that they can go out or send their kids to school at low—albeit not zero—risk. So we need to recognize that psychology and respond to it.

Interview with Dr. Mark McClellan

Dr. Mark McClellan is the Robert J. Margolis Professor of Business, Medicine, and Policy and founding Director of the Duke-Margolis Center for Health Policy at Duke University. Previously, he served as FDA Commissioner in the George W. Bush White House. Below, he argues that we will have to rely on diagnostic testing and an efficient tracing system to safely reopen.

The views stated herein are those of the interviewee and do not necessarily reflect those of Goldman Sachs.

Allison Nathan: Where do the Trump Administration's guidelines for reopening get it right, and where do they fall short?

Dr. Mark McClellan: The guidelines cover the key topics that states need to be thinking about as they contemplate reopening: the trends in cases in their region, their healthcare capacity, and the importance of testing and tracing capacity so that when there are new outbreaks, especially in high-risk places like senior facilities, there's enough capacity in place to detect those outbreaks early. They were also right to recommend a phased reopening that takes incremental steps, or, as Dr. Deborah Birx, a key health adviser to the administration, likes to say, "moves the dimmer switch" a little bit at a time to make sure that there are no adverse effects. So the framework is generally good.

But I would emphasize that these are high level guidelines. And for states to execute successfully, there are a whole host of specifics that they need to fill in: how to get sufficient testing capacity in place and increase it if necessary; what kinds of businesses should reopen when; and what people should expect in terms of wearing face masks and other behavior that will mark a "new normal" as we reopen amid the ongoing COVID-19 threat. States are right now working quickly and intensively on all of those issues in order to turn the administration's framework into a specific implementation strategy for reopening.

Allison Nathan: We've heard the argument that seeing a sustained decline in cases is not sufficient to reopen; you actually need to see a low rate of infection. What do you make of that distinction?

Dr. Mark McClellan: Some hard-hit states, and the country in general, have done a tremendous job of flattening the curve. But we're now seeing cases in a number of states plateauing or only gradually declining, and some of those states are considering reopening. If they reopen without seeing further declines in cases, their level of cases should be low enough that their healthcare system won't be overwhelmed if there is a surge from that level in the event of an outbreak. So both declines in cases and the level of cases are important factors in determining whether states are ready to safely reopen.

Allison Nathan: Do we need more PCR testing capacity in the US before we can safely reopen, and what are the remaining hurdles for ramping up such capacity?

Dr. Mark McClellan: PCR testing detects the presence of the virus in the body, and more such testing is obviously better. In particular, further improvements in testing technology that would allow for more regular testing of asymptomatic populations would certainly help as we move into more advanced stages of reopening. But for now, the priorities for testing include people with symptoms, close contacts of people who have tested positive and those in higher-risk settings, like healthcare workers and people in assisted living facilities. We are approaching, if not already at, the level of testing capacity that could enable that level of ongoing surveillance. And I think that the increased testing capacity required as states start to reopen—on the order of two million tests per week—is achievable in the coming weeks.

But the challenge is not just having tests available. The challenge is getting the tests along with the associated materials, such as the swabs required to administer them and the reagents required to run them, to the states and localities where they're needed. And it's not just a question of having enough tests and equipment, but also of having the systems, logistics, and situational awareness in each state and region to ensure that positive results are acted on quickly enough through contact tracing and quarantining to be effective in containing further spread. This is the current version of the challenge we faced last month in providing sufficient hospital, ventilator and personal protective equipment capacity as cases surged in hard-hit areas; we're now similarly trying to ramp up the availability of testing and contact tracing capacity locally. Different states and regions are at uneven levels in achieving sufficient capacity, but we're definitely making substantial progress.

Allison Nathan: How important will antibody testing be in terms of safely reopening?

Dr. Mark McClellan: Antibody testing will likely play a significant role in the future. It can be potentially helpful in identifying individuals who have immunity, and therefore don't need to take the same kind of precautions as others to avoid the risk of contracting or transmitting the virus. But the science is not there yet, on two dimensions. First, we're still in the process of understanding what antibody responses mean in terms of providing immunity to the virus. This is a new virus, and even in the earliest hit areas, people have only been convalescent for several months or so. So studies are just now underway to really understand what levels of antibody response can provide the confidence that someone won't contract or transmit the disease, and for how long. Hopefully, we will start to have better answers to these questions in a matter of weeks, but it takes time to see how immunity evolves.

The second problem is the reliability of the available tests. The antibodies to the COVID-19 coronavirus are in some ways similar to the antibodies to other coronaviruses. So some tests have cross-reactivity, and may suggest that someone is immune when they're really not. There may also be problems with false negatives. Many of the tests that are on the US market now were approved for emergency use to assist in support of

diagnosis and tracking of patient progress—not for determining immunity—and studies on their performance are mixed. So more testing on the reliability and accuracy of these tests is needed, which can be done with a concerted effort in a matter of weeks. I think it is important to conduct this validation to make sure we understand the science and put it to good use.

In the meantime, antibody tests can also give us an idea of how much exposure different communities around the country have had to COVID-19. Some of the early tests conducted with this goal suggest a significantly higher prevalence of COVID-19 exposure than positive PCR tests would suggest—on the order of perhaps 5 or 10 times as many cases. But I'd caution that even if exposure and immunity to COVID-19 is more widespread than originally thought, we're still talking about a small fraction—5-10%—of the population. So the data so far suggests that the vast majority of Americans are not immune to COVID-19. And that means that antibody tests, even when we do get them right, won't be a primary solution as we reopen. If we're going to reopen businesses broadly in an environment where most people are not immune, we'll have to rely heavily on PCR tests to do so safely, probably until we get a vaccine.

Allison Nathan: What more—if anything—should the federal government be doing to help states safely reopen?

Dr. Mark McClellan: The federal government could be doing more on several fronts. On antibody testing, it could do more to support the science that will help us understand what antibody results in people exposed to COVID-19 really mean for their future immunity. On PCR testing, it can continue to take steps to add to the stock of swabs and reagents that are available, and help distribute them more efficiently to areas where they are needed the most. It could also offer incentives to companies to help speed up innovation in diagnostic testing that could make such tests more convenient, such as enabling point-of-care testing, or tests that can be done by spitting into a cup instead of using a nasal swab. And it could do more to support states and localities in their efforts to contain the virus, both in terms of funding as well as guidance on best practices in areas like sharing data on test results. This could substantially help with state and local efforts to conduct contact tracing, testing and quarantining exposed individuals in a timely manner.

Allison Nathan: What should come first, middle and last in a safe, phased reopening of states?

Dr. Mark McClellan: Again, the notion of dialing up the dimmer gradually with a pause for a few weeks at each step is important to make sure that we're not getting into conditions of less-controlled spread. Initial steps might include reopening more retail businesses under conditions that look a lot like those for essential businesses today, with masks, frequent cleaning and handwashing being the new normal and establishments operating way below their full capacity to support physical distancing. Earlier steps might also include reopening daycare, preschool and school programs in some fashion because that's so important for the well-being of children and for supporting the economic recovery. But we'd want to go more slowly with activities and businesses that involve people gathering closer together, such as bars and larger social events. And we'll need extra steps for people who are at higher risk, such as older individuals, and people with serious co-morbidity conditions. I would expect the rules and best practices for such people—and perhaps people living with them that could expose them to the virus—to look different than for others in society.

Allison Nathan: Given all of this, are any states now ready to reopen—let alone places like Georgia and Oklahoma where businesses like salons are leading the way?

Dr. Mark McClellan: I think we're getting there. The states that have begun to reopen so far have definitely done so on the early side. But reopening should depend on local conditions, with some areas far closer to meeting the necessary conditions than others. That said, it's critical that as any state starts to reopen, all businesses, and especially places like salons, take substantial steps to protect against transmission, such as wearing masks, frequent cleaning and disinfection between clients and spacing out clients in facilities. Reopening these types of businesses is important, but should be undertaken thoughtfully and in a limited, incremental fashion so that if we do see an increase in cases, we can quickly detect that and slow down, pause or maybe pull back on reopening.

Allison Nathan: What should prompt the re-imposition of lockdown measures?

Dr. Mark McClellan: Any early indications of uncontained spread should prompt a reconsideration of these measures. Even with continued restrictions, there will be outbreaks. So it will be critical to detect them early. And if we observe an uptick in cases or even an uptick in risk factors for cases that seem to reflect a weakness or flaw in our reopening process, we should quickly take at least incremental steps towards pausing or reversing course. We're going to learn a lot more in the weeks ahead, starting with the states that are reopening first. Hopefully, those will show that there are ways to reopen while containing the spread, but we're definitely not out of the woods yet. We need a very high level of vigilance in order to pull back on reopening before the pandemic gets out of control again.

Allison Nathan: On vaccines, it seems that the much-talked about 12-18-month timeframe for a COVID-19 vaccine would be unprecedented. But is there more that the FDA could and should be doing to speed this up?

Dr. Mark McClellan: Regulatory and scientific communities around the world have come together to agree on efficient and appropriate standards for the clinical development of vaccines. This development takes time because you need a strong understanding of safety, since vaccines are given to people who are otherwise healthy, and of what will provoke immunity. The bigger challenges are going to be carrying out clinical testing when the virus may not be really active in many areas of the world later this year, as well as ramping up manufacturing capacity to the necessary scale. Encouragingly, some companies have taken on significant financial risk by pre-committing to substantial manufacturing capacity in the US. Ideally, that model will be extended around the world so that if and when a vaccine is shown to be clinically effective, there will be no delay in very large scale distribution of it to people who would benefit. At every phase of a pandemic, it's all about planning for surge capacity, which always seems to limit our ability to respond. That must be a top-level issue for all countries today.

Reopening rundown

	Virus outlook					Economic reopening plans			
	Country	Date reached 1 confirmed case per million	Date of largest increase in cases*	Confirmed cases (as % of pop)	% of pop tested	GS Effective Lockdown Index** (0-100)	Non-essential businesses	Schools	Notes
ASIA	**China**	25-Jan	17-Feb	82.8K (0.01%)	-	47	• Lockdown ended in Wuhan on April 8 • Most businesses throughout the country have resumed operations • Some service sector businesses, such as movie theatres, remain shuttered • Large scale public events are still discouraged	• Schools have started to reopen in many provinces, with colleges and high schools doing so more quickly	• The government has instituted required use of large-scale health code app to limit contagion spread
ASIA	**Singapore**	28-Jan	27-Apr	14.4K (0.25%)	1.4-2%	77	• Targeted measures appeared successful initially, but government imposed "circuit breaker"' lockdown on April 7 after surge in new cases	• All schools to adopt home-based learning through at least May 4	• Moved from a targeted approach to broad-based controls after a surge in cases in recent weeks
ASIA	**Japan**	23-Feb	27-Apr	14.2K (0.01%)	0.1-0.2%	48	• No nationwide lockdown, but "state of emergency" expanded to entire country allowing governors to request businesses close • Closures non-compulsory, but many prefectures have asked amusement and cultural facilities to close, as well as non-essential sections of shopping centers • Tokyo requests restaurants close at 8pm and stop serving alcohol at 7pm • Government expected to provide an update in early May	• Schools have been closed in Tokyo and other major cities since March • After expansion of state of emergency, most prefectures closed state schools after mid-April	• The northern prefecture Hokkaido recently re-imposed previously relaxed restrictions after experiencing a second wave of infections • Government has mostly relied on citizens' adoption of voluntary social distancing
ASIA	**South Korea**	20-Feb	9-Mar	10.7K (0.2%)	1%	44	• Many non-essential businesses are open • Extended extensive social distancing measures through May 6 • Recommend citizens postpone all non-essential gatherings or activity	• Schools have started to reopen exclusively via virtual learning • Move to online learning tiered with timeline of students' return dependent on age	• The government has instituted a rigorous contact tracing system, in which around 80% of new infections are linked to transmission source
EUROPE	**Italy**	22-Feb	30-Mar	199K (0.3%)	2-3%	88	• Some shops have been allowed to reopen, such as book and stationary stores • "Phase Two" reopening scheduled for May 4, including factory restarts, construction activity and partial easing of social distancing measures • Bars and restaurants not expected to reopen for dine-in service until June 1	• All schools will remain closed throughout the country until at least September	• Government is working to introduce a contact tracing app to help heath officials stem the spread of the virus
EUROPE	**Iceland**	28-Feb	6-Apr	1.8K (0.5%)	13.5%	-	• Larger gatherings limited to 50 people, instead of previous 20 person limit, and service providers such as salons and dentists allowed to reopen as of May 4 • No formal closure of offices, bars, restaurants and shops	• Primary schools have remained open • Universities /secondary schools to reopen with limitations May 4	• Robust testing regime has led to testing of more than 13% of the population and isolation of asymptomatic carriers
EUROPE	**France**	29-Feb	14-Apr	165K (0.25%)	0.9%	78	• National lockdown extended until May 11 • Current plan calls for a very gradual reopening of factories and shops after May 11 • Cafes, restaurants, bars, cinemas, and theatre to remain closed with a decision on reopening expected by end-May/early June	• Gradual reopening from May 11, with primary schools first then middle and high schools • Universities closed until September	• Wearing masks will be mandatory in certain settings • Government expects 700,000 tests to be carried out per week by May 11

		Virus outlook				Economic reopening plans			
	Country	Date reached 1 confirmed case per million	Date of largest increase in cases*	Confirmed cases (as % of pop)	% of pop tested	GS Effective Lockdown Index** (0-100)	Non-essential businesses	Schools	Notes
EUROPE	**Sweden**	29-Feb	27-Apr	18.9K (0.2%)	0.9%	43	• Government has imposed ban on public gatherings of more than 50 people • No formal closure of offices, bars, restaurants and shops • Large scale public events are still discouraged	• Schools for children up to 16 remain open • High schools and universities closed	• Mostly relying on guidelines for citizens to limit public travel and adopt social distancing measures
	Germany	1-Mar	6-Apr	158K (0.2%)	2.5%	59	• Small steps to reopen shops and small businesses starting April 20 • Bars, cafes, restaurants, cinemas and concert venues remain closed • Unlike other countries in Europe, Germany never closed its factories, though some factories have shut down voluntarily	• Schools scheduled to reopen gradually starting May 4	• Masks required on public transit and in most shops • National leaders set to meet May 6 to reassess lockdown measures
	Spain	1-Mar	6-Apr	229K (0.5%)	2%	84	• Four-phase relaxation of lockdown measures to begin May 4 with small shops allowed to reopen for appointments, with varying implementation across provinces • Bars and restaurants allowed to reopen May 11 at 1/3 capacity • Final phase of reopening expected to happen at the end of June at the earliest	• Nationwide school closures to continue until September, apart from exceptional cases	• Movement within provinces set to ease in phase 2 starting May 11, but restrictions on travel between provinces to remain in place
	Austria	29-Feb	31-Mar	15.2K (0.2%)	2.5%	69	• Small stores have reopened, with limits to capacity • All other stores are set to reopen on May 2 • Restaurants, hotels, and churches expected to reopen May 15 • Large gatherings prohibited until end-June	• Students in their final year set to return to classes on May 4 • All other schools scheduled to reopen starting May 18	• National curfew extended through end-April, with restrictions loosened every two to three weeks based on available data
	Denmark	3-Mar	7-Apr	8.6K (0.15%)	2.5%	64	• Some businesses, including barber shops and salons, allowed to reopen as of April 20 • Shopping centers, sports clubs, libraries and churches to open May 10 at the earliest • Bars, restaurants, cafes and barbershops will remain closed • Large public events prohibited until Sept	• First country in Europe to reopen primary schools on April 15 • Schools for 6th grade and up expected to reopen May 10 at the earliest	• Government has suggested any uptick in the number of cases could be followed by the re-imposition of restrictions
AMERICAS	**US**	7-Mar	13-Apr	987K (0.3%)	1.5%	57	• Federal government recommends gradual, phased approach for states • Most states including New York, Texas, Florida and California have extended lockdown measures into May or not yet set a timeline for reopening • Some states, including Georgia, Colorado, Alaska, and Oklahoma, among others, have reopened or begun to reopen businesses	• All states have closed schools at least temporarily, with 43 ordering or recommending they remain shuttered for the remainder of the school year	• Extent of current testing regimes varies by state, with cumulative tests covering about 4% of the population in NY, around 1.5% in FL and CA and 1% in TX
	Brazil	17-Mar	27-Apr	67.4K (0.03%)	-	56	• Due to recommendations from the federal government, some governors are easing the lockdown and allowing areas to reopen • Most states retain restrictions on stores, public events and public transportation • Sao Paulo plans gradual reopening starting May 10	• No federal policy on school closure, but schools across all 27 states are registered as closed due to policies implemented by local governments	• No tools yet developed for contact tracing
	Mexico	20-Mar	26-Apr	15.5K (0.01%)	0.05%	75	• All non-essential businesses and activities suspended until at least April 30	• All schools closed until at least May 17 • More affected regions only to return on June 1	• Very limited testing so far – 60k tests conducted (~0.05% of the population) as of April 26

*Note: all virus data as of April 27, 2020; *date of largest increase based on 7-day centred moving average of confirmed cases; ** the GS effective lockdown index combines in equal weight a "virus policy" measure based on the stringency of jurisdictions' respective lockdowns and a "policy effect" measure based on mobility data as detailed in Asia Economics Analyst: Lockdown Lexicon, April 20, 2020; for testing figures, there are substantial differences across countries in terms of the units, whether or not all labs are included, the extent to which negative and pending tests are included and other aspects.*

Source: JHU CSSE, Our World in Data, various national governments and health agencies, various news sources, University of Oxford (covidtracker.bsg.ox.ac.uk), Goldman Sachs GIR.

China's roadmap: What is/isn't applicable

Hui Shan argues that China's roadmap suggests reasons to be both optimistic and cautious about global economic reopening

In late January, mainland China shut down its economy in an effort to slow the spread of COVID-19, almost two months before other major economies. The social distancing and activity control measures China implemented to contain the virus were similar to those that have since been imposed in other countries. With most businesses and factories in mainland China now reopened, even if not at full capacity, its experience provides a valuable roadmap for what the recovery may look like when such measures are lifted elsewhere. However, because of fundamental differences in institutional structure and cultural norms, while some of the features of China's reopening are applicable elsewhere, others may not be.

What's applicable

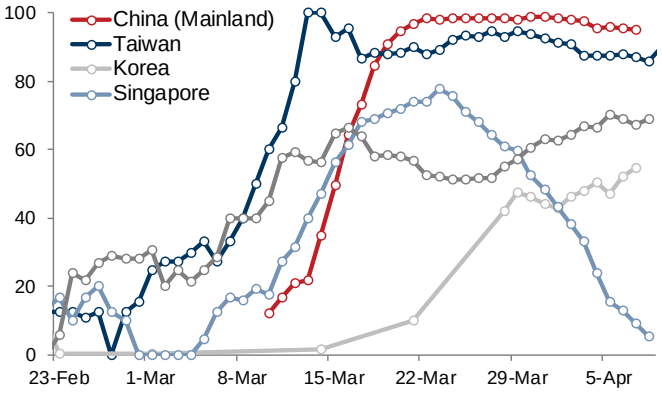
Feature #1: A real risk of a second wave: Newly confirmed cases of coronavirus in mainland China peaked in the first half of February, approximately two weeks after activity shutdowns, and new case growth fell to near zero for multiple consecutive days in early March. But this hasn't meant that social distancing measures can be lifted altogether, especially given the risk of resurgence as the virus continues to spread rapidly around the world. Indeed, China's recent experience is a testament to that fact. Despite the relaxation of national control measures, Beijing, Shanghai and Guangzhou, which are destination cities for direct international flights, had to add further flight restrictions after they saw imported cases rise in late March.

Some restrictions re-imposed due to imported cases
New confirmed cases per day, number of cases

Note: #1: Mar. 7, More than 20 provinces downgraded their alert levels and eased travel and transportation restrictions
#2: Mar. 16, Ministry of Culture and Tourism reports 30% of tourism destinations nationwide have resumed operation
#3: Mar. 26, International flights reduced to one flight per country per week for each airline; Mar. 27, all cinemas ordered to close after previously being allowed to reopen
#4: Apr. 3, Heilongjiang province starts testing all incoming travelers
Source: CEIC, Goldman Sachs Global Investment Research.

By the week of March 29-April 4, international flights had fallen to 1.2% of the pre-outbreak level, according to the Ministry of Transportation. More recently, after the number of imported cases increased sharply in Heilongjiang province that borders Russia, the province started to test all incoming travelers, and two major cities in the province subsequently decided to postpone the planned reopening of schools. Overall, China's experience suggests that the risk of a potential second infection wave is real even for countries that have made progress in slowing viral spread, and local controls may persist, or even strengthen, after national controls are removed.

Imported cases main focus in mainland China and Taiwan
Share of imported cases in new confirmed cases, 7-day average

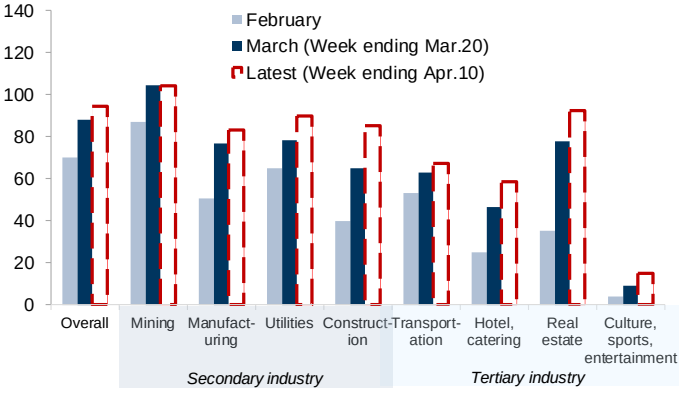


Source: CEIC, NHC, MHLW, KCDC, MOH Singapore, DOH Hong Kong, GS GIR.

Feature #2: An uneven economic recovery: Social distancing and activity control measures to combat COVID-19 have significantly impacted economic growth according to our high-frequency trackers and official statistics, with Q1 GDP falling by 6.8% yoy, the first negative year-over-year growth in decades. In late February, about 10 days after the number of new cases peaked in China, the government called for a "differentiated" approach to restarting the economy: in places where the virus situation remained pressing, the focus would remain on virus control measures; in low-risk areas, by contrast, local governments would shift their attention to economic recovery.

Our estimates using our equity analysts' data suggest that overall activity in China improved sharply from -30% yoy in February to -12% yoy in March. But the recovery has been uneven across sectors of the economy. Construction activity, for example, climbed from 40% below last year's level in February to 85% by the second week of April. Cultural, sports and entertainment industries, however, remain at only 15% their 2019 levels.

An uneven recovery across industries
Chinese activity recovery, percent of 2019 level



Source: Goldman Sachs Global Investment Research.

Official statistics paint a similarly uneven picture: industrial production was down only 1.1% yoy in March, but retail sales were still 15.8% below year-ago levels. While this shouldn't come as a surprise, it does provide an important insight—it is easier to turn a machine back on than to convince people to go to restaurants and theaters during a global pandemic.

Feature #3: New/accelerating trends emerging from the changed world: While it is still early to draw firm conclusions at this stage, a few features of the recovery process in China are worth highlighting.

- *First, moving online*. While the shift from brick-and-mortar malls to online shops was already ongoing before the viral outbreak, COVID-19 and the ensuing social distancing measures have accelerated this trend. Official statistics show that online retail sales of goods increased 11% yoy in March, in stark contrast to the 13% decline for offline sales.
- *Second, high-end outperforming*. The negative economic impacts of COVID-19 have likely fallen disproportionately on the lower-income population, as the hardest hit service industries also tend to have more lower-wage jobs. For high-income households, social distancing reduces expenditure without hurting income much, which raises their savings and purchasing power. In the automobile market, for example, sales of high-end brands led the recovery in March while the mass market lagged, according to our auto analysts.
- *Third, industry consolidation*: The pressure on corporate cash flow has been more intense on leveraged companies and small companies during the coronacrisis. By comparison, large enterprises that are not liquidity-constrained should be better positioned to weather the downturn. Our property analysts have pointed out a trend toward industry consolidation in their coverage space, and it may be happening in other industries too.
- *Fourth, temporary release of pent-up demand*. A popular local tourist site that opened for free during the Qing Ming festival in early April attracted many visitors, and there have been anecdotes of consumers waiting in line outside of certain recently reopened restaurants. While the severe economic downturn caused by the outbreak suggests such pent-up demand is unlikely to be widespread and sustainable, it is certainly possible to see it temporarily in select industries after shutdown policies are removed.

What's not applicable

Feature #4: Extensive use of surveillance technology and big data in controlling the virus: While China's experience in containing the virus has been encouraging, it is worth noting that some of the tools at policymakers' disposal may not be available in other countries. For example, citizens are required to show a health clearance code on their phones to access public transportation and facilities. People with a green code can move freely, those with a yellow code are quarantined for 7 days before being granted a green code, and a red code requires a quarantine for 14 days. Surveillance technology and big data allow the Chinese government to monitor individual movements and employ broad-based contact tracing, which has helped contain the virus, but may not be available or accepted elsewhere.

"Health code" used in the city of Hangzhou

Source: City of Hangzhou.

Feature # 5: Centralized government pressure/support for restarting: Although Chinese industrial activity recovered fairly quickly once restarts began, other countries might experience a slower process. We note the top-down nature of the Chinese economy and the fact that the government pushed hard for the resumption of work in March, especially in the industrial sector, contributed to the speed of the recovery.

Local governments, for example, helped to coordinate the restart of upstream and downstream companies in the same sector to avoid reopening factories without sufficient input materials from suppliers or orders from downstream customers. To speed up the return of migrant workers without increasing the risk of spreading the virus, the Ministry of Human Resources and Social Security launched a program to help these workers transit the country and migrant workers can submit forms expressing their need to travel via mobile phone.

Reasons for both hope and caution

China's roadmap suggests reasons to be both optimistic and cautious about economic reopening elsewhere in coming weeks and months. While China has certainly shown progress in restarting parts of its economy, the recovery has been uneven across sectors and involved setbacks requiring the re-imposition of previously relaxed control measures. At the same time, some of the key features of China's reopening success are unlikely to be applicable in other parts of the world, including Western Europe and the US.

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Interview with Dr. Barry Bloom

Dr. Barry Bloom is the Joan L. and Julius H. Jacobson Research Professor of Public Health at the Harvard T.H. Chan School of Public Health. Below, he argues that testing is the key to knowing where we are in the COVID-19 pandemic and determining how to reopen economies safely.

The views stated herein are those of the interviewee and do not necessarily reflect those of Goldman Sachs.

Allison Nathan: Is there enough evidence to conclude that social distancing measures are flattening the epidemic curve and mitigating the spread of the virus?

Dr. Barry Bloom: You know social distancing is having an impact when there are fewer people going to hospitals. That doesn't tell you that fewer people are being infected, but it does say that we are spreading out the infections, which should help protect the hospital system from becoming overrun. That's why flattening the epidemic curve is so important. And we are indeed seeing some signs that the pace of hospitalizations is slowing in some hot spots like New York, which is good news.

But without further interventions, just using social distancing to spread out infections leaves you with more people susceptible to getting the disease in the future. In other words, social distancing not only slows the pace of infections, but also the development of immunity. That said, in places with lots of testing, such as mainland China, Korea and Hong Kong, the data suggest that the imposition of social distancing measures did change the course of the epidemic. But it's hard to know if that is the case in the US given the more limited testing so far.

Allison Nathan: Given this limited amount of testing, is it possible to tell where the US is in this pandemic, which seems key to making informed decisions on reopening?

Dr. Barry Bloom: No. Although testing in the US has ramped up substantially over the past month, right now it is almost entirely restricted to testing for the presence of the virus—so-called PCR testing—in people who are sick. But if you really want to know where the epidemic is—and feel confident that you are on top of controlling it—you have to look for virus spread within the community, among people who don't seem sick but could be asymptomatic spreaders of the disease. Some people like Nobel Laureate Paul Romer have therefore suggested that the answer is to test everybody for the virus, which would require something like 30 million tests per week. But, these tests are non-trivial to conduct and analyze, and so no one that I know believes that is a realistic strategy.

That said, there are other ways to get a sense of community spread, such as conducting random testing of a sample of the community, which is already happening in other countries, and to a very limited extent in parts of the US. You don't have to do 30 million tests a day to have a sample that tells you if 1% or 30% of a population is infected. Alternatively, instead of testing for the presence of the virus, you can test for the presence of antibodies, which would indicate whether or not an individual has had the infection in the past and may be immune. That serological testing is just beginning to come online, but should be easier to conduct, and, if scientifically validated, could perhaps even be self-conducted at home before long.

The key point is that we must do a lot better on testing people in the community who are not symptomatic as we contemplate reopening so we have a better sense of how vulnerable the population still is to infection, a better chance of containing the spread from asymptomatic carriers, and a greater ability to determine, if it is shown that antibodies are protective, who is safer to send back into the community. I return to my favorite refrain: the key is testing, testing, testing.

Allison Nathan: What else would you need to see before you believe it's safe to start opening up economies again?

Dr. Barry Bloom: Ideally, reopening would not begin until two to four weeks after the expected number of cases directly generated by a single case in a susceptible population becomes less than one. That means that the number of new cases is not only slowing, but is actually declining so that the epidemic is on track to fade out in that area. We've got to know that the curve is on the way down because if it's just flat, it could pop up again in a second. Second, hospitals must have adequate capability to care for all acutely ill patients in the event that we see possible flare-ups. If the cases are declining and the rate of transmission is pointing to less than one, I don't think that will be a difficult condition to meet.

Allison Nathan: How crucial is contact tracing, and how far away is the US from having a robust system in place?

Dr. Barry Bloom: The US does not have the proper contact tracing infrastructure in place at this point, but innovations are being tested. For example, the state of Massachusetts is right now experimenting with large-scale contact tracing, which entails an army of 1,000 people calling 20, 30, 40 people a day who have been in contact with a person recently identified as COVID-19 positive, informing them of their health risk, and advising them to self-quarantine. Alternatively, Apple and Google have announced their intention to develop automated contact tracing using cell phone numbers similar to what has been effectively employed in parts of Asia but ideally in a less intrusive, more anonymized way. We don't know if any of these experiments will succeed, but it's crucial we try them because we must be able to quickly pounce on flare-ups if we have any hope of avoiding a second wave.

Allison Nathan: You said that the ability to test for antibodies would be useful. But does the presence of antibodies guarantee immunity?

Dr. Barry Bloom: At this point, it's absolutely unclear whether having antibodies to this virus protects against reinfection, and, if it does, for how long. The antibodies to common cold coronaviruses are very short-lived, typically not lasting for more than a year or so. Measles antibodies provide protection for life.

SARS antibodies seem to be somewhere in between. We won't know where COVID-19 antibodies fall on this spectrum until good serological tests in studies on people who have recovered are completed, which I hope will be sometime by the end of the summer. But my experience from a lifetime working in immunology leads to me to expect that most people who recover and have antibodies to the right target antigen would have at least a couple of years of protection. And that would be enormously valuable.

Allison Nathan: What is herd immunity and how likely is it to play a role in ending this pandemic?

Dr. Barry Bloom: Herd immunity is simply the point when enough people within a population are immune to a disease that there is broad resistance to its continued spread. But I prefer the term community protection, for two reasons. The main reason is that herd immunity doesn't mean that people who haven't been infected are immune; instead, immunity of others protects people who are susceptible. The calculations are that about 60-70% of the population would have to have protective antibodies to make it unlikely that if someone susceptible went into a room, they would be infected, because the chances that other people in that room are infected would be so low. And the second reason I don't like the term is I think referring to people like cattle is demeaning.

As we have discussed, without much greater testing of the population as a whole, we have no way of knowing how close we are to achieving community protection. What we do know is that limited testing in Europe has found antibodies present in a relatively low percentage of the population—on the order of 8-10%. In a just-completed study in hard-hit New York state, the percent of positives was modestly higher, at 14%. But that still means that an awful lot of susceptible people could be exposed as the community reopens.

Allison Nathan: So how likely is a second wave in the fall, especially as we start to reopen in coming weeks?

Dr. Barry Bloom: The likelihood that the population we release into the community will be highly susceptible, and that people will be mobile—coming and going from other places—suggests that outbreaks will be likely. The 1918 influenza, which is still the best model for this epidemic in my view, came in three waves, with the second peak in the fall being the worst one. Our epidemiological modelers at the Harvard School of Public Health believe that in the absence of herd immunity in the population, as you ease social distancing, you'll get a bounce back, as has occurred in Singapore and Hong Kong. And this would require re-imposing some restrictions. We have to be prepared for this virus to return in the fall.

Allison Nathan: How far away from a vaccine are we, and why does getting a vaccine take so long?

Dr. Barry Bloom: Testing candidate vaccines is likely to require at least 18 months or more for many reasons. First, vaccine developers must identify antibodies that react to proteins particular to this coronavirus and not to the coronaviruses that cause common colds or SARS or MERS. Second, they need to understand which of the antibodies that react to this coronavirus are actually protective, as not all will be. Third, vaccines must be thoroughly tested for safety; the difference between drugs and vaccines is that drugs are given to sick people while vaccines are given to healthy ones, so we must be as sure as humanly possible that they are safe. And this is especially tricky for coronaviruses because data for similar viruses suggest that if you produce antibodies that do not neutralize the virus, they could actually enhance the infection, which is any drug company's worst nightmare. Finally, once companies develop the vaccine and test it for safety and efficacy, they have to build the capacity to produce billions of doses a year, and it will take time to approach this global scale.

All that said, whatever timeline we end up seeing for these vaccines will be faster than anyone could possibly have conceived until recently given that companies are now using revolutionary "platforms" in the development of vaccines. These platforms can substitute almost instantly the protein from this virus into an existing vaccine, or just the genetic codes of that protein, into a lipid particle that can effectively deliver it into people. This would be vastly more efficient than the prior process that painstakingly developed an individual vaccine for a single virus. So I'm confident that we will see COVID-19 vaccines in record-short time, even if we wish it were sooner.

Allison Nathan: How concerned are you that the disease will mutate, making any vaccine eventually ineffective?

Dr. Barry Bloom: We can expect any virus to mutate, but I am not concerned that such mutation will render a vaccine ineffective. This particular virus binds to one receptor in people's lung epithelial cells, so the goal of most vaccines is to produce antibodies that will instead bind to the virus or receptor, so that the virus can't infect. And if the virus then mutates its binding domain to elude the antibody, it will lose the ability to get into a cell effectively, or at all. I'm therefore hopeful that mutation won't initially be the major problem here.

Allison Nathan: What's the likelihood that we get an effective treatment of the disease before we get a vaccine?

Dr. Barry Bloom: I'm optimistic that we will have relatively effective therapeutic interventions sooner than vaccines. The FDA website lists 440 clinical trials either planned or underway for COVID-19, which is astonishing since for many diseases there are fewer than a dozen. These interventions fall into two major categories—ones that target the virus and ones that target the immune response—the so-called cytokine storm—that appears to be what ultimately kills people.

On the former, two existing drugs have shown particular promise in preliminary COVID-19 studies—remdesivir and favipiravir, but we won't know their true effectiveness until results of randomized trials are in, which will happen as early as May. Many other drugs and novel therapeutic interventions also look promising like the use of plasma from recovered donors and monoclonal antibodies that neutralize the virus. In the second approach, several drugs are now being tested to address the overactive immune response to the virus and the ultimate organ failure that it can produce. I think progress is likely to be made in relatively short order in this area as well. So, I'm pretty hopeful that at least some useful treatments will be developed this year—and potentially as early as this fall.

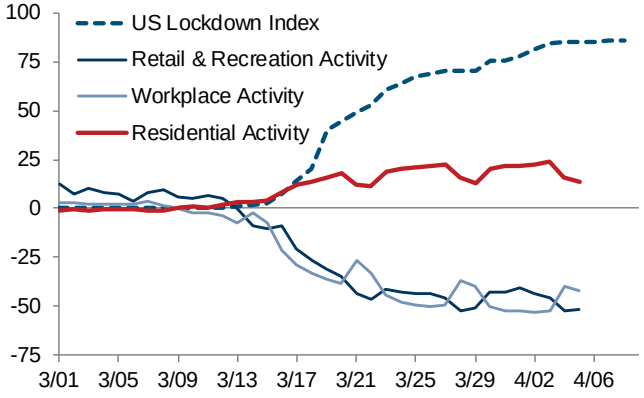
Reopening the US economy

David Choi and David Mericle discuss what US reopening might look like, and implications for the pace of the US economic recovery

The US is now largely in lockdown mode and social distancing has increased nationwide. Our US Lockdown Index—a measure of the GDP-weighted share of the country that has shut down schools, closed non-essential businesses, and issued stay-at-home orders—has now reached 86%, and virus fears and lockdown orders have led to much greater social distancing, with roughly 50% declines in the share of time spent at workplaces and retail stores and a 25% increase in time spent at home. But with the daily number of new confirmed virus cases plateauing, discussion is turning to the plan for reopening.

Most of US is in lockdown and social distancing has risen

Statewide activity declines vs. pre-COVID, GDP-weighted, % change



Source: National Governors Association, IMHE, Google, Goldman Sachs GIR.

What will reopening look like?

Several countries have already started the process of gradually reopening their economies from virus lockdowns or have announced plans to start soon, and such plans provide a glimpse of what reopening might look like in the US. They offer three key lessons for the US. First, initial reopening timelines often prove too optimistic, with most changes to initial plans so far instead moving toward more stringent restrictions and longer lockdowns. Second, reopening plans should be gradual and conservative. Third, recovery is quicker in manufacturing than in consumer services.

Indeed, absent a vaccine, scalable treatment breakthrough, or development of herd immunity—all of which are unlikely in the near term—reopening in the US will also have to remain gradual to avoid a second wave of virus spread. Given the tight balancing act between reopening and controlling the virus spread, we see a few prerequisites for reopening: further declines in confirmed new infections, some excess capacity in hospital systems, greater ability to test large numbers of people quickly, and the ability to trace and quarantine those who have come into contact with infected people in order to control future outbreaks. These goals look generally achievable in the US in coming months, although substantial uncertainty remains given that at least some if not all of them are not being met across most of the US today. We expect that the speed of reopening will vary across the country depending on local conditions as well as different perspectives on the tradeoff of health versus economic risks between states.

But while state and local governments may pursue reopening at different speeds, it is important to emphasize that most of the increase in social distancing in the US has been a voluntary reaction to virus fears, not a response to government lockdown orders, and the public will have to be persuaded that any plan for partial reopening is safe.[1]

With this in mind, we see two possible approaches to the order of reopening. An optimal approach might start with activities whose reopening offers maximum economic benefit for a given "cost" of virus risk, with total permitted activity constrained to a level that keeps virus spread under control. For example, economic activity that can be conducted nearly as well from home and therefore doesn't generate much "cost" in exchange for less health risk would come later in the reopening order. However, measuring this might be difficult in practice, as would actually implementing it given that the private economy would not necessarily arrive at that approach on its own because of incomplete information about virus risk and a failure of businesses and individuals to account for the virus transmission externalities of their own activities.

Reopening might instead proceed from the safest activities to the most dangerous, as people initially limit their out-of-home activities to those with the least risk of infection. Absent strong government intervention, the actual path of reopening is likely to fall somewhere in between these two approaches. And, as reopening begins, we see many possible adjustments to office and factory work arrangements, commercial activity, and social life can help to reduce the risk of virus spread.

Reopening will require changes to commercial and social life

Prerequisites for reopening	Slower pace of new cases/hospitals not overstretched Ability to test large numbers quickly Ability to trace and quarantine infected people
Adjustments to permit gradual reopening	Wider use of masks Frequent handwashing, disinfecting, deep cleaning Contact tracing/quarantining following breakouts Restore lockdowns if cases rebound too quickly Encourage those older/at-risk to limit time in public International and/or domestic travel restrictions Increase to-go offerings and cashless transactions Bring back workers who are immune Maintain distancing measures/gathering limitations Limit allowable capacity in public spaces Stagger employee shifts and lunchtimes Surveillance systems and temperature checks Use tech/data to identify areas of concern State-by-state, starting in areas with less cases
Ways to accelerate reopening	Therapeutic or preventative treatments Vaccine/antibody testing Favorable seasonal effects Wider immunity than previously thought

Source: Goldman Sachs Global Investment Research.

[1] *See Blake Taylor, "Measuring Lockdown: State Orders, Economic Activity, and Social Distancing Across the US," US Economics Analyst, 12 Apr 2020.*

Adjustments such as the use of masks, hand-washing, more frequent deep cleaning, routine health checks, maintaining physical distancing, and limitations on gatherings might apply to most areas of public life. Reduced density could be achieved through staggered shifts at work sites or lower capacity limits on public transit or at restaurants and other commercial and cultural locations. Life might reopen to a different degree for different groups, with those who are immune returning first, while those most at risk continue to limit social interactions until a vaccine is available.

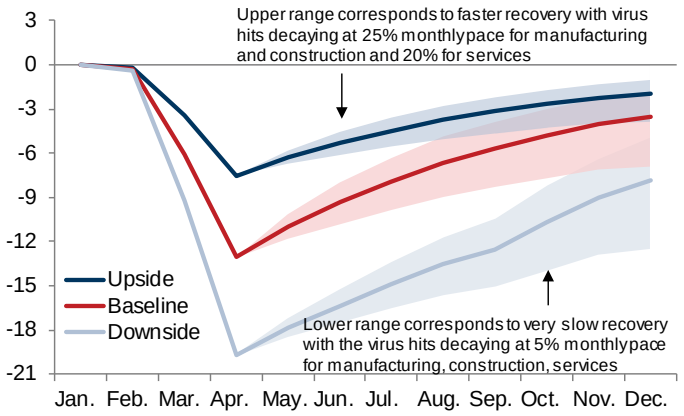
The economic recovery: A scenario analysis

As states and localities begin to reopen in the coming weeks and months, we strongly expect the economy to begin to recover from the current bottom in activity. While longer-lasting economic damage that delays the recovery is possible, so far the news has been mostly reassuring. On the labor market side, most layoffs have been temporary, meaning that most employer-employee relationships remain intact. On the business side, there has been no major uptick in bankruptcies so far. Admittedly, it is still very early to know how both concerns will evolve in coming months.

The quarterly growth path largely depends on three key factors: the depth of the peak decline, the length of lockdown, and the speed of recovery during the reopening process. We estimate a 25% peak hit in April to manufacturing, a 30% hit to construction, a 60% hit to brokerage fees and home improvements, and a 14% hit to consumer services. We assume that the recovery starts in May and June and thereafter proceeds at a gradual pace, with the manufacturing and construction drag fading by 15% each month, and the drag from services activity fading by 12.5% each month.

We see both upside and downside risks to our baseline path

Coronavirus hit to the level of US real GDP, %



Note: This is relative to a counterfactual of 1.75% potential growth; solid lines show an upside scenario (7% peak growth hit), our baseline (13& peak growth hit), and downside scenario (20% peak growth hit, 6 month lockdown) under our baseline speed of recovery.

Scenario	2020 QoQ AR Q1	Q2	Q3	Q4	2020 YoY Q1	Q2	Q3	Q4	2020 Full-year
Deep hit, 6 mo lockdown	-7	-53	20	20	-0.3	-18.0	-14.6	-11.1	-11.0
Baseline peak hit	**-8**	**-34**	**19**	**12**	**-0.6**	**-10.9**	**-7.4**	**-5.2**	**-6.0**
Small hit	-7	-20	11	7	-0.3	-6.1	-4.1	-3.0	-3.4

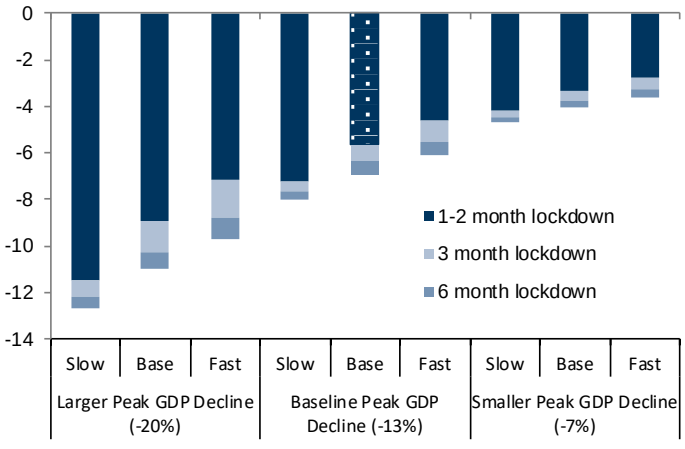
Note: Chart is implied quarterly growth rates, assuming baseline recovery speed.
Source: Goldman Sachs Global Investment Research.

Our baseline forecast for GDP growth puts the quarterly annualized pace at -8% in Q1, -34% in Q2, +19% in Q3, and +12% in Q4. This implies 2020 growth of -6.0% on an annual average basis and -5.2% on a Q4/Q4 basis. In addition to our baseline scenario, we also consider several upside and downside scenarios. An upside scenario could involve greater progress on treatment, much slower viral spread in warmer weather, or more effective adaptation that makes social distancing measures less economically costly. A widely available vaccine would likely lead to an even sharper recovery of economic activity, but appears unlikely in the near future. A downside scenario could involve a slower decline in the number of new infections, longer lockdowns, a second wave of infections that results in an oscillation between easing and tightening restrictions, larger second-round income effects, and more persistent avoidance of face-to-face interactions. Specifically, we consider an upside case with a 7% peak hit to activity (vs. 13% in our baseline) and a downside case with both a 20% peak hit to activity and a lockdown that lasts for 6 months.

In an even broader range of scenarios that vary the peak hit to growth, length of lockdown and speed of recovery, the worst case scenario would result in a double-digit hit to 2020 growth. But perhaps even more striking, the most optimistic scenario that would see a relatively small peak hit to activity, a 1-2-month lockdown, and a faster recovery would suggest 2020 growth of -2.8%, which would still be the lowest full-year pace since 1946. While we see both upside and downside risks to our baseline path, risks to our 2020 growth forecasts are skewed to the downside.

2020 growth largely depends on the peak decline, the length of lockdowns, and the speed of recovery

2020 full-year GDP growth, %



Note: Slow, base, and fast correspond to the expected speed of economic recovery; shaded bar represents our 2020 full-year growth forecast assuming a baseline peak decline in GDP, a baseline speed of recovery, and a 1-2-month full lockdown.
Source: Goldman Sachs Global Investment Research.

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Testing: a vital part of the story

Michael Cahill argues that confirmed case counts only tell half the story; testing practices are key to getting the whole picture

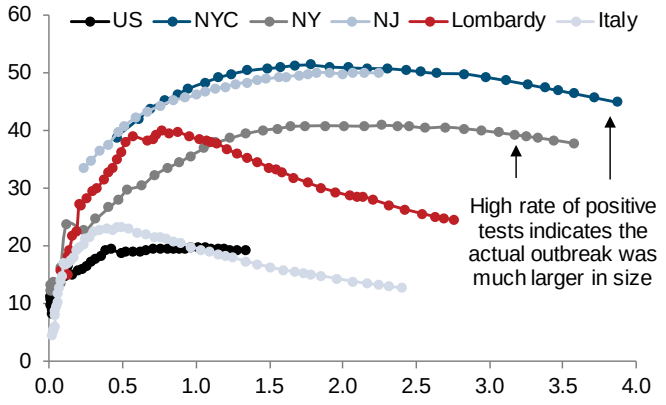
Many investors are keenly focused on metrics, such as the daily percentage change in confirmed cases, to gauge how the outbreak is progressing. But this really only tells half of the story. Without knowing more about the "denominator" of the equation—the number of tests being conducted, and on whom—it is hard to get a sense of the real trend of the virus. And the denominator itself faces its own set of challenges that further muddy the picture.

The fog of data

The New York City area and the Lombardy region in Italy—which are among the hardest hit regions—offer a clear example of how growth in the confirmed case count can be misleading. For two weeks straight at the end of March and beginning of April, the number of tests conducted in the City was fairly constant—with a little over 8k tests per day on average—and between 50 and 60% of them came back positive. By definition, this produced a steady increase in the number of confirmed cases.

But the high positivity rate—a function of the fact that only the "sickest of the sick" people were being tested—was a clear signal that the actual outbreak was much larger in size. At the same time, the constant pace of testing suggested that the availability of testing itself was a constraint. A similar pattern occurred in Lombardy, which averaged close to a 50% hit rate over a 10-day stretch in mid-March. So in both regions, the small variations in daily cases were mostly just a function of the number of tests completed, not a change in overall conditions.

Growth in confirmed case counts can be misleading
% of population tested (x-axis); % of tests with positive result (y-axis)

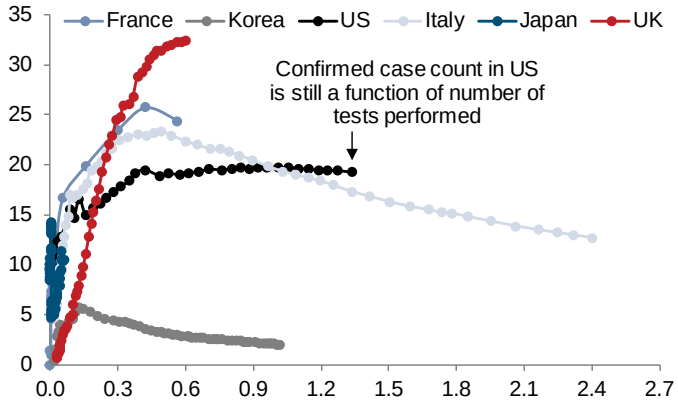


Source: National Health Ministries, US State Health Dept., Goldman Sachs GIR.

Cross-country comparisons and capacity constraints

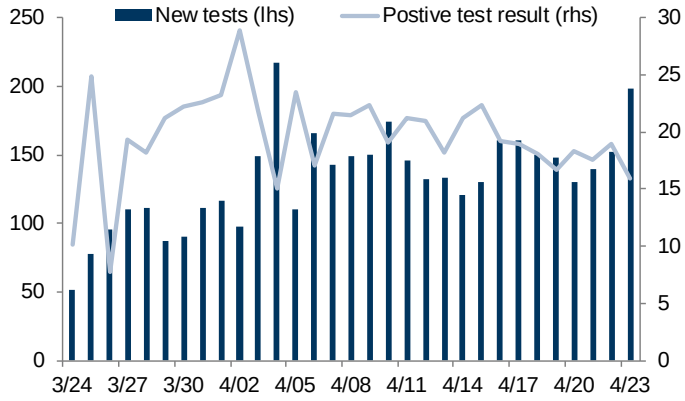
Differences in testing regimes also complicate cross-country (and state) comparisons. For example, at its peak in early March, South Korea confirmed about 5.5k cases over a ten-day period—but they ran over 125k tests. By comparison, the UK (which has a bigger population) has only recently matched that pace of testing, with over 50k confirmed cases during that time. And in the US, testing started off slowly before picking up, but then plateaued to around 150k people tested per day for much of April by our count, with the positive hit rate of those tests remarkably stable around 20%. So it appears that the number of cases confirmed in the US each day is still somewhat a function of the number of tests performed.

Differences in testing complicate cross-country comparisons
% of population tested (x-axis); % of tests with positive result (y-axis)



Source: National Health Ministries, US State Health Dept., Goldman Sachs GIR.

US testing plateaus while positive hit rate has stabilized
thousands of tests (lhs); % of tests with positive result (rhs)



Source: State Health Departments, Goldman Sachs Global Investment Research.

From beginning to end

Public health officials have stressed the importance of testing through each stage of the "curve." In the beginning, it is instrumental for proper containment. In the middle, it is necessary to assess the true scope of the issue. US and WHO officials have said that jurisdictions should aim for about a 9-10% positivity rate on all tests to ensure they have a good sense of the scale. And afterwards, a well-tested population can establish a benchmark for antibody testing with fewer false positives. In the meantime, market participants should keep an eye on the "denominator" to get a better sense of the real trends as well as to understand its own limitations.

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Control measure efficacy and reopening

Daan Struyven and Isabella Rosenberg look at the impact of control measures on viral spread

As coronavirus case growth appears to have leveled off globally, several countries, including the US and some in Western Europe, are beginning to relax lockdown measures initially intended to control the spread of the virus. However, this relaxation has increased concerns about a potential second wave of infections on the view that the recent improvement mainly reflects the impact of stringent virus control measures. Therefore, the efficacy of various virus control measures is a key question for the economic and market outlook. To answer this question, we use policy information, social distancing measures, and other variables from US states and other countries to explain the growth in coronavirus cases.

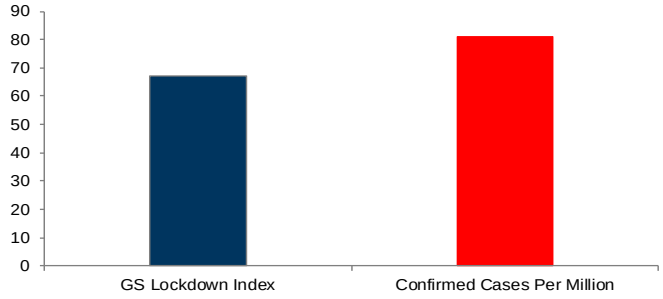
Bending the curve: from lockdowns to public hygiene

Our analysis yields three main results. First, at both the US state level—using our GS lockdown index—and the country level—using Oxford University researchers' government response stringency index—public virus control measures have a large, negative impact on infection growth. Lockdowns have been followed by significantly lower growth in infections, even when we control for other factors, such as population density, income inequality, and temperature.

That said, we find that in the US, actual social distancing behavior—based on data from Google's Community Mobility Reports—is an even more important driver of case growth than policy-imposed lockdowns. Intuitively, this is probably because the public's actual, practiced social distancing is also strongly influenced by non-policy factors, including fear of contracting the virus or spreading it to others. Indeed, we find that the number of state cases better explains social distancing than lockdown orders, suggesting public confidence will play an important role for the resumption of economic activity. Controlling for policy and social distancing, we also find that population density and income inequality have significantly positive relationships with infections.[2]

Confirmed cases a key driver of social distancing behavior

Variation in US social distancing index explained by factor, R-squared

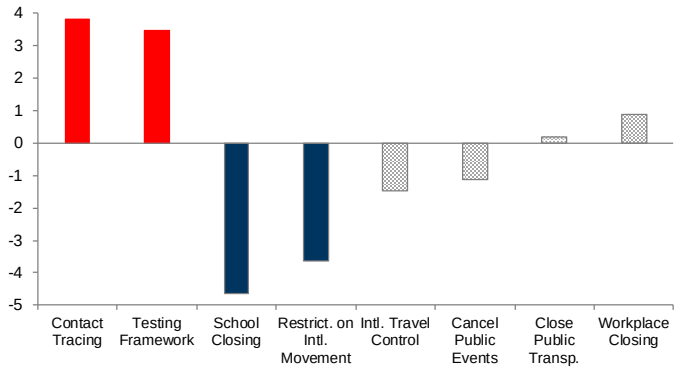


Note: The GS Lockdown index is a GS measure of the stringency of US state-level lockdowns based on governor-ordered school closures, stay-at-home orders and the closure of non-essential businesses.
Source: Goldman Sachs Global Investment Research.

Second, our cross-regional analysis reveals that even after controlling for policy restrictions and social distancing, Asian regions have experienced systematically lower growth in cases, especially those that experienced a SARS outbreak in 2003. Regions that experienced SARS have also relied more heavily on testing and contact tracing—and less on school closures and restrictions on internal movement—to mitigate and control the spread of the virus relative to other regions.

Regions with SARS experience have relied more on testing/contact tracing than on movement restrictions

Statistical significance of SARS in explaining regional-level policy mix, T-stat



Note: includes geographies with at least 200 SARS confirmed cases in 2002-2003; Canada, Mainland China, Hong Kong, Singapore and Taiwan.
Source: Goldman Sachs Global Investment Research.

Third, we find that countries with stronger self-reported handwashing practices have experienced lower case growth. Moreover, "big data" measures, such as Google searches, indicate a sharp recent rise in global attention to handwashing, masks and face touching, which has coincided with a larger drop in case growth in recent weeks in the US and globally than we can otherwise explain. This suggests that global attention to and likely learning about prevention has risen sharply.

Concerns confirmed

Overall, our analysis confirms two main concerns as we move towards reopening the economy. First, our finding that public virus control measures have a large, negative impact on infections highlights the significant risk of a second wave if policy or distancing behavior are eased prematurely and indiscriminately. Second, a successful reopening strategy is likely to require a sharp increase in testing and contact tracing from current levels in the US and other countries, as well as low-cost public hygiene measures, including campaigns for handwashing, masks, and gloves.

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[2] *This could reflect that lower-income households in more unequal regions often have less access to affordable or spacious housing, safe transportation, paid sick leave, or other health prevention measures.*

Q&A on testing, treatments and vaccines

Salveen Richter, GS lead analyst for the US Biotechnology sector, answers key questions on where we are on US testing, treatments and vaccines for COVID-19

Q: What are the different ways that healthcare companies are tackling COVID-19?

A: As the impact of the COVID-19 pandemic on the global economy and modern-day society continues to unfold, diagnostics (testing for infection), treatments (to treat symptoms of COVID-19) and prophylactic vaccines (to prevent infection of SARS-CoV-2—the virus that causes COVID-19) are being developed. There are primarily two types of diagnostic tests: molecular and serological. While molecular tests quantify the presence of viral infection (implies infection), serological tests detect the presence of antibodies to coronavirus in the blood (implies immunity). Of the ~49 diagnostic tests approved by the FDA under its emergency use authorization (EUA), over 80% are molecular. However, as state and federal policy makers begin to think about re-starting the economy, serology tests with high specificity are becoming a focus.

On the therapy side, there are two broad groups for COVID-19—prophylactic vaccines and treatment. Prophylactic vaccines are intended to provide protection from infection and confer immunity in people who have not been exposed to COVID-19, while treatments address the different symptoms associated with COVID-19, such as acute respiratory distress syndrome (ARDS). According to the Milken Institute COVID-19 tracker, there were over 250 therapies in the pipeline as of April 27, with 96 of these being vaccines and 55 antibodies. We note that according to the WHO, there are 89 vaccines currently in the pipeline, seven of which are in clinical development.

Q: What progress have we made in ramping up diagnostic testing capacity in the US and globally, and where are we still falling short?

A: The global capacity for molecular diagnostic testing of COVID-19 is now at ~30 million tests per month. While the current testing capacity is not sufficient to meet the entire demand on a population basis, we note an improvement in testing in the US over the past few weeks according to the COVID Tracking Project, from a total of 866 tests as of March 4 to 4.7 million tests as of April 23—largely driven by the FDA's flexibility towards labs and manufacturers in this time of crisis. We expect the FDA's decision to implement its EUA (emergency use authorization) on in vitro diagnostics for the detection and/or diagnosis of COVID-19 will continue to accelerate testing efforts. The FDA emergency use guidelines relax the standards that allow tests to be available, in part by expediting review timelines to as little as one day and allowing labs to begin testing prior to FDA review of the validation data.

But while the increase in available tests represents meaningful progress compared to the past couple of weeks, the availability of resources, including swab samples and trained professionals to collect these samples, and testing turnaround times continue to hinder the widespread scale up and availability of testing. Errors in the tests themselves, such as false negatives, present an additional hurdle for diagnosing COVID-19. As capacity for testing increases, it will be key to delineate between testing for the presence/absence of the actual infection, where there was meaningful progress in March, and testing for immunity generation, which will be relevant going forward.

Q: What is the status of antibody testing, and when can we expect to see a ramp up of such testing in the US?

A: Serological testing (i.e. presence of antibodies) can provide insight into herd immunity (the resistance to the spread of disease within a population resulting from a sufficiently high proportion of individuals immune to the disease), which is important because once approximately >60% of the population is immune to the virus, a "next wave" of infections stemming from the same version of the virus is unlikely. Several companies are developing antibody tests to measure the markers of an immune response to COVID-19, namely immunoglobulin M (IgM) and immunoglobulin G (IgG) antibodies. IgM antibodies are the first to appear in response to the initial exposure of a viral infection, and they begin to fade after the infection ends. As the body clears the infection, there is an increase in IgG antibodies, which provide long-term immunity. Thus, COVID-19 IgM antibodies may indicate more recent exposure to the virus, and the detection of COVID-19 IgG antibodies may indicate a later stage of infection. In order to determine the stage of infection, it is therefore critically important to have a highly specific test that identifies the specific antibody present rather than a highly sensitive test that quantifies levels of the antibody. To that end, we highlight two serological tests: Abbott's, which has a specificity and sensitivity of 99.6% and 86.4%, respectively, and Roche's, which has a specificity and sensitivity of >99% and >95%, respectively.

Based on the different proposed plans for the path forward in the US, we estimate the country would need an estimated 50 to 100 million antibody tests per month. In the US, Abbott committed to shipping 4 million tests in April, ramping to 20 million tests in June, and notes that its testing instruments can run up to 100 to 200 tests per hour. Roche is currently working with the FDA for an EUA on its tests, and plans to reach a capacity of 100 million tests per month by June, with a goal to ramp up further towards year-end. According to Roche, its instruments can run up to 300 tests per hour, depending on the analyzer used.

Q: What are the most promising types of treatments for active cases being developed right now, and what is a realistic timeframe for having an effective treatment widely available?

A: In broad terms, treatments for COVID-19 include approved drugs that can be repurposed, antiviral therapies that counteract the virus, antibody therapies that introduce neutralizing antibodies against the virus and convalescent plasma therapies, in which plasma from convalescent patients is administered to those infected. On the therapeutic side, Gilead's remdesivir and Regeneron's antibody cocktail are most in focus. Gilead's remdesivir is an Nuc inhibitor that terminates viral replication by preventing the function of RNA-dependent RNA polymerases (an enzyme that catalyzes the replication of RNA), resulting in a decrease in viral RNA production. Thus far, there has been emerging data for remdesivir in COVID-19, but we await full Phase 3 results in late April (for severe patients), late May (for moderate patients) and data from the NIAID sponsored study in mid-to-late May to elucidate the profile of the drug. Regeneron is developing a novel multi-antibody cocktail that can be used as a treatment for COVID-19 in infected individuals. This treatment will use two undisclosed antibodies that target different parts of the virus to protect against multiple viral variants. Regeneron's antibody cocktail will be ready to enter the clinic by early summer, with a goal of producing hundreds of thousands of doses per month by the end of summer.

As it relates to symptomatic relief of COVID-19, anti-IL6 inhibitors are in development, with Roche's Actemra in a Phase 3 trial (data in 2H20, potentially in the summer) and Regeneron/Sanofi's Kevzara currently in Phase 2/3 testing. On the latter, going forward, the Phase 3 trial will only include "critical" patients with results (US) expected in June and the rest of the global studies in 3Q20. We also highlight Grifols, Takeda and CSL Behring, all of which are independently developing a novel convalescent plasma therapy against COVID-19. One potential limitation of this approach is the requirement of donor plasma, which could limit its scale.

Q: What are the most promising vaccines currently in development, and what is the earliest timeline we can expect to see for getting a vaccine to the public?

A: With several vaccines in development, we believe Moderna's mRNA-based vaccine (mRNA-127) and Johnson & Johnson's vaccine candidate, which uses established and validated AdVac technology, are the leading contenders to address the public health needs of the global community. Moderna has previously issued guidance on the potential for emergency vaccine use in primary populations (including physicians) as early as fall 2020, following the release of Phase 1 safety data in the spring and immunogenicity data in the summer and Phase 2 initiation in 2Q20. We expect Johnson & Johnson to initiate Phase 1 trials in September, with topline safety and immunogenicity data expected by the end of 2020, and note the vaccine could be available under EUA in early 2021 (see other vaccines in development on pgs. 20-21.)

Q: Will any vaccine need to be administered every year, like a flu vaccine, or will it be effective over a multi-year period?

A: On the duration of efficacy, it is unclear if the COVID-19 vaccine will be similar to the yearly flu vaccine or whether it will be able to confer multi-year efficacy. While some experts believe multi-year protection is likely, more research is needed to determine if this is the case based on what we know about similar viruses. Using the 2002 SARS and 2012 MERS epidemics as analogs is not helpful in this case because there is not much known about their reinfection rates given the limited epidemiological details of both – there were >8,000 cases of SARS over 3 months, and only 2,500 observed cases of MERS over 8 years.

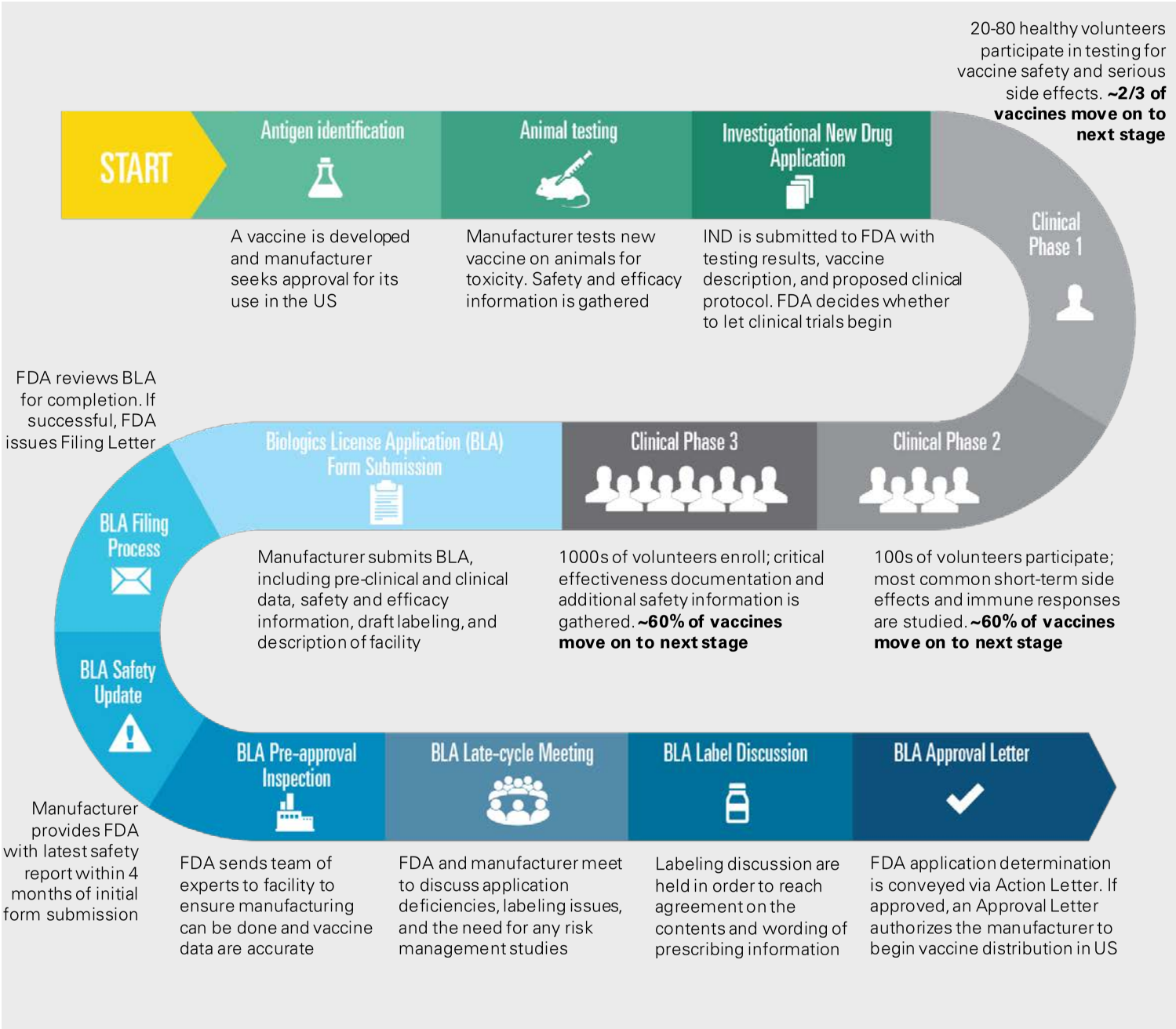
COVID-19 therapies and diagnostics

Company (Compound)	Category	GS comment	Event
Approved therapies			
ROG **(Actemra/ RoActemra)**	Anti-IL-6	While not currently for use in COVID-19 patients with pneumonia, we note that it has been included in the 7th updated diagnosis and treatment plan for COVID-19 issued by China's National Health Commissions (NHC) on March 3, 2020.	Ph3 data expected in 2Q20
REGN/SNY **(Kevzara)**	Anti-IL-6	The companies have initiated global Ph2/3 studies evaluating Kevzara (anti-IL-6 approved to treat RA) for the treatment of severe symptoms.	Ph2/3 data in mid-20+
INCY/NVS **(Jakafi)**	JAK inhibitor	Ph3 clinical trials will begin, ex-US, in patients with COVID-19 associated cytokine storm. Jakafi is currently being distributed in the US under the emergency Expanded Access Program (EAP).	
ALXN **(Ultomiris)**	C5 inhibitor	Ph3 trials will be conducted in COVID patients (n=270) with severe pneumonia or acute respiratory distress syndrome. Preclinical data demonstrates reduced lung inflammation in animals with pneumonia and evidence of effect in the compassionate use program.	Ph3 trials expected to start in May 2020
Fujifilm Holdings **(favipiravir/ Avigan)**	Anti-flu	Management has started Ph3 trials in Japan to expand the indication of an influenza treatment. It has already reported that clinical trials in China suggested that the drug is effective in the treatment of COVID-19.	Trials are expected to be completed in June 2020
Generic **(chloroquine / hydroxyl-chloroquine)**	Anti-malaria	FDA has authorized emergency use of both drugs. NVS and Bayer have committed to 30mn and 3mn doses of CQ, respectively, for immediate use in controlled clinical studies. WHO is running a SOLIDARITY trial testing the efficacy of these drugs against remdesivir and anti-HIV drugs.	
Generic **(lopinavir / ritonavir)**	Anti-HIV	Initial expectations were dimmed due to a recent study, in China, where no difference was seen in mortality or rate of improvement in comparison to standard of care.	
Pipeline therapies			
MRNA **(mRNA-1273)**	Vaccine	Management guided to potential for emergency use in primary populations (including physicians) in fall 2020.	Initial Ph1 safety data expected in spring and immunogenicity data in summer
JNJ **(Ad26-SARS-CoV-2)**	Vaccine	JNJ has identified a vaccine candidate for clinical development and plans to initiate clinical studies by Sept 2020. The company intends to scale production in parallel to enable supply of one billion doses. JNJ anticipates the vaccine could available for emergency use authorization in early 2021.	Efficacy and safety data expected by year-end
VIR/WuXi Biologics	Vaccine	VIR has partnered with WuXi to expedite the development of their lead COVID-19 candidate. WuXi is responsible for and is in early stages of cell-line development, formulation and initial manufacturing.	
SNY	Vaccine	SNY is developing a novel, recombinant, protein-based vaccine in partnership with BARDA using SNY's recombinant DNA platform.	Initial human trials will begin in 4Q20
SNY/TBIO	Vaccine	Novel mRNA COVID-19 vaccine using TBIO's mRNA platform. TBIO will likely be able to meet the demand for a pandemic response since it has established single batch production with its clinical platform and also is partnered with a contract manufacturing company.	Ph1 trials to begin early 2021
SNY/GSK	Vaccine	SNY and GSK have entered into an agreement to use SNY's S protein antigen in combination with GSK's pandemic adjuvant technology to develop a vaccine against SARS-CoV-2. If successful, SNY/GSK aim to have the vaccine ready by 2H21.	Clinical trials to begin 2H20
PFE/BNTX **(BNT162)**	Vaccine	This potential mRNA vaccine will be jointly distributed (excluding China).	Clinical trials will begin by end of April 2020
MRK	Vaccine	Company is screening their existing anti-viral products to see if any can be leveraged against COVID-19.	
GSK/Clover Biopharmaceuticals **(S-Trimer)**	Vaccine	Clover is responsible for manufacturing since it has one of the largest in-house, commercial scale cGMP manufacturing facilities in China.	
CSL	Vaccine	Partnered with the University of Queensland where CSL will provide technical expertise and its adjuvant technology, MF59 which has been used in seasonal/pandemic influenza vaccines. Program is currently in early stages of development.	
Inovio/IVI/KNIH **(INO-4800)**	Vaccine	First patient in Ph1 US trial (n=40) has been dosed. Each patient will receive two doses of INO-4800 four weeks apart. In parallel, Inovio will collaborate with IVI and KNIH to test INO-4800 in a Ph1/2 study South Korea with an aim to produce 1mn doses by YE.	Initial immune responses and safety data expected by late August
CureVac	Vaccine	CureVac is leveraging its mRNA platform to develop a vaccine for COVID-19.	
Novavax **(NVX-CoV2373)**	Vaccine	Novavax has identified NVX-Co2373 as a vaccine candidate that produces high levels of neutralizing antibodies in animal studies.	Ph1/2 trial to begin in mid-May 2020 with preliminary readout in July 2020
Oxford University	Vaccine	The first phase (n=1,110) will be administered to healthy volunteers and will include a control arm (meningitis vaccine). Each patient will receive two doses over four weeks.	First patients have been dosed; results expected in ~6 months
GILD **(remdesivir)**	Antiviral therapy	Thus far, there is emerging data for remdesivir in COVID-19. We await results from the full remdesivir GILD Ph3 studies to elucidate the profile of the drug.	Full remdesivir Ph3 results expected in late April (severe patients) and late May (moderate patients) as well as data from NIAID sponsored study in mid-to-late May

VIR/ALNY	Antiviral therapy	VIR has expanded its partnership with ALNY to develop an RNAi therapy against SARS-CoV-2.	
REGN	Antibody therapy	REGN is developing an antibody cocktail therapy as prophylaxis or treatment for individuals infected with the virus, similar to their Ebola program which is currently under regulatory review.	Ph2/3 data in mid-20+
VIR/BIIB	Antibody therapy	VIR has modified its novel antibody to extend its half-life and increase its short term (vaccinal) potency. The drug will be produced both with and without the vaccinal mutation.	Clinical trials to begin in July-September 2020
VIR/GSK **(VIR-7831/32)**	Antibody therapy	VIR has identified antibody candidates (VIR-7831/VIR-7832) which it is now developing in partnership with GSK. The companies are additionally utilizing VIR's CRISPR screening and machine learning approach and GSK's vaccine technologies to further other initiatives in search for a vaccine for COVID-19.	Begin Ph2 clinical trials in the next 3-5 months
AMGN/ADPT	Antibody therapy	This partnership will leverage ADPT's immune medicine platform to identify neutralizing antibodies from COVID-19 survivors and develop therapeutics for prophylaxis and treatment.	
LLY **(LY3127804)**	Antibody therapy	Ph2 trial in hospitalized COVID patients with pneumonia to begin in April.	Data readouts expected in early summer
KNSA **(Mavrilimumab)**	Antibody therapy	Initial study in six severe COVID-19 patients shows promise. Company is working with the FDA to begin trials in the US.	
Takeda **(TAK-888)**	Plasma therapy	TAK-888 will likely be used to treat high-risk patients only.	Trials to begin June/July 2020 and launch is anticipated by YE20
Grifols	Plasma therapy	Currently the only company authorized to collect plasma from donors who have had COVID-19 in the US.	
CSL	Plasma therapy	CSL is exploring development of hyper-immune serum enriched with COVID-19 antibodies but has not provided timelines.	
Diagnostics			
ABT	RT-PCR	ABT's molecular test will be performed on ABT's M2000 system already in hospital and reference labs.	FDA approved; ABT is manufacturing 50k tests/day of the new 5-min PoC test with plans for 2mn tests/month by June
TMO	RT-PCR	Test provides results within four hours of receiving sample. As of March 16, TMO has 1.5mn tests available to ship under the EUA label.	TMO received FDA approval and expects to scale production up to 5mn tests per week during the month of April.
ROG	RT-PCR	In our view, this approval and subsequent commercialization is unlikely to materially impact Roche's broader growth outlook, however, we do see it as potentially enabling a de-bottlenecking of some of the constraints faced by healthcare systems.	FDA approved, capacity of >3.5mn tests/month available now with an aim to significantly expand this capacity
PKI	RT-PCR	PKI has expanded production capacity of its extraction and RT-PCR tests throughout its global facilities and guides to the capability to ship millions of test kits.	FDA approved
DGX	RT-PCR	Conducting ~25k COVID-19 tests per day, with capacity to scale to ~30k tests bringing weekly capacity to ~200k. As of March 23, DGX has performed ~100k tests.	DGX received FDA approval and expects to meet full US demand over the next ~2 weeks.
LH	RT-PCR	Capacity to perform more than 30k COVID-19 tests per day, with greater capacity expected in the coming weeks assuming adequate supplies. LH has performed ~350k tests to date.	Per prior management commentary, LH plans to scale to more than 100k tests per week. It has also received FDA approval.
QGEN/TMO **(QIAstat-Dx)**	RT-PCR	Developed a panel that can differentiate SARS-CoV-2 from 21 other pathogens.	Initially evaluated at a hospital in Paris and is now being tested at four hospitals in China
Grifols	TMA	Grifols anticipates that its TMA test can detect the virus with a sensitivity equivalent (or potentially) superior to that of PCR. Each automated instruments can run >1k samples per day.	Test should be ready in the following weeks
ABT (ID NOW)	PoC	ABT received US approval of its ID NOW system which targets the coronavirus' RdRp gene and can yield positive results in five minutes and negative results in 13 minutes. Per GS estimates, 1mn test can be manufactured per month.	FDA approved and ABT will start shipping 50k tests/day of new 5-min PoC test from April 1st
DHR **(Xpert Xpress SARS-CoV-2)**	PoC	Test is able to detect SARS-CoV-2 in ~45 min and is performed on Cepheid's GeneXpert Systems platform (~5k in the US; 23k worldwide). While PoC provides faster results, each sample is run individually vs traditional PCR where multiple samples can be run in parallel.	First to receive EUA from the FDA
BDX	Serological	HSIC is working to make tests available to medical care facilities in the US.	BDX expects to supply >1mn tests in the coming months
ROG **(Elecsys anti-SARS-CoV-2)**	Serological	The test is able to identify people who have been infected with COVID-19, even if they do not display symptoms. The test will run on ROG's Cobas E systems through a blood sample, with results available in 18 min and a test throughput of up to 300 tests per hour, depending on the analyser. Per Roche, this test already has a specificity of >99% and a sensitivity >95% to the SARS-CoV-2 virus. ROG aims to make the test available in countries accepting the CE mark by early May, and is working with the FDA for an Emergency Use Authorization.	Capacity of 100mn tests/month by June with an aim to ramp up capacity further later in the year
ABT	Serological	Test will run on ABT's Architect i1000SR and i2000SR instruments. Per the company, there are >2k instruments in use in the US and can run up to 100-200 tests per hour. It tests only for IgG and has a sensitivity of 86.4% and a specificity of 99.6%. ABT began shipping tests on April 16 and is priced at $5 per test.	ABT will ship 4mn tests in April 2020 and will ramp up to 20mn tests in the US in June 2020
CEMI	Serological	Per press reports, CEMI received FDA approval for its 15 min PoC test.	Expects to begin shipping tests with the help of its partner LumiraDX, in April 2020

Note: Latest as of April 28, 2020.
Source: Data compiled by Goldman Sachs Global Investment Research. See here for more details. Special thanks to Salveen Richter.

The race to a vaccine



APPROVAL STAGES

PRE-CLIINICAL

Typical timeline:
3-7 years

COVID-19 timeline:
2+ months

Shortened by:
(1) Developments over the last few years in vaccine platform technologies that can instruct a patient's own cells to produce proteins that can prevent infection

(2) Use of research on the existing SARS vaccine as a starting template, as COVID-19 shares 80% of its genetic code with SARS

CLINICAL

Typical timeline:
4-8 years

COVID-19 timeline:
~12+ months, but potentially sooner for certain populations

Shortened by: A fast-tracked process for each stage of clinical trials based on surrogate endpoints rather than clinical endpoints, with Phase 2 and Phase 3 trials being combined

REGULATORY REVIEW

Typical timeline:
1-2 years

COVID-19 timeline:
Few months

Shortened by: Potential use of FDA's Emergency Use Authorization (EUA)

Special thanks to Salveen Richter.

Source: FDA, WHO, CDC, MIT, World Economic Forum, The New England Journal of Medicine, European Journal of Immunology, Johns Hopkins, Biotechnology Innovation Organization, NCBI, NLM, NIH, Nuventra, Goldman Sachs GIR.

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開示事項

規制に基づく開示事項

米国法ならびに米国の規制に基づく開示事項

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グローバル調査資料：配布機関

ゴールドマン・サックスのグローバル・インベストメント・リサーチ部門は、全世界でゴールドマン・サックスのお客様向けに調査資料の発行と配布を行 っています。世界各地のゴールドマン・サックスのオフィスに勤務するアナリストは、業界および企業、マクロ経済、為替、市況商品、ポートフォリ オ戦略に関する調査資料を発行しています。本資料の配布については、オーストラリアではゴールドマン・サックス・オーストラリアPtyリミテッド (ABN 21 006 797 897)が、ブラジルではゴールドマン・サックス・ドゥ・ブラジル・コレトラ・デ・ティツロス・エ・ヴァロレス・モビリアリオスS.A.が、オンブスマン・ゴールドマン・サックス・ブラジル： 0800 727 5764 および/または ouvidoriagoldmansachs@gs.com (平日の午前9時から午後6時にお問い合わせください)。Ouvidoria Goldman Sachs Brasil: 0800 727 5764 e/ou ouvidoriagoldmansachs@gs.com. Horário de funcionamento: segunda-feira à sexta-feira

(exceto feriados), das 9h às 18h、カナダではゴールドマン・サックス・カナダ・インクまたはゴールドマン・サックス・アンド・カンパニーが、香港ではゴールドマン・サックス(アジア)LLC が、インドではゴールドマン・サックス(インド)セキュリティーズ・プライベート・リミテッドが、日本ではゴールドマン・サックス証券株式会社が、韓国ではゴールドマン・サックス(アジア)LLC ソウル支社が、ニュージーランドではゴールドマン・サックス・ニュージーランド・リミテッドが、ロシアでは000ゴールドマン・サックスが、シンガポールではゴールドマン・サックス(シンガポール)Pte(Company Number: 198602165W)が、米国ではゴールドマン・サックス・アンド・カンパニーが、これを行います。ゴールドマン・サックス・インターナショナルは英国および欧州連合内での本資料の配布を承認しています。

欧州委員会：英国プルーデンス規制機構により認可され、英国金融行動監視機構ならびに英国プルーデンス規制機構の監督を受けるゴールドマン・サックス・インターナショナルは、欧州連合域内および英国国内における本資料の配布を承認しております。ドイツ国内においては、ドイツ連邦金融監督庁の監督を受けるゴールドマン・サックスAG およびゴールドマン・サックス・インターナショナル フランクフルト支店も本資料の配布を行うことがあります。

一般的な開示事項

本資料はお客様への情報提供のみを目的としています。ゴールドマン・サックスに関する開示事項を除き、本資料は信頼できると思われる現在の公開 情報に基づいて作成されていますが、当社はその正確性、完全性に関する責任を負いません。本資料に記載された情報、意見、推定、予想等は全て本 資料発行時点のものであり、事前の通知なしに変更される場合があります。当社は本資料中の情報を合理的な範囲で更新するようにしていますが、法 令上の理由などにより、これができない場合があります。定期的に発行される一部の業界リポートを除いて、大部分のリポートはアナリストの判断に より変則的な間隔を置いて発行されます。

ゴールドマン・サックスは、投資銀行業務、投資顧問業務および証券業務を全世界で提供する総合金融会社です。当社はグローバル・インベストメント・リサーチ部門が調査対象としている企業の大部分と投資銀行その他の業務上の関係を持っています。米国のブローカー・ディーラーであるゴールド マン・サックス・アンド・カンパニーは証券投資家保護公社(SIPC)(https://www.sipc.org)に加盟しています。

当社のセールス担当者、トレーダーその他の従業員は、口頭または書面で、本資料で述べられた意見と異なる内容の市場に関するコメントや投資戦略 を、当社の顧客およびプリンシパル取引部門に提供することがあります。当社の資産運用部門、プリンシパル取引部門、投資部門は、本資料で示され た投資見解や意見と整合しない投資決定を下すことがあります。

当社および当社の関連会社、役員、社員は、法令あるいはゴールドマン・サックスのポリシーで禁じられていない限り、本資料に記載された証券また は派生商品(もしあれば)の買い持ちや売り持ち、および売買を時として行うことがあります。

当社主催のコンファレンスで、当社の他の部門の従業員を含む、サードパーティのスピーカーが示す見解は、必ずしもグローバル投資調査部の見解を 反映したものではなく、また当社の公式見解でもありません。

ここで述べるサードパーティは、セールス担当者、トレーダー、その他プロフェッショナル、およびその同居家族を含み、本資料で言及された金融商 品について、本資料を執筆したアナリストの見解と相反するポジションをとることがあります。

本資料は市場や業種、セクターを越えた投資テーマに重点を置いています。本資料は当社が言及する業種またはセクター内の個別企業の見通しやパフォーマンスを識別しようとするものではなく、個別企業の分析を提供しようとするものでもありません。

本資料における、ある業種またはセクター内の一つもしくは複数のエクイティまたはクレジット証券に関する取引推奨は、いずれも本資料で論じた投 資テーマを反映するものであり、テーマから切り離して当該証券を推奨するものではありません。

本資料は売却・購入が違法となるような法域での有価証券の売却もしくは購入を勧めるものではありません。本資料は個人向けの推奨を構成するもの ではなく、また個々のお客様の特定の投資目的、財務状況、もしくは要望を考慮したものでもありません。お客様は、本資料のいかなる意見または推 奨に基づき投資行動をとる場合でも、その前にそれらがお客様の特定の状況に当てはまるか否かを考慮に入れるべきであり、必要とあれば税務アドバイスも含めて専門家に助言を求めて下さい。本資料に記載されている投資対象の価格と価値、およびそれらがもたらす収益は変動することがありま す。過去の実績は将来のパフォーマンスを約束するものではありません。将来の収益は保証されているわけではなく、投資元本割れが生じることはあ り得ます。為替変動は特定の投資の価格と価値、およびそれがもたらす収益にマイナスの影響を与えることがあります。

先物、オプション、およびその他派生商品に関係する取引は大きなリスクを生むことがあり、すべての投資家に適切な取引ではありません。投資の際 にはゴールドマン・サックスの担当者もしくはウェブサイトhttps://www.theocc.com/about/publications/character-risks.jspおよびhttps://www.fiadocumentation.org/fia/regulatory-disclosures_1/fia-uniform-futures-and-options-on-futures-risk-disclosures-booklet-pdf-version-2018を通じて入手可能なオプションおよび先物に関する最新の開示資料をよくお読みください。オプションの買いと売りを組み合わせるスプレッドなどのオプション戦略では取引コストがかなり高くなることがあります。関連資料をご希望の方はお申しつけください。

グローバル投資調査部が提供する異なるレベルのサービス：当社グローバル投資調査部が提供するサービスのレベルならびに種類は、コミュニケーションを受け取る頻度や手段に関するお客様のご要望、お客様のリスク特性や投資の重点分野ならびに大局的な投資観(市場全体、セクター固有、長期、短期等)、当社との顧客関係全体の規模や範囲、法律や規制による制約といった様々な要因により、当社の社内顧客および社外の他の顧客に提供 されるサービスと異なる場合があります。一つの例として、特定の有価証券に関する調査資料の発行時に通知を依頼されるお客様もいれば、当社顧客 向け内部ウェブサイトで入手可能なアナリストのファンダメンタル分析の基礎となる特定のデータの、データフィードその他手段による電子配信を依 頼されるお客様もいます。アナリストの根本的な調査見解の変更(株式の場合はレーティングや目標株価、業績予想の大幅な変更など)については、か かる情報を含む調査リポートが作成され、当社顧客向け内部ウェブサイトへの掲載という電子的発行または必要に応じてその他手段により、当該リポ ートがそれを受け取る資格のあるすべての顧客に広範に配布されるまでは、いかなる顧客にも伝達されることはありません。

すべての調査資料は電子的発行手段により当社の顧客向け内部ウェブサイトですべての顧客に一斉に配布され、閲覧可能となります。調査資料のすべ ての内容が当社顧客向けに再配布されたり、第三者のアグリゲーターに提供されたりするわけではなく、ゴールドマン・サックスは第三者のアグリゲーターによる当社の調査資料の再配布に責任を負っているわけでもありません。一つ以上の有価証券や市場、資産クラス(関連サービス含む)に関して ご利用可能な調査資料やモデル、その他データについては、当社の営業担当者にお問い合わせいただくか、https://research.gs.comをご覧ください。

その他の開示事項については、https://www.gs.com/research/hedge.htmlをご参照いただくか、200 West Street, New York, NY 10282のリサーチ・コンプライアンスから入手することができます。

金融商品取引法第37 条に定める事項の表示

本資料とともに、金融商品取引をご案内させていただく場合は、各金融商品取引の資料をよくお読みください。金融商品取引を行われる場合は、各商品等に所定の手数料等(たとえば、株式のお取引の場合には、約定代金に対し、事前にお客様と合意した手数料率の委託手数料および消費税、投資信託のお取引の場合には、銘柄ごとに設定された販売手数料および信託報酬等の諸経費、等)をご負担いただく場合があります。また、すべての金融商 品には、関連する特殊リスクがあり、国内外の政治・経済・金融情勢、為替相場、株式相場、商品相場、金利水準等の市場情勢、発行体等の信用力、 その他指標とされた原資産の変動により、多額の損失または支払い義務が生じるおそれがあります。さらに、デリバティブのお取引の場合には、弊社 との合意により具体的な額が定まる保証金等をお客様に差し入れていただくこと、加えて、追加保証金等を差し入れていただく可能性もあり、こうした 取引についてはお取引の額が保証金等の額を上回る可能性があります(お取引の額の保証金等の額に対する比率は、現時点では具体的条件が定まっ ていないため算出できません)。また、上記の指標とされた原資産の変動により、保証金等の額を上回る損失または支払い義務が生じるおそれがあり ます。さらに、取引の種類によっては、金融商品取引法施行令第16条第1項第6号が定める売付けの価格と買付けの価格に相当するものに差がある場合 があります。なお、商品毎に手数料等およびリスクは異なりますので、当該商品等の契約締結前交付書面や目論見書またはお客様向け資料をよくお読 みください。

権利行使期間がある場合は権利を行使できる期間に制限がありますので留意が必要です。

期限前解約条項、自動消滅条項等の早期終了条項が付されている場合は、予定された終了日の前に取引が終了する可能性があります。

商号等：ゴールドマン・サックス証券株式会社 金融商品取引業者 関東財務局長(金商)第69号

加入協会：日本証券業協会、一般社団法人金融先物取引業協会、一般社団法人第二種金融商品取引業協会