

# TOP *of* MIND

## COVID-19: WHERE WE GO FROM HERE



Well into the COVID-19 pandemic, countries continue to grapple with managing the virus while restoring economic activity. With the next major leg of normalization in the US—school reopenings—upon us, where the virus will go from here, what that means for schooling, the economy and markets—and how the vaccine outlook might impact all of the above—are Top of Mind. We speak to Harvard’s Dr. Marc Lipsitch, who believes that the rising expectation for a resolution of the pandemic in 2021 is a plausible best-case scenario, but one we likely won’t be sure of until at least mid-year. Our own Jan Hatzius argues that economic activity should be able to normalize further even if the virus remains an issue, and that a vaccine would only reinforce

the economic recovery. We find that some markets may still be underpricing an early vaccine scenario, though recent optimism also increases market vulnerability. Finally, we ask CEPI CEO, Richard Hatchett, if the rise in vaccine optimism is warranted. He’s also hopeful about the vaccine timeline, but cautions vaccines likely won’t be a magic bullet.



In many parts of the world, the virus still has a lot of room to run until we reach enough infections that herd immunity starts to slow the virus spread.

- Dr. Marc Lipsitch

When we initiated our COVID-19 vaccine development program in late January 2020, we ambitiously set a target of 12 to 18 months for the availability of a vaccine at scale. Six months into the development effort, we’re still on target for the first half of 2021.

- Dr. Richard Hatchett

We are reasonably confident in our above-consensus view on growth because relatively low-cost measures have been shown to materially lower infection rates, which should enable a significant portion of economic activity to continue to normalize.

- Jan Hatzius



...AND MORE

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**Dr. Marc Lipsitch**, Professor, T.H. Chan School of Public Health, Harvard University

**Jan Hatzius**, Head of Global Investment Research and Chief Economist, Goldman Sachs

#### PRICING VIRUS SCENARIOS

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#### KEY FACTS: VIRUS SPREAD AND CONTROL

Daan Struyven, GS Global Economics Research

#### SCHOOL REOPENING RISKS

David Choi and Joseph Briggs, GS US Economics Research

Allison Nathan | [allison.nathan@gs.com](mailto:allison.nathan@gs.com) Gabriel Lipton Galbraith | [gabe.liptongalbraith@gs.com](mailto:gabe.liptongalbraith@gs.com) Jenny Grimberg | [jenny.grimberg@gs.com](mailto:jenny.grimberg@gs.com)

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# Macro news and views

We provide a brief snapshot on the most important economies for the global markets

## US

### Latest GS proprietary datapoints/major changes in views

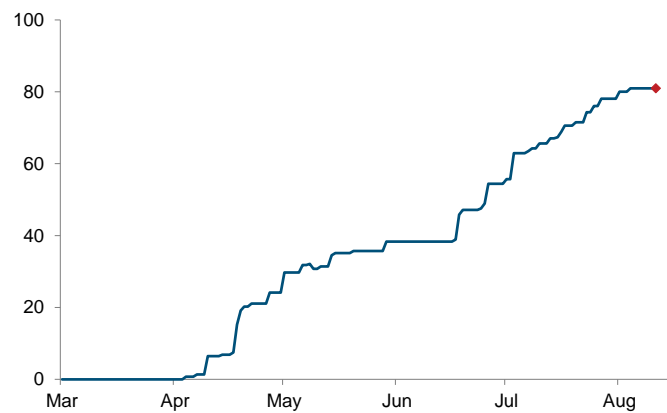
- We raised our 2021 US GDP forecast to 6.2% on our view that much of the US will be vaccinated by the end of 2Q21.
- We lowered our unemployment rate forecast to 6.5% by end 2021 on stronger-than-expected July labor market data and the more positive GDP forecast.
- We now expect the Fed to adopt outcome-based forward guidance in its November meeting.

### Datapoints/trends we're focused on

- Reopening risks; states representing 80% of the pop. have now reimposed restrictions or put reopening on hold.
- Fiscal stimulus; we expect Congress to pass a fiscal package of at least \$1.5tn by September, but risks have grown.

### Over 80% of the US is now under a mask mandate

Population of the US under a face mask mandate, percent



Source: Masks4All.co, Goldman Sachs Global Investment Research.

## Europe

### Latest GS proprietary datapoints/major changes in views

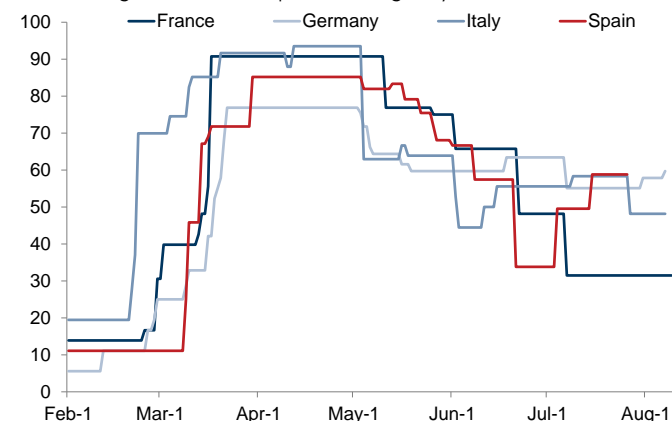
- We expect 8.9% and 3.4% qoq na GDP growth in 2H20 and 7.4% in 2021 following a smaller-than-expected Q2 GDP decline and new containment measures in parts of southern Europe.

### Datapoints/trends we're focused on

- Virus resurgence; despite an uptick in cases in some countries, we believe Europe is better placed than in the spring to limit the economic fallout from virus containment.
- Vaccine timeline; we think a large share of the European population will be vaccinated by the end of 3Q21.
- Recovery Fund; we expect the EUR 750bn fund to be ratified by the European Parliament and the 27 national parliaments by year-end.

### Some EU countries have tightened control measures

COVID-19 government response stringency index



Source: Oxford COVID-19 Govt Response Tracker, Goldman Sachs GIR.

## Japan

### Latest GS proprietary datapoints/major changes in views

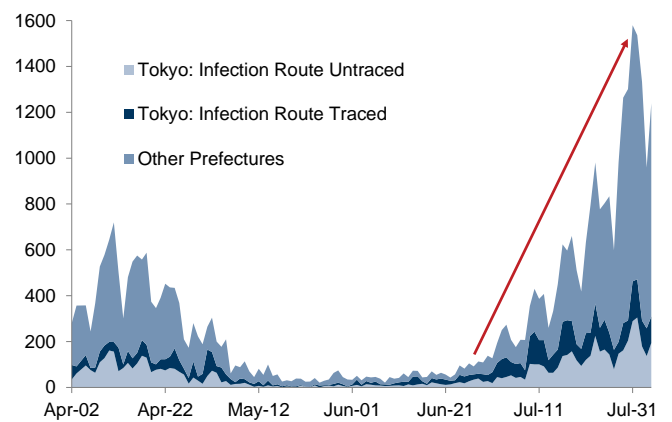
- We believe the Bank of Japan's COVID-19 response is effectively complete for now, and the BOJ will likely continue to monitor policy effects for the time being.

### Datapoints/trends we're focused on

- Virus resurgence; following a further increase in virus cases, we think nationwide consumption could decline 9% under another state of emergency.
- Elections; despite growing speculation, we think that early elections are unlikely to be held as long as the COVID-19 outbreak continues to widen.

### Virus cases are rising again in Japan, mainly in Tokyo

Total new virus cases in Japan



Source: NHK, Tokyo Metropolitan Government, Goldman Sachs GIR.

## Emerging Markets (EM)

### Latest GS proprietary datapoints/major changes in views

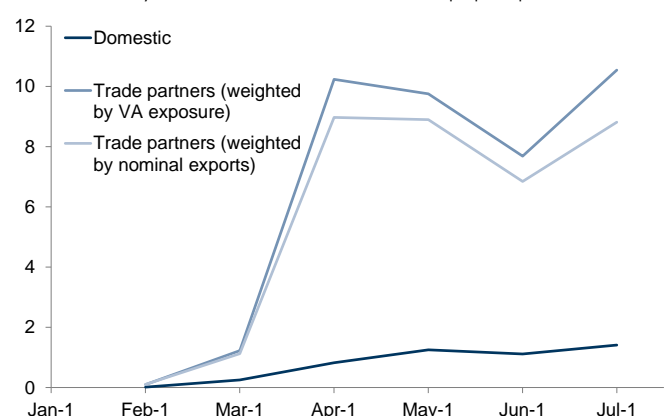
- We expect EM growth will contract by 1.2% in 2020 before rebounding to 6.8% in 2021.
- We expect fiscal support to remain strong in China in 2H20.

### Datapoints/trends we're focused on

- Virus divergence; case growth remains high in LatAm and EM Asia, while continuing to decline in CEEMEA.
- Asia trade; following a rise in infection rates in Asia's export markets, we think the risks to the recovery of trade-dependent Asian economies have increased.
- US-China tensions, which continue to rise.

### New cases in Asia's export markets have risen sharply

New monthly confirmed cases as share of pop., bp



Source: JHU, UN, Haver Analytics, Goldman Sachs GIR.

# COVID-19: Where we go from here

Roughly seven months into the [COVID-19 pandemic](#), countries around the world continue to grapple with managing virus spread while restoring economic activity. Indeed, the strong economic recovery underway since mid-April appears to have stalled in some places like Spain, Japan and parts of the US that have been forced to roll back reopenings to stem new outbreaks. With the next major leg of potential [reopenings](#) in the United States—school reopenings—upon us, where the virus will go from here, what that means for schooling, the economy, and markets—and how the developing vaccine outlook might impact all of the above—are Top of Mind.

We first speak to Dr. Marc Lipsitch, Professor of Epidemiology at the Harvard T.H. Chan School of Public Health, to assess the potential virus trajectory ahead. He explains that three factors—seasonality, herd immunity, and control measures—will together determine how the virus evolves in coming months. This leaves him less concerned about virus resurgence in places that have already been hit hard by the disease because they likely have somewhat higher herd immunity, greater adherence to control measures given their firsthand experience with the horrors of a virus surge, and more resources already devoted to avoiding, as well as preparing for, another one. But he's more worried about places that have not yet experienced a high incidence of the disease for the opposite of these same reasons. In his view, resolving the pandemic in 2021 with the help of a vaccine is a plausible best-case scenario, but we likely won't know if that timeline is achievable until at least the middle of next year.

We then turn to Jan Hatzius, GS Head of Global Investment Research and Chief Economist, to discuss what many more months—if not years—of living with virus risk means for the global economic outlook. He argues that continued economic normalization is possible even as the virus remains an issue, largely because low-cost measures such as avoiding large gatherings, social distancing, and—crucially—face mask mandates have proven very effective in controlling virus spread, reducing the need for costly, widespread lockdown measures to stem future outbreaks (see a review of the evidence on virus control and spread by Daan Struyven, GS senior Global economist, on pages 22-23.)

That said, the vaccine outlook has also improved. Based on historical experience, Struyven concludes that the substantial number of COVID-19 vaccines currently under development (167), and the fact that eight of them are already in late-stage Phase III trials, means that at least one vaccine is likely to be approved by the US FDA this year. We therefore now assume that much of the US and European populations will be vaccinated well before late 2021. All told, Hatzius continues to expect a meaningful sequential improvement in growth ahead, with global growth reaching an above-consensus pace of 6.5% in 2021, and many developed countries returning to pre-virus activity levels by mid-to-late next year.

As for markets, Dominic Wilson, GS senior markets advisor, finds that consensus has also shifted to a more positive growth scenario, consistent with an improving vaccine outlook. But he notes that even with the equity market at new highs, options on US equities—and on more cyclical sectors and indices in particular—still seem to be underpricing the risk of an early vaccine.

Given the importance of the vaccine outlook for growth and markets, we then sit down with Dr. Richard Hatchett, CEO of the Coalition for Epidemic Preparedness Innovations (CEPI), a coalition of countries and philanthropic organizations focused on the development of vaccines against emerging infectious diseases, which has funded a portfolio of nine COVID-19 vaccines currently under development. He is also optimistic about the prospect of an FDA-approved vaccine before the end of this year, and contends that vaccine availability should be sufficient to reduce the “sting” of the pandemic in 2021, with the hope of vaccinating healthcare workers and most at-risk populations—20% of the global population—next year.

But Hatchett also stresses that a vaccine likely won't be a magic bullet that eradicates COVID-19 anytime soon given how much is unknown about the disease and the degree and durability of protection any vaccine can provide against it—questions that will only be answered over time. Another important unknown in Hatchett's view is people's willingness to get a vaccine even when it becomes widely available, which could also be a constraint on achieving global herd immunity.

So what if the optimistic vaccine assumptions that our economists and the markets are making prove to be wrong? Hatzius says that a scenario in which vaccine availability is delayed by a year would likely reduce our 2021 global GDP growth forecast by roughly 2pp, with some of the largest effects in the US—where the underlying virus situation is relatively bad and our assumed vaccination timeline is relatively early. And to the extent that the market is currently pricing a relatively low probability of a downside growth scenario consistent with a delayed vaccine outlook, Wilson sees the market as more vulnerable to the risks of virus resurgence and vaccine disappointments (see also pages 14-15 for a snapshot of our asset-by-asset views and risks around them.)

Finally, beyond the growth and market implications of the virus and vaccine trajectory, GS US economists David Choi and Joseph Briggs drill into the other pressing issue at hand: whether US schools should reopen in the face of current virus risks. They emphasize that successful school reopenings around the world have largely occurred in places with much lower local infection rates than in many parts of the US, suggesting greater virus risk around US school reopenings today. But Choi and Briggs find that the cost of not reopening schools is also substantial, potentially inflicting a large near-term hit on the labor market in the education sector and beyond. They also see significant longer-term costs of keeping schools closed, such as negative effects on students and the economy from lower quality education, increased rates of depression and anxiety, and worsening income inequality. They conclude that US school reopenings will most likely be staggered, and their success—as is the case with many areas of the economy—will depend crucially on the success of virus control more broadly.

P.S. Don't forget to check out the podcast version of this and other recent GS Top of Mind reports—on [Apple](#) and [Spotify](#).

## Allison Nathan, Editor

Email: [allison.nathan@gs.com](mailto:allison.nathan@gs.com)  
Tel: 212-357-7504  
Goldman Sachs and Co. LLC



# Interview with Dr. Marc Lipsitch

Dr. Marc Lipsitch is Professor of Epidemiology and Director of the Center for Communicable Disease Dynamics at the Harvard T.H. Chan School of Public Health. Below, he discusses what we've learned about the transmission of COVID-19, how the virus may evolve from here, and if consensus expectations that the virus will largely be resolved in 2021 are realistic.

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



**Allison Nathan: Given that infection levels have generally remained at lower levels in much of Europe and Asia, and the number of new US infections also appears to be on the decline, are we past the peak in the pandemic globally?**

**Dr. Marc Lipsitch:** It's very hard to predict what will happen globally from

here, but many places still have plenty of people that remain susceptible to the virus and control measures that are unlikely to stay in place for very long—or as intensely—if they haven't already been lifted, like they have been in much of the US. And if you have susceptible people and inadequate virus control measures, cases will go up. So, in many parts of the world, the virus still has a lot of room to run until we reach enough infections that herd immunity starts to slow virus spread.

**Allison Nathan: Can regional differences in virus containment be wholly attributed to differences in implementing control measures like social distancing and face mask wearing, or is the virus itself just running its course in some places faster than in others?**

**Dr. Marc Lipsitch:** One world leader asked me if what they had been told about viral spread was true—that viruses are like copier cartridges and just run out of ink at some point. Viruses don't just run out of ink. There's no natural limit on viral spread, other than immune people blocking chains of transmission—so-called herd immunity—or deliberate efforts—mandated or voluntary—to block chains of transmission.

Even though we haven't reached a level of infection high enough for immunity alone to block transmission chains, the evidence is clear that deliberate efforts like containment measures can effectively control it. Almost every part of Europe and East Asia that implemented intense control measures, including severe lockdowns, social distancing and face mask mandates, contact tracing and other measures, saw a roughly 10-fold decline in infection rates over about a two-month period. In contrast, parts of the US that began reopening earlier—amid much higher levels of daily case rates—have generally experienced a period of much worse virus spread.

**Allison Nathan: In the case of SARS, there was no herd immunity or a vaccine, but it did seemingly disappear. Why?**

**Dr. Marc Lipsitch:** SARS did not just disappear. Our group was one of the first to estimate the transmissibility of SARS, so I watched it carefully. It was beaten into submission by extremely intense public health measures and some good luck. For example, it did not take off in the United States, despite probably about two dozen introductions. It was also a different

virus that was easier to control in some ways, but especially because—unlike COVID-19—it did not have a wide spectrum of illness where people could be infectious, but you didn't know it; the sick people were the infectious people and the infectious people were the sick people, so you could easily identify and isolate cases. And there was a relatively long period of time between infections, which provided more time for public health measures to work. The public health response to SARS was also very quick—not quick enough to prevent it from reaching multiple countries, but every country swiftly and intensely dealt with the problem once they had it. One piece of evidence that SARS would not have just disappeared without very deliberate action was the fact that Canada had a second wave because a couple of cases in Toronto went undetected, even despite an almost perfect public health response. So SARS was only controlled, and eventually eradicated, with incredibly intense public health measures.

**Allison Nathan: What have we learned about the seasonality of the virus during the Northern Hemisphere summer, and why hasn't it seemed to help control the virus as much as some people had hoped?**

**Dr. Marc Lipsitch:** We've confirmed that warmer, wetter weather is not a magic bullet in virus control. But nobody serious in the scientific community thought warmer weather would be enough on its own to prevent transmission. Given so many other factors influencing the disease trajectory, it's hard to separate out a seasonal component to transmission. But evidence we and others have collected suggests seasonal factors likely reduced transmission by 10-20% in recent months, and will likely increase it by a similar amount in colder weather. So, we've likely been in a modestly better position this summer than we would have been if it had been winter, and we'll likely be in a modestly worse position in the winter having allowed case numbers to climb so high and then having to deal with a growth rate that's more resistant to our interventions.

**Allison Nathan: Is there any chance that herd immunity can help slow virus spread in the coming months?**

**Dr. Marc Lipsitch:** Some places may be starting to see a measurable impact from herd immunity. Sometimes people think herd immunity is binary—we've either reached it or we haven't, and if we haven't, there's no impact on the virus trajectory. But herd immunity is actually a continuous quantity. Initially, the small number of people that have been infected with the virus does nothing to slow its spread. But the more people that become infected, the more the growth rate of new infections will slow, until, ultimately, enough people have been infected that the herd immunity threshold—the point at which the growth rate of new infections becomes negative—is reached. Where that actual threshold sits is a big debate in the



epidemiological community, with estimates ranging from 20% to 60%, or more. I'm somewhere in the 40-80% camp, which is admittedly a big range. But, today, serological surveys show a single-digit or low double-digit share of various populations having been infected, so we're likely much less than halfway to where we need to be to achieve the herd immunity threshold that would by itself put the disease in decline.

But, again, herd immunity can contribute to reducing virus spread before we reach the threshold where it can do it alone. And, right now it appears that the US is getting some benefit from each of the three factors that are multipliers on the reproduction number—herd immunity, seasonality and control measures. But that benefit is still only enough in some places to slow the number of new cases, not push the trajectory into negative territory and get transmission under control. So the US isn't in a great place right now and I am quite worried that we will be in an even worse place a month from now as schools reopen in places with a still-high incidence of disease, potentially leading to multiple cases in schools that may cause further outbreaks.

**Allison Nathan: So, you don't think schools in the US should reopen?**

**Dr. Marc Lipsitch:** I think that places where the virus is reasonably controlled, meaning 10 cases or less per 100,000 people per day, should reopen primary schools on the grounds that primary schools seem to be much less prone to outbreaks, as we've encouragingly seen in places like Sweden, and children of that age seem to be considerably less susceptible and maybe less infectious than older kids and adults. But the argument for school reopening is not just about lower virus risk, for which the data is honestly not great, but about the value of schools, especially for the least advantaged kids in our society, who receive not just education, but food and often medical services through schools. And so it's really about balancing the known risk of much worse outcomes for these kids if they're not in school against the still unknown virus risk of school reopening. This tradeoff is a much tougher call for high school kids, who seem to be just as susceptible and infectious as adults, and tend to do better with remote education than younger children. So I come out on the side of reopening just primary schools in places where the virus is relatively controlled, and can think of no better reason to impose control measures—including full lockdowns—in places where it isn't, because keeping bars open is not a good tradeoff with keeping schools closed.

**Allison Nathan: Given all of the above, what will the virus trajectory most likely look like in the coming months?**

**Dr. Marc Lipsitch:** As I said, seasonality is likely to start to work against places where the weather is turning colder, and herd immunity could begin to play a bigger role in slowing virus spread as more people are infected, and could eventually be aided by a vaccine that induces an immune response. But epidemic forecasting is very difficult because the virus trajectory will likely depend to a large degree on our actions. One observation I've made in this pandemic is that, especially in the United States, local experience with the disease seems to be an important determinant of adherence to control measures. Populations that have suffered the horrors of a big

surge in cases tend to be more cautious, and those that haven't don't take control measures as seriously. I view this as a companion notion to herd immunity; it's not real herd immunity, but it has a similar effect in keeping the population diligent in virus control and slowing transmission.

So I am relatively optimistic that places like New York and Massachusetts that have already been hit hard by the virus and have devoted resources to reducing the pandemic numbers will have the resolve and the means, in terms of contact tracing, hospital surge capacity, etc.—as well as the likely benefit of slightly higher herd immunity—to control transmission going forward. But I am worried about much of the rest of the country that hasn't had a bad experience yet and isn't taking the pandemic as seriously, as well as many of the places with high case rates right now, because I'm not confident that they will be able to get them down.

Beyond the US, I am hopeful that many of the places that have national strategies and a coordinated approach to controlling the virus—like much of Europe and East Asia—will continue to experience fairly low amplitude cycles of more cases met with more control measures that will keep case numbers relatively low for the foreseeable future. This type of national strategy and commitment to keeping the virus under control is the fundamental missing ingredient that has kept countries like the US and Brazil—global leaders in the biomedical industry—from getting the virus under control versus other countries with far less resources but far more success in controlling the virus.

The complete abdication of responsibility by the US federal government has been a remarkable, tragic and heartbreaking failure of leadership, leading to ongoing deaths and economic damage that have largely been self-inflicted. People were horrified by initial estimates that the disease could kill 250k Americans, but now, at over 160k deaths in the US, reaching that number seems totally predictable—we are effectively rushing toward it. I'm not saying this isn't an incredibly challenging virus, but being one of the countries hardest hit by the virus and least reactive to it makes it harder still.

**Allison Nathan: The consensus view seems to be that the pandemic will be largely resolved next year with the help of a vaccine. Do you agree with that timing?**

**Dr. Marc Lipsitch:** That's a best case scenario, which is not implausible. But I do think it's going to be at least the middle of next year before we really have a sense of virus control, for a few reasons. First, as far as I am aware, none of the current vaccine candidates are being tested in children yet. That might be fine for the short run, but children comprise much of the population and clearly play some role in virus transmission. So before we can return to normal, children will have to be immunized, which will require testing vaccines for safety and efficacy in children. Then there's uncertainty about how good the vaccines will be, and, in particular, whether they will significantly contribute to herd immunity by reducing the chance of getting infected or transmitting the disease, or whether they will mainly work through reducing symptoms, which would help protect people, but not as much as if they contributed to herd immunity. All of that remains to be seen. So there's much to hope for, but a lot of things still have to go right for vaccines to be true game changers.

# Interview with Jan Hatzius

Jan Hatzius is Head of Global Investment Research and Chief Economist at Goldman Sachs. Below, he discusses where we are—and where we're headed—in the global economic recovery from the coronavirus.



**Allison Nathan: Where are we today in the global economic recovery from the coronacrisis?**

**Jan Hatzius:** We estimate that we've made up a bit over half of the 17% contraction in global GDP that occurred between mid-January and mid-April as manufacturing and construction have recovered strongly

in many places, and even consumer services—which have been slower to rebound due to the large amount of face-to-face interaction involved—have begun to show signs of life. In terms of the countries driving this recovery, we've seen some outperformers and underperformers with China, for example, basically completing what looks like a V-shaped recovery in output, and India and Brazil are only starting to recover. But, activity in the major advanced economies has been generally synchronized, with huge declines in activity in the second half of March and in April, and a meaningful recovery since.

**Allison Nathan: How do you expect the virus will evolve from here, and what does that imply for growth ahead?**

**Jan Hatzius:** We expect the virus to remain a constraint on economic activity until we have an effective vaccine that can be produced and distributed in sufficient numbers to limit infections and ultimately achieve herd immunity. Until then, we'll likely continue to see local and regional outbreaks that lead to renewed restrictions on high-risk activities like going to bars and dining indoors, and on other types of face-to-face interaction. In terms of numbers, we assume these outbreaks will occasionally push new daily cases to the hundreds or single-digit thousands—much like we're now seeing in Europe, Japan, and Australia—over the next six months or so. In the US, the average number of new cases a day has declined from the peak, and we expect daily new cases to fall significantly further in coming months on the back of changes in behavior, including an increased use of face masks and the avoidance of high-risk activities. Based on those trajectories, we forecast solid sequential growth ahead, with global growth of 6.5% in 2021, and the US, Euro area and China posting growth of 6.2%, 7.4% and 8.1% in 2021, respectively.

Although this magnitude and speed of growth rebound would be unprecedented in the history of economic recoveries over the last several decades, growth is coming from a very low base. So we only expect to return to pre-virus levels of GDP in 2H2021 or later, depending on the country. In the US and Germany, we assume we'll get there by mid-to-late 2021. But in some southern European countries, where the downturn was larger and fiscal resources more limited, we don't expect to return to pre-virus levels until 2022, and 2023 in the case of Spain, where we're currently seeing a sizable virus resurgence. All that said, these forecasts are moderately higher than consensus expectations given our view that it's probable we'll

see further normalization in manufacturing and construction—as well as parts of the consumer services sector—even in an environment in which the virus remains an issue.

**Allison Nathan: What gives you confidence in this normalization and your above-consensus view on growth?**

**Jan Hatzius:** We are reasonably confident in our above-consensus view on growth because relatively low-cost measures have been shown to materially lower infection rates, which should enable a significant portion of economic activity to continue to normalize. If we think about virus control, closing bars and banning potential super-spreading events certainly play a big role. But our work shows that enacting face mask mandates is also critical. We've found that such mandates have a sizable effect on face mask usage, raising the rate of actual usage by around 25pp on average. And if you take the US as an example, we estimate that such an increase in face mask usage can reduce the growth rate of confirmed infections by more than half. Based on the experience of various countries since the start of the pandemic, we calculate that achieving the same decline in infections through control measures would require broad lockdowns that could subtract as much as 5% from the level of GDP. So it's clear that requiring face masks—which have a low monetary and convenience cost—makes sense from a cost-benefit perspective.

Of course, face masks have become a politicized issue. But even without a national face mask mandate in the US, state and local level mandates are now mimicking a national mandate to a large degree, with the share of the US population under a face mask mandate rising sharply from 40% a few months ago to 80% now. And we're seeing large increases in mask usage in other parts of the world as well. So these types of low-cost interventions leave me somewhat optimistic that we should be able to manage this virus while resuming economic activity.

**Allison Nathan: If we were to see more of these types of interventions and best practices adopted globally, could growth outperform even our above-consensus forecasts?**

**Jan Hatzius:** It's possible that the rebound in less susceptible sectors of the economy, like manufacturing and construction, will run somewhat ahead of even the reasonably optimistic numbers that we've built into our forecasts. That's already happening in the US housing sector and in the purchasing managers' indexes and other business surveys globally, which have generally exceeded our expectations in recent months.

But, for the most part, the upside risks to our forecasts revolve around the development of a vaccine or more comprehensive medical solutions at an earlier date than we assume. That said, based on encouraging results on vaccine development so far, our baseline assumption on the vaccine front is relatively optimistic; we assume that the FDA will approve at least one vaccine this year and that large shares of the US and European populations will be vaccinated before late 2021. This is

consistent with professional forecasts, such as those from the Good Judgment Project, which now assign a 47% probability to the deployment of a vaccine before March 2021, and an 83% probability before September 2021—substantially higher than even a month ago. We just boosted our US GDP forecasts for 1H2021 by about 2pp on the back of this more optimistic vaccine assumption.

**Allison Nathan: What are the growth implications if we don't get a vaccine in 2021, or even beyond?**

**Jan Hatzius:** A delay in the availability of a vaccine would stretch out the timeline for recovery, especially in sectors like air travel, sports and entertainment, and tourism. It would also increase the risk of prolonged scarring effects, such as more permanent closures of businesses, particularly in these sectors, and more distress for workers who could not be easily redeployed. So a scenario in which vaccine availability is delayed by, say, a year relative to our forecasts would likely reduce global GDP growth by roughly 2pp next year, with bigger effects in the US—where the underlying virus situation is relatively bad and our baseline incorporates the earliest timeline for vaccination—and smaller effects in EM. That said, the more severe effects would likely be felt on the micro level as highly exposed sectors come under increased stress.

It's important to note, though, that a vaccine is not the only form of medical progress we could make. The medical community is constantly learning about ways to treat the virus, making therapeutics an important part of the virus response. Sufficient progress in treatment that lowers rates of fatalities and of serious illness closer to those of the seasonal flu would go a long way toward the normalization of economic activity, even without a vaccine. We're not there yet; COVID-19 is still far more dangerous than the flu. But it's no longer quite as dangerous as it was when the pandemic first began, and I expect further improvements in treatments over time.

**Allison Nathan: How much downside risk would a second major wave of infection pose to your forecasts? Could we see a new bottom in the level of activity?**

**Jan Hatzius:** If some of the recent declines in confirmed new cases in the US turn out to be fleeting, and we get into colder weather in the Northern Hemisphere—which is generally believed to be a bad thing for virus spread as people spend more time indoors—it's possible that we'll be forced to enact more aggressive lockdowns in the US and elsewhere, especially if low-cost interventions aren't really adopted or prove less effective than we expect. But I have a very hard time believing that a second round of lockdowns would be as aggressive as the first round, because we've learned so much about the virus and how to control it, especially in manufacturing and construction settings. So I see potential risk of a renewed, milder contraction for a quarter or two on virus setbacks. But I am pretty confident that April marked the low in the level of US and global GDP for the cycle, and view hitting a new bottom in GDP growth as an extreme tail risk.

**Allison Nathan: If the US continues to struggle on virus control relative to other countries, won't that weigh on the ability of the rest of the world to continue to recover?**

**Jan Hatzius:** Deterioration in US growth would hold global growth back to some degree, but not to a large extent, for two reasons. First, the sector that is most exposed to virus risk in the US is domestic consumer services, and the linkages from that to the rest of the world are not very significant. Second, a lag in the US economic recovery would likely cement the willingness of central banks, and especially the Federal Reserve, to provide large amounts of monetary support. Given the outsized importance of Fed policy and the US Dollar to the global financial system, this could actually generate positive spillovers that may be helpful for other countries. I won't go as far as to say that a scenario in which the US continues to struggle with virus control would be a net positive for the world, but it likely won't prevent other places that are doing a better job on virus control from continuing to recover.

**Allison Nathan: Are you concerned about an abrupt decline in growth in the near term if the US Congress and other governments don't extend virus-related fiscal support? What about over the medium term, should the appetite for further policy easing slow before the economy has a chance to fully recover from the crisis?**

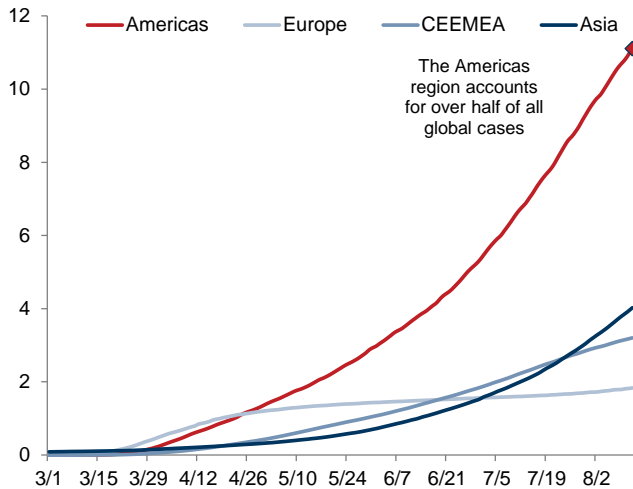
**Jan Hatzius:** I am somewhat concerned about fiscal policy because it is of course made by elected officials, and when policy interacts with electoral politics, there's always a risk of premature policy shifts. In the US, we still expect Congress to pass a deal that extends support for households enacted in response to the crisis, although risks around this expectation have clearly risen. Many countries outside of the US will also have to make decisions about extending wage subsidies, among other policies, but the near-term risk in the US is likely greater, because we're approaching a very pivotal election and the partisan gaps are so large today.

Longer-term, there is clearly some concern about the size of government deficits in most major economies. I'm not particularly worried about fiscal solvency, especially given the current low interest rate environment. But if the recovery takes longer than we expect, support for fiscal stimulus may fade. In the US, the election outcome is likely to have some bearing on the extent to which this happens. If Democrats sweep the elections as prediction markets currently expect, we'd likely see higher taxes but also a greater extension of fiscal support than in alternative election outcomes.

In both the short and medium term, I am less concerned about the monetary policy side because monetary policy is made by technocratic institutions. Monetary policymakers obviously get a lot of things wrong as we all do, but they tend to look closely at lessons from the past. And, today, they seem intent on not repeating the errors made in the aftermath of the Global Financial Crisis, when monetary stimulus was withdrawn prematurely, particularly in the Euro area. Monetary policymakers in most major central banks appear to have bought into the importance of continuing to provide support to cushion the economy for a prolonged period in the aftermath of a large shock, and we expect this lesson will continue to influence central bank actions, not only this year, but also in 2021, 2022, and beyond, if need be.

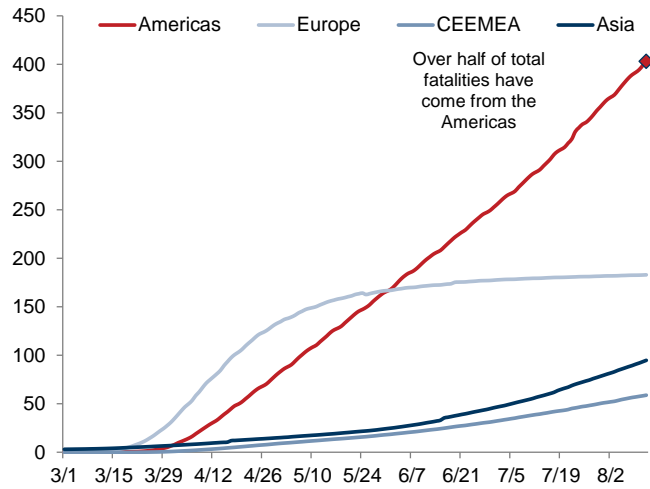
# Where are we today...

Over 20 million people have been infected worldwide...  
Total confirmed COVID-19 cases by region, millions



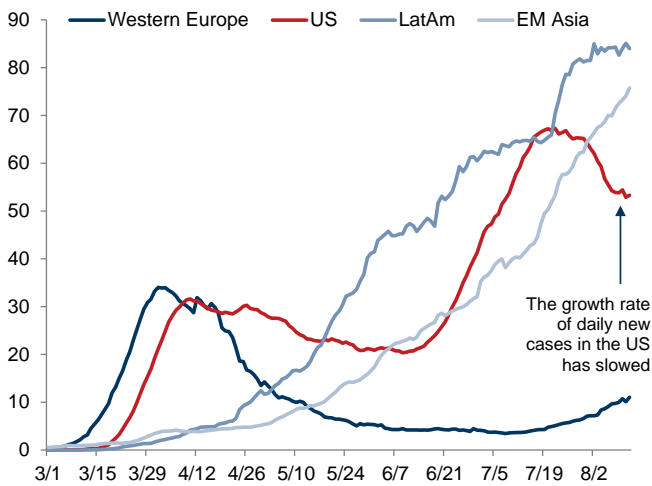
Source: JHU CSSE, Goldman Sachs Global Investment Research.

...and over 750k people have died of COVID-19  
Total fatalities by region, thousands



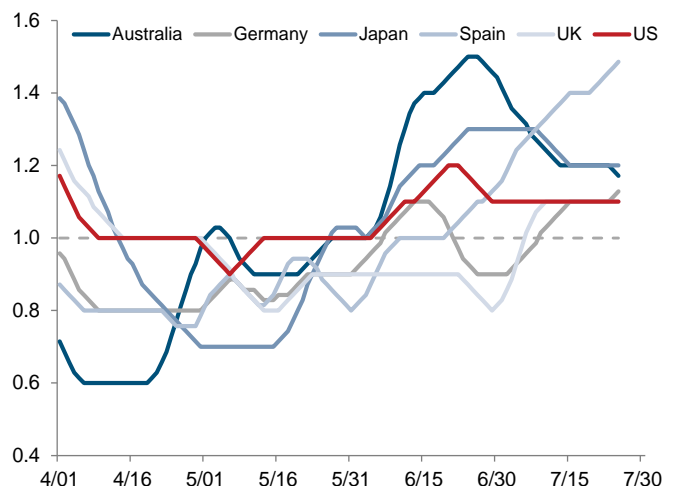
Source: JHU CSSE, Goldman Sachs Global Investment Research.

The US is showing improvement in rates of case growth...  
Daily change in confirmed cases, 7-day ma, thousands



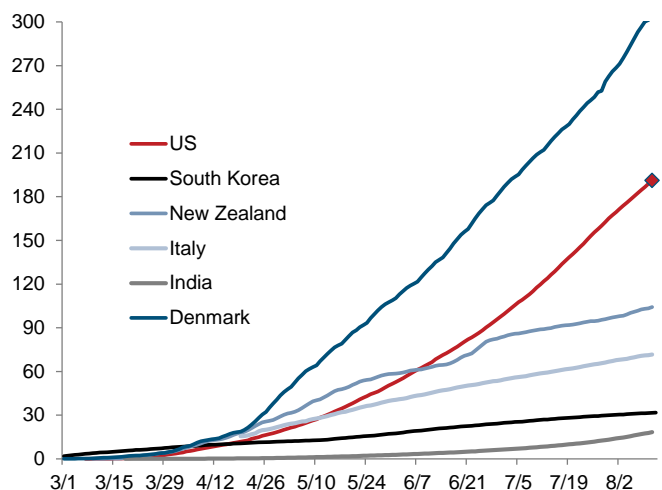
Source: JHU CSSE, Goldman Sachs Global Investment Research.

...and has a lower virus reproduction rate than other DMs  
Estimated effective reproductive number (Rt), 7-day ma, ratio



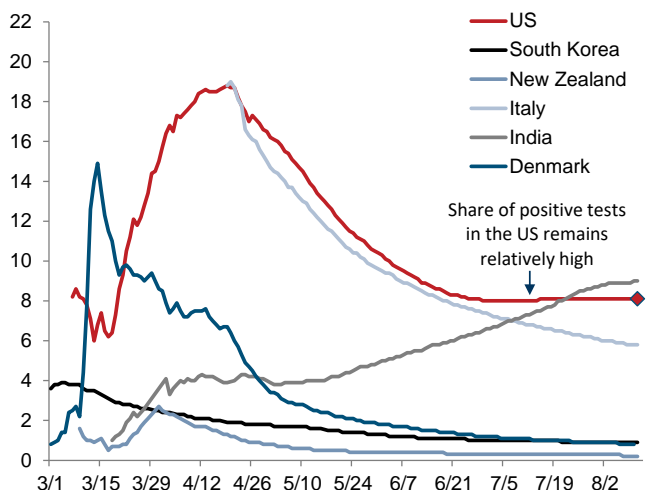
Source: EpiForecasts, Goldman Sachs Global Investment Research.

Testing penetration remains relatively low in many places...  
Total COVID-19 tests per 1,000 people by country



Note: Comparisons of testing data across countries are affected by differences in the way data are reported.  
Source: Official sources collated by Our World in Data, Goldman Sachs GIR.

...but rates of positive tests have fallen in some places  
Confirmed cases as a share of total number of people tested, %

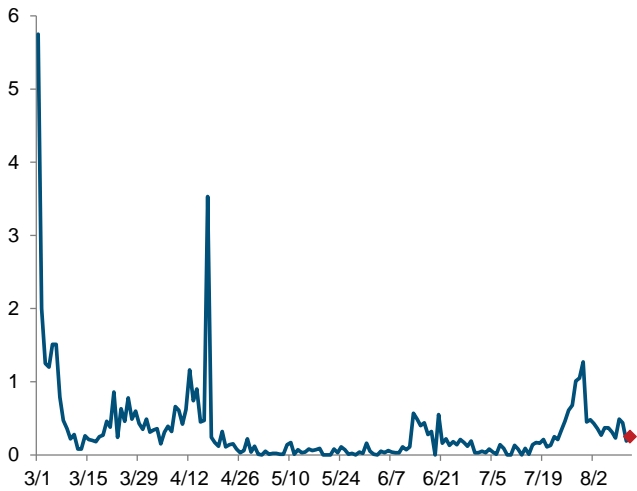


Note: Comparisons of testing data across countries are affected by differences in the way data are reported.  
Source: Official sources collated by Our World in Data, Goldman Sachs GIR.



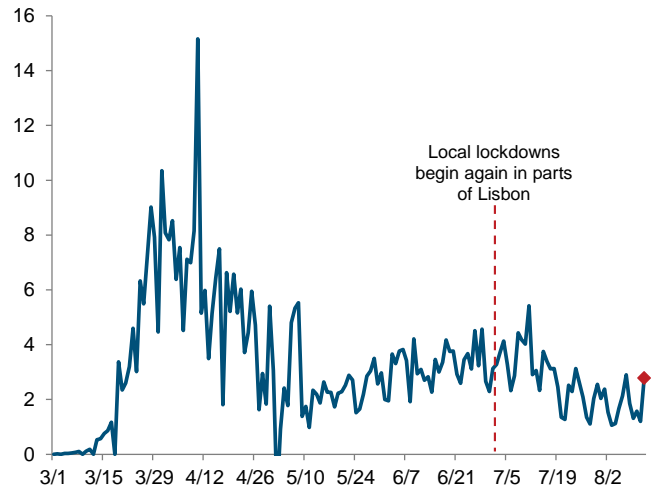
# ...in the global pandemic?

Mainland China has had success managing a second wave...  
Change in total confirmed cases, hundreds



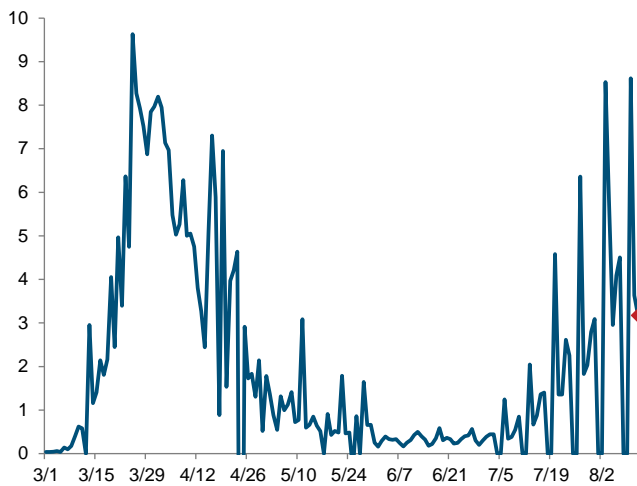
Source: JHU CSSE, Goldman Sachs Global Investment Research.

...as has Portugal by enacting local lockdowns  
Change in total confirmed cases, hundreds



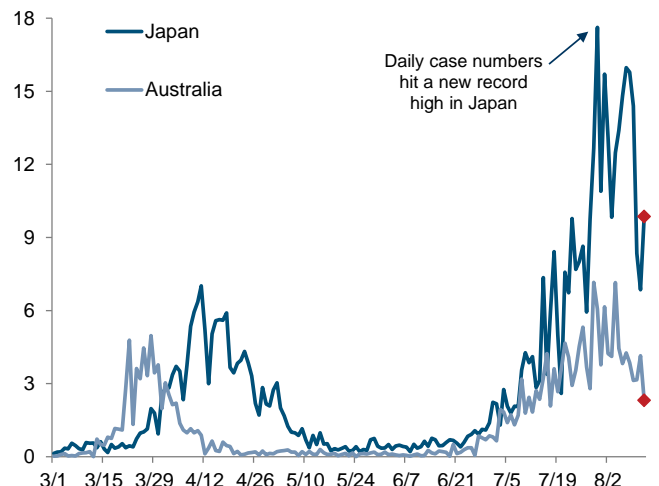
Source: JHU CSSE, Goldman Sachs Global Investment Research.

In Spain, a second wave of infections continues to grow...  
Change in total confirmed cases, thousands



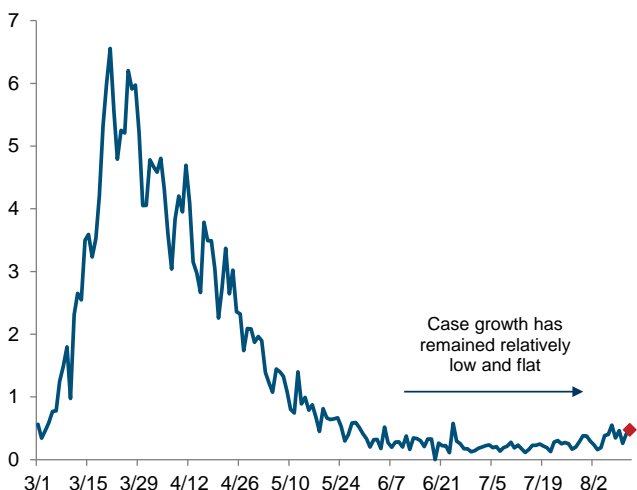
Source: JHU CSSE, Goldman Sachs Global Investment Research.

...and some parts of Asia-Pacific are also struggling  
Change in total confirmed cases, hundreds



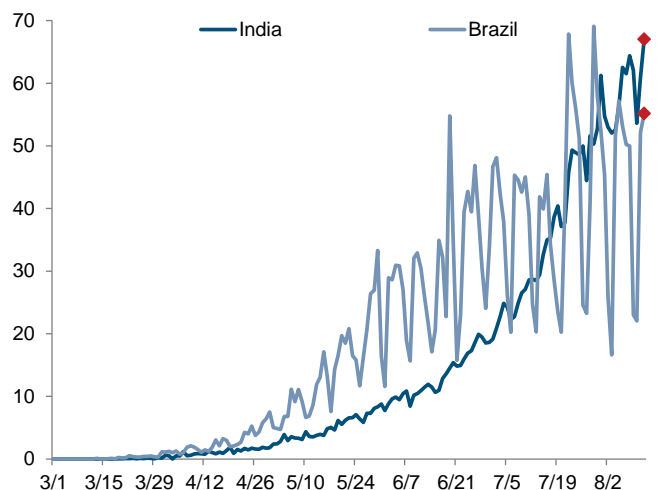
Source: JHU CSSE, Goldman Sachs Global Investment Research.

Italy has yet to experience a second wave of infections...  
Change in total confirmed cases, thousands



Source: JHU CSSE, Goldman Sachs Global Investment Research.

...while some EMs are still struggling with the first wave  
Change in total confirmed cases, thousands



Source: JHU CSSE, Goldman Sachs Global Investment Research.

# Interview with Dr. Richard Hatchett

Dr. Richard Hatchett is the CEO of the Coalition for Epidemic Preparedness Innovations (CEPI). Below, he discusses the outlook for a COVID-19 vaccine, concerns about safety and global distribution, and whether a vaccine breakthrough will be sufficient to achieve herd immunity.

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



**Allison Nathan: What is CEPI's involvement in the pursuit of a vaccine for COVID-19?**

**Dr. Richard Hatchett:** CEPI is a coalition of countries and philanthropic organizations, including the Gates Foundation and the Wellcome Trust, that was set up in 2017 to focus on vaccine development against

emerging infectious diseases. Before COVID-19, we were involved in the development of about 20 vaccines against high-priority emerging infectious diseases like Ebola, Lassa Fever and MERS—another coronavirus. And with COVID-19, we have funded a diversified portfolio of nine vaccine candidates. Seven of the nine COVID-19 vaccines are now in clinical trials, and an eighth vaccine will be entering clinical trials soon.

**Allison: When do you expect we'll have a safe COVID-19 vaccine that can be distributed at scale?**

**Dr. Richard Hatchett:** When we initiated our COVID-19 vaccine development program in late January 2020, we ambitiously set a target of 12 to 18 months for the availability of a vaccine at scale. Six months into the development effort, we're still on target for the first half of 2021. Data from preclinical animal trials and early stage human clinical trials have been encouraging. We've seen protection in animal challenge studies and an immune response in humans that is producing neutralizing antibodies to the disease. And eight vaccines globally are now in Phase III clinical trials only six months in—a truly unprecedented accomplishment, from which we're hoping to get some definitive results by the end of the year. That timing will depend on how quickly the tens of thousands of people required for these trials are enrolled, and how long it will take to accumulate enough cases in unvaccinated participants to demonstrate conclusively that the vaccine works. The prevalence of disease in many countries is unfortunate, but helpful in this regard, so we're hopeful that we're on track to have a vaccine available within the next year.

**Allison Nathan: Coronaviruses have been around for a long time, yet a vaccine has never been developed. Why is that?**

**Dr. Richard Hatchett:** It's true that we've never had a licensed human coronavirus vaccine. Some coronaviruses that are associated with the common cold are highly infectious but cause very mild illness, which doesn't necessarily warrant a vaccine. But the SARS virus that took hold in 2002 and the MERS virus that appeared in 2012 are two known coronaviruses that cause even more severe illness and higher mortality rates than COVID-19. As for why no vaccines for those ever reached licensure, in the case of SARS, the epidemic came and went over a matter of several months and when it disappeared, it was gone. Although vaccine efforts were initiated in this period, developers encountered

challenges with what is called an "immune enhanced disease" response, and, given that the disease was no longer a threat as they ran into these challenges, SARS vaccine development was halted. Vaccine development efforts were initiated more recently for MERS; in fact, as I mentioned, MERS was one of the first three diseases that we focused on at CEPI, not only because it is a scary disease with mortality rates in excess of 30%, but also because it was the second concerning coronavirus that we had encountered. But, unfortunately, we weren't that far into the development of a vaccine for MERS when COVID-19 emerged.

**Allison Nathan: Given that we've never successfully developed a coronavirus vaccine before, what are the chances that we fail to do so now?**

**Dr. Richard Hatchett:** There is always a risk that any vaccine development effort will fail. The risks of failure of a new vaccine that hasn't yet entered clinical trials is probably greater than 90%. On top of that, the biology of some diseases like HIV, tuberculosis, and malaria, presents significant challenges for vaccine development, either because the disease mutates or the targets don't neutralize the virus or the bacteria. But, at least at this point, COVID-19 doesn't seem to fall into this category. While I don't want to make any strong predictions about the prospect of mutation, the COVID-19 mutation rate so far seems to be low to moderate. And there is a very prominent protein on the surface of the virus called the spike protein that is important for binding the virus to its target cells, and is therefore an obvious vaccine target. Trials so far indicate that targeting the spike protein elicits an immune response, and the immune response produces neutralizing antibodies, which should prevent the virus from being able to infect. So, the science is encouraging in terms of our ability to develop a vaccine, even if any one vaccine candidate may fail.

**Allison Nathan: Are you concerned that nearly all of the vaccines in development target the same spike protein?**

**Dr. Richard Hatchett:** I'm not particularly concerned about that, because if such an approach fails to elicit a strong enough immune response, there are other approaches that may be able to induce one, such as targeting more antigens along with the spike protein or employing a live attenuated virus. So, if this first round of vaccine candidates fails, that doesn't mean we won't ultimately develop a successful vaccine. But it does make a strong case for maintaining investment in research and development for backup candidates that use diversified approaches to neutralize the virus. Even if an effective vaccine is developed in this first round, ongoing research may develop a better one. For example, the first polio vaccine to demonstrate effectiveness was the Salk vaccine, which was an inactivated vaccine that had to be injected. At the time, it was considered a godsend. But it proved not to be ideally suited for mass vaccination of populations and polio eradication. The Sabin vaccine, which was an oral vaccine that was easier to

administer and produced very effective immunity, came along several years later, and that became the vaccine that we've used for the last 60 years to control polio. So, the first vaccine may help us end the pandemic, but it may not be the longer-term solution that ultimately eradicates the COVID-19 virus.

**Allison Nathan: Even if we get a vaccine, how confident can we be in its safety given the speed of development?**

**Dr. Richard Hatchett:** Safety is absolutely critical, and developing a vaccine against COVID-19 at speed absolutely does not mean cutting corners with regards to safety. However, alongside absolutely stringent levels of safety it is crucial that confidence about vaccine safety remains high in the general population because any safety problem—real or perceived—could jeopardize the global immunization effort, which would be tragic.

We must also be mindful that any approved COVID-19 vaccine will likely be initially prioritized for populations at greatest risk, such as elderly populations or people with underlying medical conditions. These are essentially members of the population that are already at greater risk of death or severe illness regardless of the additional threat that COVID-19 poses. It is therefore critically important to monitor the vaccinated population to understand baseline rates of predictable health events, such as heart attacks and strokes, given their age and underlying health conditions, in order to avoid mistakenly attributing these events to vaccination. Case in point: the 1976 swine flu vaccination program was temporarily suspended prior to its termination because three elderly people vaccinated on one day died, although it was ultimately determined that those deaths were unrelated to the vaccine.

**Allison Nathan: Beyond safety, how confident can we be that a COVID-19 vaccine will provide protection against the disease since we're still learning about immunity to it?**

**Dr. Richard Hatchett:** The real answer is that only time will tell. We just haven't accumulated enough time or experience with the virus, and we are only beginning to get information about the nature of the antibody response, which may not even end up determining immunity. It may be the case that another type of immune response—a “cell-mediated” response—might be required instead of or in addition to an antibody response to achieve sustained immunity. And there's certainly a chance that COVID-19 will require booster immunizations in the event that the immune response doesn't prove to be durable for more than a year, or a handful of years. But all of this remains to be determined and is going to require continued research, monitoring and clinical trials.

**Allison Nathan: Even if an approved vaccine is available next year, will we be able to achieve full herd immunity?**

**Dr. Richard Hatchett:** We don't expect to have enough vaccine supply to achieve global herd immunity in 2021, meaning that enough people become resistant to the disease through vaccination that the disease is pushed into decline. But we think we could have enough vaccine next year to protect healthcare workers and the populations at greatest risk globally,

which we estimate to be 20% of the global population, requiring two billion doses. So the near-term aim is to take the sting out of the pandemic by reducing death rates and severe disease and by protecting healthcare systems, which should put the world on the road to restoring normal economic activity.

That said, this will likely only happen with coordinated action. One of the lessons of recent history is that leaving the allocation of a vaccine to general market mechanisms during a pandemic will result in misallocation of supply because some countries will over-buy vaccine supply to ensure their population is protected. These actions will indeed protect their populations, but won't end the global pandemic given the resulting scarcity of the vaccine for the rest of the world. We saw this type of behavior during the 2009 H1N1 influenza pandemic, in which over a dozen countries cornered the supply of influenza vaccine globally. To avoid a repeat of this scenario, CEPI and our partners [Gavi, the Vaccine Alliance](#) and the World Health Organization (WHO) have joined together in an entity called [COVAX](#) that pools risks through a diversified portfolio of vaccine candidates, actively manages that portfolio, and then oversees vaccine distribution on an equitable basis that will most efficiently help bring the global pandemic under control. Through these efforts, we hope to end the acute phase of the pandemic by the end of 2021. That said, we've already seen the US and some EU countries that have formed a buyers group enter into bilateral agreements with companies to procure vaccines for their populations. But, while those efforts are concerning, I don't think that they will keep COVAX from functioning effectively and efficiently.

Longer term, vaccine supply should be less of a constraint on achieving global herd immunity as vaccine production continues to ramp up. And the question will become one of demand. Many epidemiologists think that 60-80% of the population needs to be immune to achieve herd immunity. To hit that target through vaccination, most individuals in the community will need to be vaccinated. But we just don't know what the uptake of the vaccine will be, and it will likely differ between communities, populations, and demographic groups. The reality is that we don't know if there will be enough demand for the vaccine to achieve global herd immunity through vaccination.

**Allison Nathan: Given all of the above, is it fair to say that even if we do get an approved vaccine on your accelerated timeline, it won't be a magic bullet?**

**Dr. Richard Hatchett:** That's absolutely true. There's a lot we don't know about the vaccines. There's a lot we don't know about COVID-19. Almost every week we're learning something new about the disease; a few months ago, we observed an inflammatory syndrome in children. Now we're learning that children are probably infected at higher rates than we originally appreciated, just with very mild disease. There will be a period of several years in which we continue to learn about the disease, the vaccines, and the immune response. And it will also take time and cooperation to produce and distribute any successful vaccine, which some people could ultimately decide not to take. So even if our vaccine timelines are achieved, global herd immunity may still be a long way off.

# An optimistic vaccine (and growth) outlook

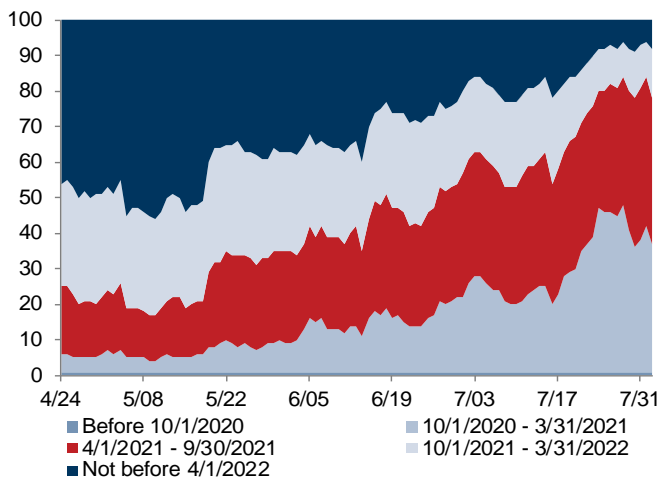
Daan Struyven\* argues that vaccine developments are on track to see much of the US and European populations vaccinated next year, reinforcing our positive growth outlook

\*The author thanks Dan Milo and Sid Bhushan for their contributions, and Salveen Richter and team for their inputs

Global confirmed case growth continues to rise, the virus is flaring up in many countries, and the recovery is stalling in virus hotspots. A sustained strong recovery will therefore likely remain challenging until the virus is controlled. Fortunately, the vaccine news has improved significantly. The “superforecasters” in the Good Judgment project now see a 47% probability that 25 million doses of an FDA-approved vaccine will be available by March 2021, and an 83% probability by September 2021. Two months ago, these numbers stood at 9% and 35%, respectively. Consistent with the improved vaccine outlook, our economic forecasts assume widespread distribution of a vaccine in the US and Europe over the next 2-3 quarters that we expect to lead to a sustained boost to growth next year.

## Vaccine news has improved significantly

Share of superforecasters who believe enough doses of FDA-approved COVID-19 vaccine(s) to inoculate 25mn will be distributed in the US, %



Source: Good Judgment Project, Goldman Sachs Global Investment Research.

### The facts

To assess the vaccine outlook, we first summarize key facts on development, approval, production, and demand.

#### Development

Researchers are developing [167 vaccines](#) against the coronavirus. Among the 31 candidates in clinical trials, 11 vaccines have reached Phase II of expanded safety trials, and 8 vaccines are in the final Phase III of large-scale effectiveness tests. For context, it took hepatitis B—the disease with the largest number of attempts—decades to reach the number of developments COVID-19 has sparked in a few quarters.

The nine leading vaccine candidates currently fall into two

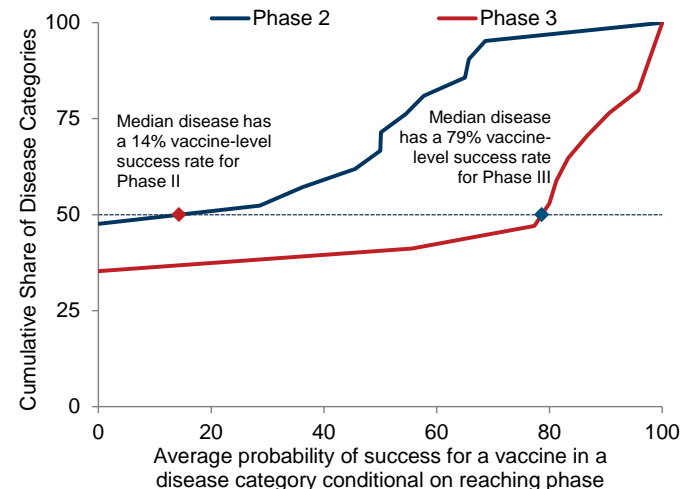
groups (see pg. 15).<sup>1</sup> The first group—Pfizer/BioNTech, AstraZeneca/Oxford, Moderna, SinoVac, Sinopharm, and CanSino—has completed Phase II trials, with mostly positive results. All six showed strong antibody responses, which were sometimes weaker among elderly and individuals already exposed to the adenovirus. The responses of T-cells, which can provide long-lasting immunity, varied between strong, mixed, and unreported. Eight vaccines are now working on Phase III trials on large international samples and target end dates in Q4 2020. CanSino is planning to start Phase III soon but has already obtained approval for use in the Chinese military.<sup>2</sup> The second group consists of Johnson & Johnson, Sanofi/GSK and NovaVax. All three have raised large amounts of funding, but have presented fewer results than the first group. Looking across both groups, the US is leading funding of all six non-Chinese vaccines, with Europe and Japan somewhat behind.

#### Approval

While highly uncertain, our baseline expectation is that a large number of vaccines eventually gain approval, with at least one FDA approval in 2020. The history of vaccine trials points to numerous future approvals, with a large number of industry-sponsored vaccine attempts typically [going](#) hand in hand with many approvals. This historical relationship would suggest an eventual approval of 43 vaccines. Furthermore, the historic approval odds of a given Phase III vaccine targeting the median disease is 79%. The fact that eight developers are currently running Phase III trials therefore reinforces our confidence in securing an approved vaccine this fall, as does increased regulatory transparency, flexibility, and speed. The FDA, for instance, has released specific safety and effectiveness standards, is working directly with developers and analyzing interim results, and can provide Emergency Use Authorization as soon as studies have demonstrated safety and effectiveness.

#### Historic approval odds of a Phase III vaccine are high

Cumulative distribution of vaccine success rates, %



Source: Lo et al. 2020, Goldman Sachs Global Investment Research.

However, the history of trials and the fact that all major vaccines currently target the same spike protein also suggest

<sup>1</sup> We identify leaders based on trial progress, funding and purchase agreements, and analysis from our health care equity analysts.

<sup>2</sup> The Russian Ministry of Health has approved a vaccine from the Gamaleya institute before a Phase III trial has started and has announced that mass production of the vaccine is likely to begin in



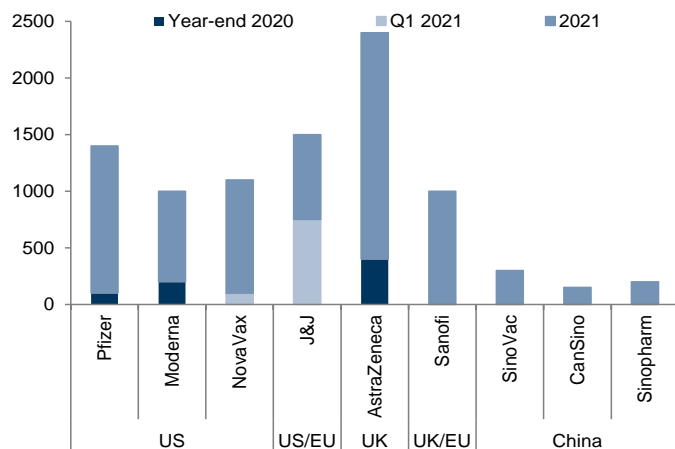
that vaccine approvals are likely correlated, with either many succeeding or all failing, as was the case for HIV. And, an early approval does not imply full effectiveness or long-run protection. On effectiveness, the FDA only requires the vaccine to reduce infections by 50%. Effectiveness for the elderly also remains uncertain, with weaker antibody responses to the CanSino vaccine and no elderly testing in most other vaccine trials so far. On the length of protection, [little reinfection](#) so far and the potential for T-cells to provide long-lasting immunity are encouraging, but a recent Nature [study](#) found that antibody levels started to decline after 2-3 months.<sup>3</sup> Finally, approval could be overturned subsequently, as happened with the yellow fever and rotavirus vaccines that were pulled from the market after rare severe side effects.

**Production and distribution**

US and European developers are projecting large production amounts already this year and especially next year, with around 1 billion doses per vaccine in 2021. The US and the UK are leading advance purchases, while the EU and Japan are currently in talks with several producers. If most of the leading vaccines succeed and achieve their production and purchase targets, the US and the UK will likely have a surplus, and the EU and Japan will likely also have substantial supply, but probably later than the US or the UK.

**US and UK firms project large production capacities**

Potential produced doses by top vaccine, millions

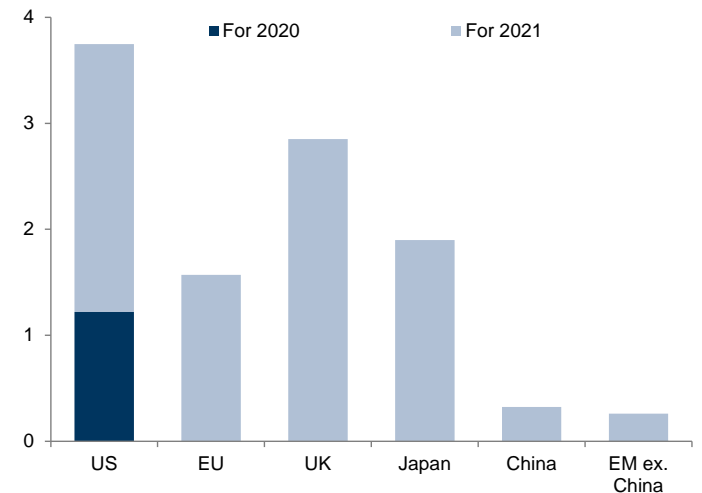


Source: Goldman Sachs Global Investment Research.

The outlook is even more uncertain in EMs, but likely less positive, on net. On the positive side, China, Russia, and India have vaccines that show signs of progress, with CanSino in particular already producing and vaccinating Chinese military members. On the negative side, many other EMs do not appear to have their own pipeline. Some DM health officials have also [questioned](#) some EM approval processes, and the available EM advance purchases are much smaller, especially on a per capita basis, despite an AstraZeneca commitment of 1bn doses to low and middle income countries and support from the COVAX and CEPI groups. Overall, several EM populations may lack sufficient supply in 2021.<sup>4</sup>

**The US and UK are leading advance purchases**

Purchased potential doses by region for top vaccines, doses per person



Note: Top vaccines refer to Pfizer/BioNTech, Moderna, AstraZeneca, SinoVac, CanSino, J&J, NovaVac, Sinopharm, Sanofi; EU includes the 300mn doses Sanofi deal which is still in advanced talks; China includes all production from CanSino and SinoPharm as purchased.

Source: Goldman Sachs Global Investment Research.

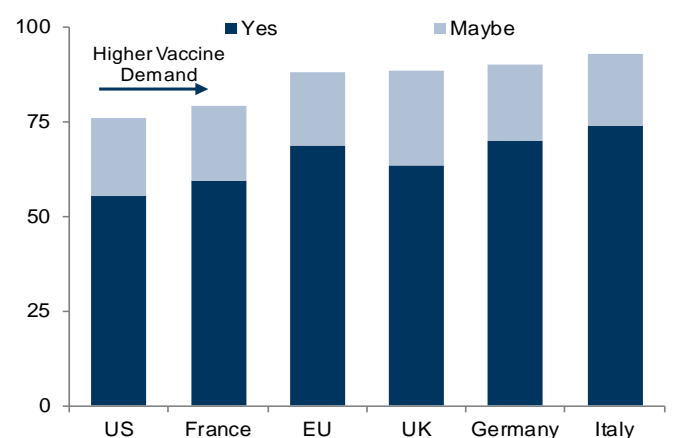
While the production projections for DMs look strong, experts have voiced concerns about supply chain shortages. Key challenges include the availability of glass vials, syringes, and specialized storage and transportation equipment. Still, the [US](#) was able to deliver 174.5mn doses of the flu vaccine last season with a peak rate of 33mn doses in a week, and governments are investing in vial and syringe manufacturing capacity.

**Demand**

Consumer surveys suggest that demand for vaccines is roughly in line with standard estimates of herd immunity in the US and across Europe. Survey data on general attitudes towards

**Large share of population in DMs is willing to get a vaccine**

Self-reported share willing to take a COVID-19 vaccine, % of population



Note: US, France, and UK average surveys from multiple sources and EU is a pop-weighted average of Germany, Denmark, Netherlands, France, Portugal, and Italy.

Source: YouGov, ORB International, NIH, Centre for Countering Digital Hate, AP-NORC, Washington Post, OECD, Wellcome Global Monitor, Goldman Sachs GIR.

<sup>3</sup> While vaccine and natural infection immunity length correlate in [measles](#), the relationship is unclear for COVID-19. Mutation may also require a new vaccine each year like for the flu, but COVID-19 has mutated more slowly than other viruses so far, and Pfizer/BioNTech has neutralized [17 disease variants](#).

<sup>4</sup> It is plausible that a non-negligible fraction of the population in many EMs such as Brazil may already have been infected by early next year and would therefore not need a vaccine. Additionally, the much lower hospitalization and fatality rates among young individuals and their larger population share may also help EM policymakers to manage scarcity by targeting the elderly.

vaccines and actual flu and child vaccination rates suggest strong vaccine demand in China, Japan, and the UK compared to South Africa, France, Russia, Brazil or the US. Overall, these data and upcoming public campaigns suggest that demand will likely be sufficient to eventually control the virus, assuming a vaccine is perceived as safe, effective, and widely available.

**2021 growth booster**

Based on these data on development, approval, production, and demand, we assume that sufficiently large shares of the US and European populations will receive a vaccine by the end of Q2 2021 and Q3 2021, respectively, with the EM vaccine outlook more uncertain. The risks around this vaccine baseline, however, are clearly skewed to the downside, with conflicting expert views on the odds of a 2020 approval.

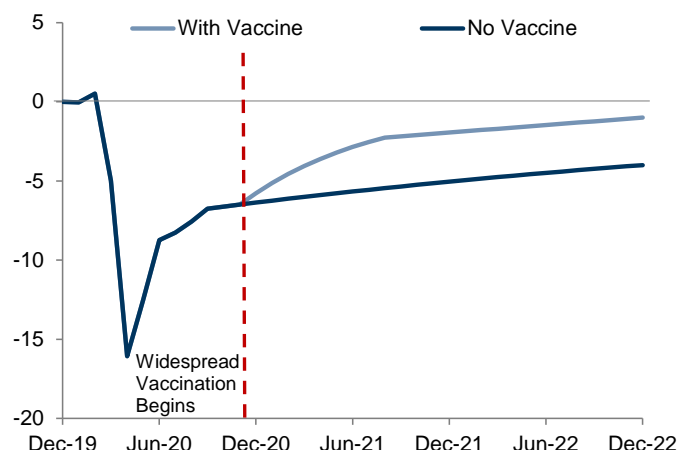
So how would a potential vaccine impact growth? We assess this by splitting output into activities with high COVID-19 risk (e.g. travel, restaurants) and low risk, and assuming that the risky sector only partly recovers without a vaccine, with scarring effects from bankruptcies and layoffs leaving overall output below the pre-virus trend<sup>5</sup> In contrast, we assume that a

vaccine accelerates the recovery in the (previously) risky sector and halts permanent damage to output earlier at a lower level<sup>6</sup>

The upshot is that the significant vaccine distribution in the next 2-3 quarters that we assume would likely lead to a sustained boost to growth next year, which supports our above-consensus forecasts for US, Euro Area and global GDP growth in 2021, despite challenging virus control and the recent slowdown in high-frequency activity data.

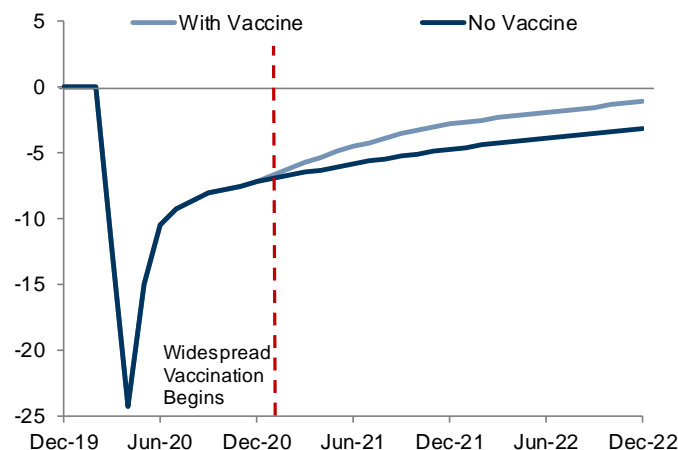
Three additional points to note: First, a vaccine will likely boost activity in the US more than in Europe and especially China because the US is assumed to continue to lead the vaccine race and because virus spread will likely remain high without a vaccine in the US, compared to Europe and particularly China. Second, a vaccine will likely have a smaller impact if it becomes available later because scarring effects, which a vaccine cannot undo, grow over time. Additionally, gradually improving virus control even without a vaccine—reflecting better testing, treatments, or herd immunity—would likely also support activity, leaving less room for a vaccine boost. Finally, another important benefit of a vaccine is that it greatly reduces the probability of a range of very bad tail scenarios that are much worse than our baseline outlook.

**The US to get a significant growth boost from a vaccine**  
US real GDP level relative to pre-COVID trend, % relative to trend



Source: Goldman Sachs Global Investment Research.

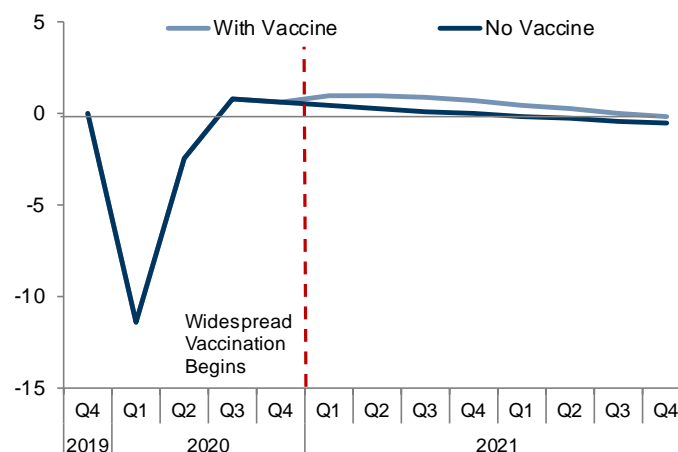
**The Euro area to get a smaller growth boost than the US**  
EA real GDP level relative to pre-COVID trend, % relative to trend



Note: Euro area includes Germany, France, Spain, and Italy.

Source: Goldman Sachs Global Investment Research.

**China to get an even smaller growth boost from a vaccine**  
China real GDP level relative to pre-COVID trend, % relative to trend



Source: Goldman Sachs Global Investment Research.

**Daan Struyven, Senior Global Economist**

Email: [daan.struyven@gs.com](mailto:daan.struyven@gs.com)  
Tel: 212 357-4172

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<sup>5</sup> Our Europe and China country team forecasts implicitly assume a smoothed probability of vaccine approval and distribution from Q4 2020 onwards. Therefore, we use country team forecasts until the end of Q3 2020, and then apply our vaccine-related assumptions thereafter.

<sup>6</sup> We estimate permanent damage under no vaccine for the US of -4% by putting the virus recession in the context of results from Haltmaier, Summers and Fatas, and Yagan. In the Euro Area, we estimate a lower permanent hit under no vaccine due to better virus control of around -3%. For China, we estimate a permanent hit of only ½% as output is expected to exceed the pre-virus trend in Q3 2020.

# Leading COVID-19 vaccine candidates

Company (Country)	Government/NGO Funding/Contracts	Phase I/II	Phase III
<b>Sinovac</b> (China)	<b>China:</b> Contributed part of \$140mn	<b>Side Effects:</b> No severe <b>Antibodies:</b> Strong response <b>T-cells:</b> Unknown	<b>Start:</b> July <b>Target End:</b> October 2021 <b>Sample:</b> 9,000 healthcare workers in Brazil
<b>Sinopharm</b> (China)	<b>China</b> state-owned	<b>Side Effects:</b> No severe <b>Antibodies:</b> Strong response <b>T-cells:</b> Unknown	<b>Start:</b> July 15 <b>Target End:</b> N/A <b>Sample:</b> 15,000 in Abu Dhabi
<b>Pfizer</b> (US) <b>BioNTech</b> (Germany)	<b>US:</b> \$1.95bn <b>Germany:</b> Access to €750mn fund <b>UK:</b> 30mn dose order (price undisclosed) <b>Japan:</b> 120mn dose order (price undisclosed) In talks with <b>EU</b> and members states	<b>Side Effects:</b> No severe <b>Antibodies:</b> Strong response <b>T-cells:</b> Strong	<b>Start:</b> July 27 <b>Target End:</b> As early as October <b>Sample:</b> 30,000 in US, Argentina, Brazil and Germany
<b>AstraZeneca</b> (UK)	<b>US:</b> \$1.2bn <b>CEPI and Gavi Coalitions:</b> \$750mn <b>UK:</b> £65.5mn <b>Brazil:</b> \$127mn <b>Germany, France, Italy and the Netherlands:</b> €750mn <b>Serum Institute of India:</b> 1bn dose order (price undisclosed) <b>Japan:</b> In talks	<b>Side Effects:</b> No severe <b>Antibodies:</b> Strong response with 2 doses, but weaker for people already exposed to the adenovirus <b>T-cells:</b> Strong helper T-cell response but lacking killer T-cells*	<b>Start:</b> July <b>Target End:</b> 2H20 <b>Sample:</b> 50,000 in Brazil, UK, US, and South Africa
<b>Moderna</b> (US)	<b>US:</b> \$959mn	<b>Side Effects:</b> Some severe symptoms at high dosages <b>Antibodies:</b> Strong response <b>T-cells:</b> Strong helper T-cell response but weak killer T-cell response*	<b>Start:</b> July 27 <b>Target End:</b> December <b>Sample:</b> 30,000 in US
<b>CanSino</b> (China)	N/A	<b>Side Effects:</b> No severe <b>Antibodies:</b> Strong response, but weaker in elderly and those already exposed to the adenovirus <b>T-cells:</b> Strong in all ages	<b>Start:</b> Soon, in talks <b>Target End:</b> N/A <b>Sample:</b> 40,000 in Russia, Brazil, Chile and Saudi Arabia
<b>Johnson &amp; Johnson</b> (US)	<b>US:</b> >\$1bn In talks for supply contracts with <b>EU, Japan,</b> and <b>Bill &amp; Melinda Gates Foundation</b>	Started on July 29 with a sample of 1,000 in the US and Belgium after positive results on animals; plans for Phase I/II trials in Japan, Netherlands, Spain and Germany	<b>Start:</b> September <b>Target End:</b> N/A <b>Sample:</b> 30,000 in US
<b>Novavax</b> (US)	<b>US:</b> \$1.66bn CEPI Coalition: \$388mn	Clinical results on antibody and T-cell levels from a sample of 131 expected soon	<b>Start:</b> Fall 2020 <b>Target End:</b> N/A <b>Sample:</b> 30,000
<b>Sanofi</b> (France) <b>GSK</b> (UK)	<b>US:</b> \$2.44bn <b>UK:</b> £500mn Advanced talks for 300mn dose deal with the <b>EU</b>	Expected to start in September	<b>Start:</b> End of 2020 <b>Target End:</b> N/A <b>Sample:</b> N/A

\*Helper T-cells assist in the production of antibodies while killer T-cells directly attack the virus.

Source: Reuters, Science Translational Medicine, Goldman Sachs Global Investment Research.

# Pricing virus scenarios

Dominic Wilson argues that US equity options may still be underpricing an early vaccine, but increased vaccine optimism also raises market vulnerability to vaccine disappointments

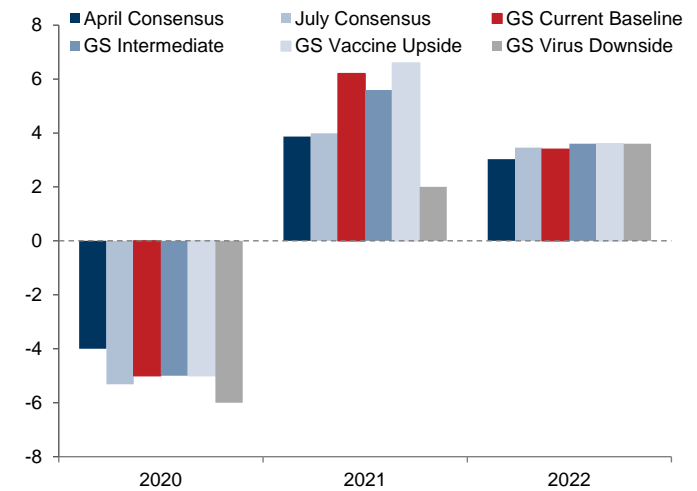
The balancing act between ongoing downside health risks and the possibility of COVID-19 treatment options remains at the heart of many market decisions. One of the challenges is trying to think about what the market is (and should be) pricing under different assumptions about the health outcomes. We have been using stylized economic scenarios for an “intermediate”, “upside” and “downside” virus scenario to estimate where the S&P 500 would be if the market moved to the growth expectation associated with each scenario and to then back out the probabilities of each scenario that would be consistent with the market level.

The most striking recent shift is a significant increase in the probabilities of an early vaccine, and, in turn, the “upside” scenario. As a result, our simple exercise implies that current market levels are now consistent with this being the most likely case. In fact, our US economists recently upgraded their growth forecasts to incorporate an early vaccine as the baseline. Even with the equity market at new highs, options on US equities—and on more cyclical sectors and indices in particular—still look like they are underpricing the risk of an early vaccine. Our estimate of the probability being placed on the downside risk case, however, has fallen sharply, though it is not yet back to the June lows. This means that the market is also more vulnerable to any “second wave” risks of vaccine disappointments.

## Growth views still more optimistic than consensus

We consider three US economic scenarios, corresponding to an “upside”, “intermediate” and “downside” scenario (defined by our US economists a couple of months ago) compared to the July consensus forecasts. The “upside” scenario is one in which a vaccine discovery comes on the early side (by the end of Q1 2021). This allows for a faster pace of recovery in areas of spending that require more face-to-face contact than our baseline assumes and as a result, for a more rapid pace of GDP growth in 2021 in particular. The “downside” scenario is one in which “second wave” virus concerns lead to a renewed and significant retrenchment in consumer spending, pushing growth down in late 2020 and leading to a much slower recovery in 2021. The “intermediate” case is a weighted average across a range of possible vaccine scenarios (including the possibility of no vaccine in 2021). These three scenarios are obviously stylized (the true distribution is more varied), but we have found them to be helpful approximations of the main potential outcomes.

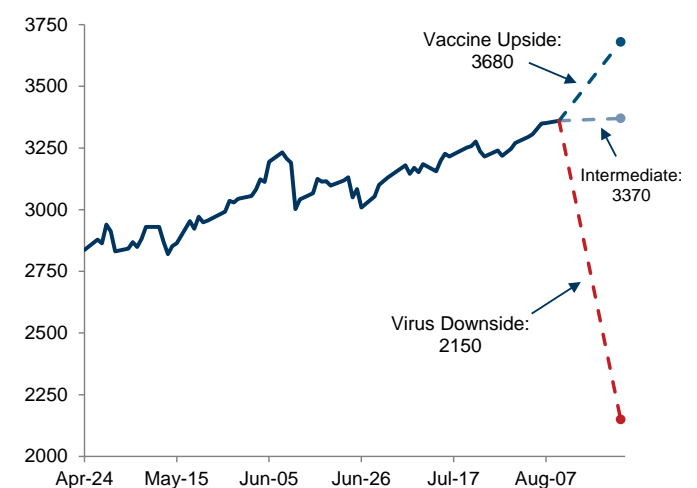
Our 2021 growth views are well above consensus  
US GDP growth, %



Source: Consensus Economics, Goldman Sachs Global Investment Research.

We showed in previous work that changes in our US growth factor could be explained in part by consensus forecast revisions over the following two years. We can use this linkage, in combination with other previous work that estimates S&P 500 sensitivity to our US growth factor, to translate our three scenarios into rough estimates of the levels of the S&P 500 that we think would be consistent with each outcome, assuming that the market consensus moves to GS growth expectations in each scenario. From this exercise, we get predicted S&P 500 values of roughly 3370 for our “intermediate” scenario, 3680 for our vaccine “upside” scenario, and 2150 for our virus “downside” scenario.

The S&P 500 could rise further in the case of an early vaccine  
S&P 500 index, level



Source: Goldman Sachs Global Investment Research.

## Rising vaccine probabilities an upside “drag”

We can then use these estimates of the outcome for each scenario to back out the implied probabilities that are “consistent” with market pricing at different points in time. To do that, we assume that at any given time the current level of the S&P 500 index is a weighted average of these three predicted S&P 500 index levels, weighted by the probability that the markets are placing on each. We also assume that

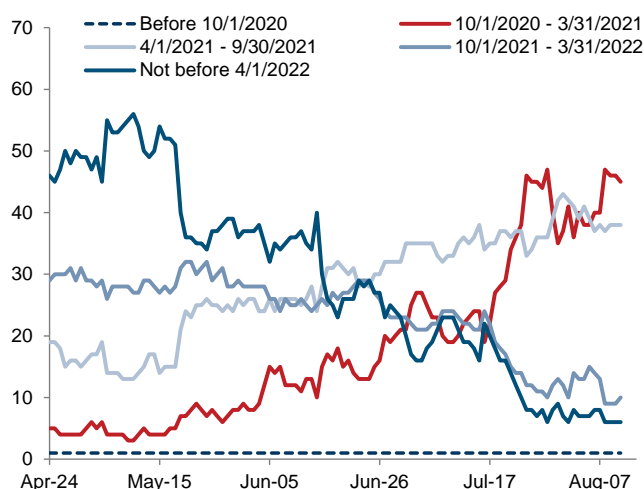


these scenarios are the only scenarios (that is, that their probabilities sum to one). Because we collapse the distribution of actual outcomes into three generic scenarios, we are clearly simplifying a much more complex set of possibilities, but we think that this simplification is a helpful one.

We use outside estimates of the probability of an early vaccine. The “superforecasters” at the Good Judgment Project have been producing a set of daily updated forecasts for the probabilities of vaccine delivery at various points in time. Their series allows us to track an independent assessment of the likelihood of a vaccine being delivered by the end of Q1 2021, which is consistent with our own upside scenario. That probability has risen sharply over the last month or so. The probability of our upside case from the “superforecasters” stood at less than 10% in early June and hovered around 15% for much of that month, but climbed rapidly in July. Its current value of just below 50% implies that the likelihood of an earlier vaccine delivery has risen significantly, in line with positive news on vaccine development.

### The likelihood of an earlier vaccine has risen significantly

Share of superforecasters who believe enough doses of FDA-approved COVID-19 vaccine(s) to inoculate 25mn will be distributed in the US, %

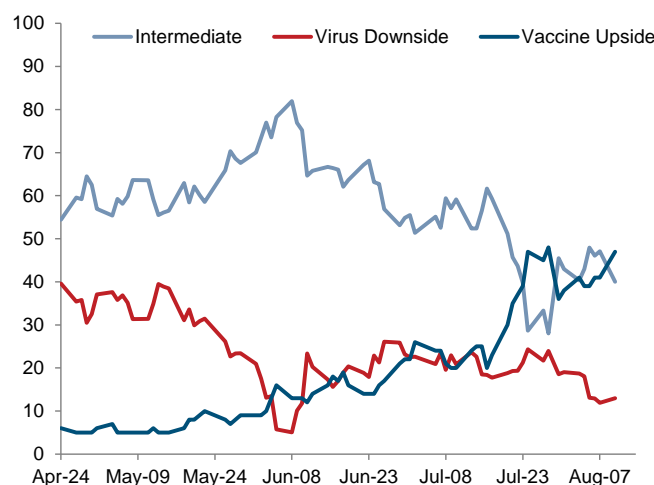


Source: Good Judgment Project, Goldman Sachs Global Investment Research.

Using this probability series and our estimates of the S&P 500 level consistent with each scenario, we can then generate probabilities of each scenario implied by the current index level. Given the rise in vaccine probabilities, the probability of the “upside” scenario has risen in the recent period and is now the most likely one. On the other side of the distribution, the implied probability of the downside case fell steadily in May and early June and then turned sharply higher after the first week of June as US case growth reaccelerated. The virus downside risk probability peaked in late June, as some of the affected areas began to take more deliberate action to contain the spread of the virus. Over the last two weeks, it has fallen much more clearly again. While the downside probability is not back to the January lows, current market levels again look consistent with a relatively low probability of that downside case. The “intermediate” case has drifted lower and ceded its place as the dominant scenario.

### Markets are pricing an early vaccine as the most likely scenario

Probabilities of various virus scenarios implied by S&P index level, %



Source: Goldman Sachs Global Investment Research.

### Market may be underpricing the tails, particularly the upside

We would not lean too hard on the precision of these estimates. Beyond the uncertainties over our own scenarios and the mapping of these scenarios into equity values, these estimates do not take into account other shifts that may impact the index over time, including shifts in the real rate structure or any influence from the upcoming US election, both of which may be important drivers. It is also possible that the “superforecaster” predictions are too optimistic about the vaccine outlook or underestimate the obstacles to production and distribution.

Despite its simplicity, however, we think this framework points to several potential conclusions. First, it is becoming even more important to follow the vaccine news, which is starting to have a much more meaningful impact on the distribution of outcomes. Our US economics team recently shifted to an early vaccine case as their new base case and upgraded their 2021 growth forecast. This shift is consistent with the shift in probabilities that now sees the upside case as the most likely scenario. Second, even with new highs in the equity market, we think the upside vaccine case is still underpriced in options markets. But we also think that as market levels become consistent with low weights on the downside case, the market is also becoming more vulnerable to any signs of “second wave” infections in the fall or to vaccine disappointments. Third, beyond the potential upside to equity markets from an early vaccine, the shift to a stronger growth path should favor more cyclical sectors and markets and could reverse some of the recent flattening of yield curves and declines in longer-dated yields—so more positive vaccine news may still lead to meaningful shifts and rotations in the pattern of asset returns.

### Dominic Wilson, Senior Markets Advisor

Email: [dominic.wilson@gs.com](mailto:dominic.wilson@gs.com)  
Tel: 212 902-5924

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# Snapshot of our mainline asset views...

## What do you expect for your asset class under our baseline virus/growth scenario?

### EQUITIES

David Kostin, Kathy Matsui, Peter Oppenheimer, Tim Moe & Teams

- **US:** Under our baseline, we expect S&P 500 EPS will decline by 21% to \$130 per share in 2020 before rebounding by 30% to \$170 in 2021. Our 2021 EPS forecast is above bottom-up consensus expectations of \$165, given our economists' strong US economic growth forecast. However, at the sector level, we expect the earnings recovery will be uneven, with Info Tech and Health Care EPS surpassing 2019 levels by the end of 2021 but Energy and Financials still below 2019 levels at that point. We recommend overweight allocations to Info Tech, Industrials and Utilities, and underweight allocations to Health Care, Real Estate, Energy and Materials.
- **Europe:** A near-term move higher looks tough with stretched valuations and the prospect for margin pressure likely to grow. But given our expectation for a strong European economic recovery, we expect a 1% 12-month return for the SXXP, and outperformance relative to the US. In dollar terms, we see Europe rising 7% over 12 months, outstripping returns in the US and Japan.
- **EM:** We see moderate upside of 3% for MSCI EM to 1130 on a 12-month basis as earnings continue their recovery, offsetting a contraction in valuations. We see the most upside in Latin America equities (~ +25% in USD terms) and CE-3 equities (~ +20%) on this horizon and prefer value expressions that are likely to benefit the most during the global recovery given demanding valuations at the index level.
- **Asia-Pacific:** We expect the MXAPJ index to rise by 6% to 590 on a 12-month basis based on higher earnings, in part due to greater optimism regarding a vaccine and its effect on global growth, higher valuations driven by persistent low rates, and expectations of continuing dollar weakness. Our 3-month 530 target (-6%) reflects risks of waning macro data improvements, partly due to COVID-19 infection persistence, as well as the US election, geopolitics and technical overhangs.
- **Japan:** We expect Japanese equities to remain range-bound for the coming 3-6 months, mainly due to lack of policy catalysts and external risks such as the US elections and China-US tensions. However, since we forecast a rebound in global GDP in FY21 and EPS to rise by 50%, and foreign investor positioning remains light, we expect TOPIX to rise to by 4% to 1675 in 12 months.

### FX

Zach Pandl, Kamakshya Trivedi & Team

- **DM:** We expect the Dollar to continue to trend lower on high valuation, low rates, and improving global growth. We expect EUR/USD to hit 1.25 in 12 months as (i) the Euro area appears well-placed for a continued smooth and steep reopening, (ii) we view the new Recovery fund as a major institutional upgrade, and (iii) longer-term investors remain underweight European assets.
- **EM:** The expected global cyclical upswing—reinforced by optimism about vaccine development—would tend to reinforce the weak-Dollar trend, even if the vaccine is developed in the US, given the currency's safe haven properties. This upswing, especially if paired with a downshift in US-China tensions, could induce more participation from the Chinese Yuan, trade-sensitive currencies like the Korean Won and, eventually, EM FX more broadly. We forecast USD/CNY at 6.70 on a 12-month basis based on strong China macro fundamentals and our expectation for further Dollar weakening.

### RATES

Praveen Korapaty & Team

- **DM:** We expect longer-term yields across G10 rates markets to steadily reprice higher as improving growth and ebbing downside risk support steeper curves in a world in which central banks remain on hold for the foreseeable future. We expect a rise in US 10-year yields to 1.05 by year-end 2020.
- **EM:** On the back of improving global growth, we expect EM local yields to trend higher on aggregate from the current historical lows, in sympathy with core duration. Nevertheless, EM local fixed income, at least among high-yielders, still embeds meaningful risk premia and offers high carry relative to DM rates, so we expect a relative total return outperformance in the next 12 months. We expect traded inflation in EM low-yielders to further catch-up to the recent re-pricing in DM from current depressed levels.

### CREDIT

Lotfi Karoui & Team

- **DM:** We expect the economic recovery will likely continue to support risk appetite and thus the absolute direction of credit spreads, and think the impact will be much more visible across sectors that have been severely disrupted by the virus shock, including Retail, Travel & Leisure, and Airlines. These sectors have lagged the recovery of the broader market and have room to catch up under our baseline virus/growth scenario.
- **EM:** Under the baseline scenario, EM sovereign credit still looks inexpensive, especially in HY where spreads remain at historic wides and is pricing only a modest growth pickup. We see room for EM HY spreads to move ~150bp tighter on a 12-month basis.

### COMMODITIES

Jeff Currie & Team

- **Gold/Silver:** We expect gold and silver to continue to trade higher into the economic recovery, and retain 12-month price targets of \$2300/toz and \$30/toz, respectively. While positive vaccine news may trigger a temporary correction in gold, we don't expect it to change the structural precious metals bull market driven by ultra-loose policy globally.
- **Oil:** We expect the challenge of normalizing global oil demand will persist until a vaccine is available, leaving prices fairly range-bound through year-end 2020. But with fundamentals likely to turn more bullish in 2021, we maintain above-consensus price forecasts of \$60/bbl and 65/bbl for WTI and Brent, respectively, by year-end 2021, and expect oil to be an outperforming asset class next year.

# ...and virus risks to those views

## What about in a virus resurgence scenario that sees the economic recovery stall?

### EQUITIES

David Kostin, Kathy Matsui, Peter Oppenheimer, Tim Moe & Teams

- **US:** In a downside virus scenario that sees renewed economic weakness, we think S&P 500 EPS could decline to \$105 in 2020 (-36%) and recover to \$135 in 2021 (+29%), leaving 2021 EPS 18% below 2019 levels. In this scenario, defensives would likely outperform.
- **Europe:** We see the potential for a 10-15% SXXP correction in a downside virus scenario, which would raise the risk premium, as investors question the potency of further policy support, and increase fears about more structural scarring.
- **EM:** In a downside virus scenario that stalls the growth recovery, we would expect a continuation of the growth vs. value theme with North Asia outperforming due to the market's perception of the region's strength in controlling the virus and the relative defensiveness of Tech. However, such outperformance would likely still see absolute declines given the demanding valuations in the region.
- **Japan:** A downside scenario that forces the Japanese government to declare another nationwide state of emergency could cause consumption to fall by 9% on an annualized basis, according to our economists, posing material downside risk to earnings and TOPIX returns, especially since investors are likely to remain risk-averse.

### FX

Zach Pandl, Kamakshya Trivedi & Team

- **DM:** If the global recovery stalls, we would expect a pause in the Dollar's depreciation trend, given the currency's safe haven properties. We think the performance of particular crosses will depend on the correlation between risk and real rates, as well as the virus trajectory across regions. If the reopening of schools in the US proceeds less smoothly than in other countries, the Dollar could continue to underperform—assuming the US avoids broad lockdowns that threaten a double-dip recession.
- **EM:** In a modest downturn in which virus resurgence and labor market shocks avoid extremes, and continue to be more pronounced in the US than in the Euro area, we think the continuation of a narrower, Euro-centric Dollar down move is possible, which would feature outperformance of the Euro and Euro proxies (like the Polish Zloty). In a more-severe downturn, however, investors would likely see a flight of capital away from EM FX towards the safety of the Dollar, Yen, and Swiss Franc.

### RATES

Praveen Korapaty & Team

- **DM:** A resurgence of the virus that sees the economic recovery stall would likely restrain yields, though the extent of any rally is likely to be limited by the proximity of many markets to the effective lower bound. For markets where the lower bound is more binding, a resumed deterioration in the growth outlook would be increasingly visible in lower traded inflation (and, in turn, higher real yields).
- **EM:** Should the recovery in activity stall, we would expect the policy stance across EM central banks to remain biased towards more easing, leaving EM local yields and inflation pricing near current lows, especially among low-yielders. A prolonged weakness in activity could exacerbate the fiscal imbalances of the most fragile EM high-yielders (e.g., BRL, COP, ZAR), with risks of renewed curve steepening and the cheapening of bonds relative to swaps.

### CREDIT

Lotfi Karoui & Team

- **DM:** In a scenario in which the economic recovery stalls, we would expect spreads to move wider in sympathy with the broader risk environment. However, we think the direct support provided to the asset class by major DM central banks would likely put a ceiling on how wide spreads could go. In our view, this policy tailwind would likely allow credit to outperform its "beta" to other risk assets.
- **EM:** EM HY credit would be particularly vulnerable to a scenario in which the economic recovery stalls resulting in lower trend growth but still higher market rates. Several HY sovereigns including Angola and Pakistan have relied on official sector support to cushion the impact from COVID-19, which would otherwise have forced them to fund themselves at rates that would deem their debt unsustainable. The majority of the official sector support has come with low conditionality, which is suitable for a short crisis, but not for one which ends up lasting longer and could have structural implications. As such, in an adverse scenario, conditionality around official sector lending would likely increase, thereby increasing the share of sovereigns going through with debt restructurings.

### COMMODITIES

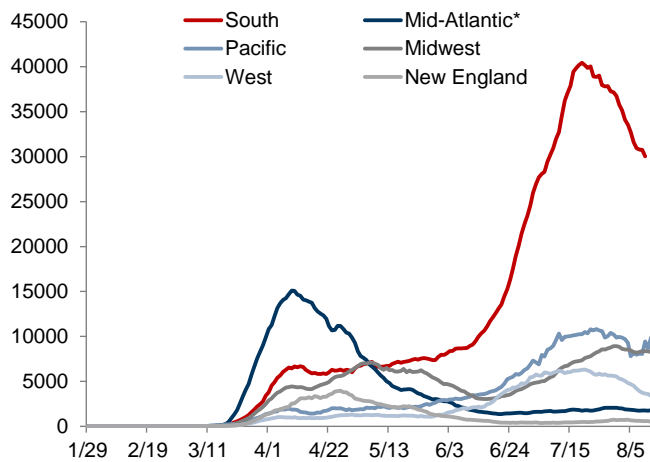
Jeff Currie & Team

- **Gold/Silver:** We would expect a similar rally in Gold and Silver as under our base case in the event of virus resurgence, which would likely trigger more fiscal spending, higher long-term inflation expectations, and greater debasement concerns. Indeed, this is what has occurred in the US over the past 2 months in which breakeven inflation rates have increased despite a resurgence in the number of new cases. Therefore, we think that precious metals stand to perform independent of virus developments as long as monetary and fiscal policy globally remain super accommodative.
- **Oil:** A stall in the economic recovery causing oil demand to move sideways from current levels (around 10 mb/d below its pre-COVID-19 path) would put the market back into surplus in the coming months as OPEC+ loosens its quotas and global shut-ins unwind. This would likely require OPEC+ to pause its production recovery and push prices back into the high 30s to disincentivize shut-in barrels from coming back on line.

# Where are we today...

## US virus waves have hit at different times...

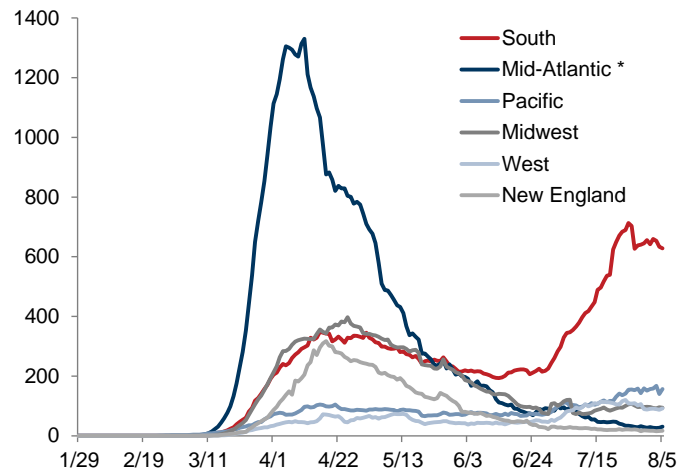
Daily change in confirmed cases by region, 7dma



Note: Mid-Atlantic includes NY, NJ, and PA; regions based on [US Census Bureau classifications](#); Northeast broken out into New England and Mid-Atlantic. Source: JHU CSSE, Goldman Sachs Global Investment Research.

## ...but new fatalities are still below March high

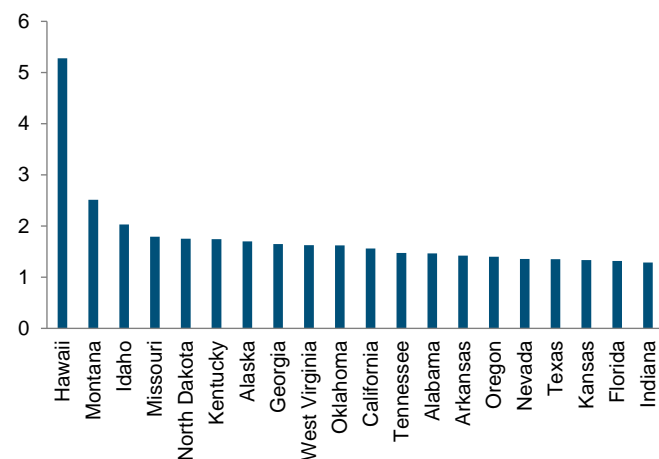
Daily change in confirmed fatalities by region, 7dma



Note: Mid-Atlantic includes NY, NJ, and PA; regions based on [US Census Bureau classifications](#); Northeast broken out into New England and Mid-Atlantic. Source: JHU CSSE, Goldman Sachs Global Investment Research.

## Case growth remains fairly high across many US states...

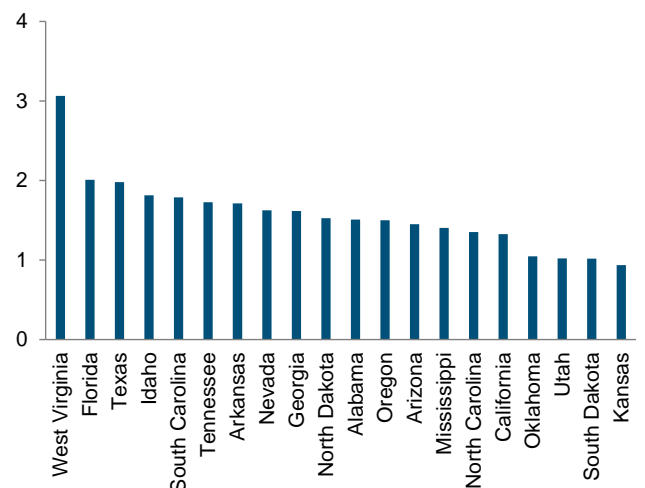
Daily change in confirmed cases by state, % (7dma)



Source: JHU CSSE, Goldman Sachs Global Investment Research.

## ...and fatalities have started to pick up

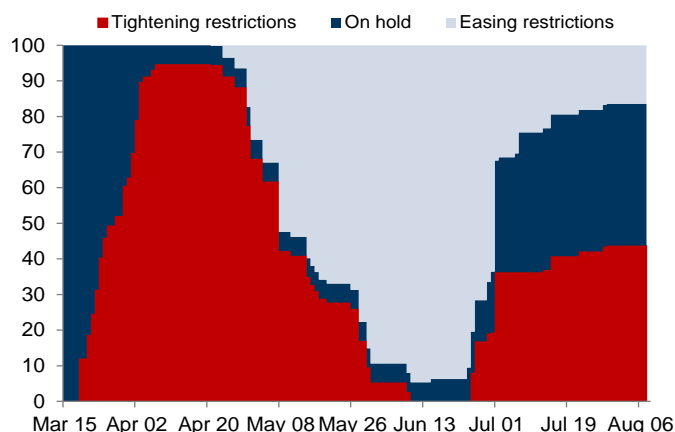
Daily change in confirmed fatalities by state, % (7dma)



Note: Includes states with more than 100 COVID-related deaths. Source: JHU CSSE, Goldman Sachs Global Investment Research.

## Restrictions tightening/on hold in over 80% of the US...

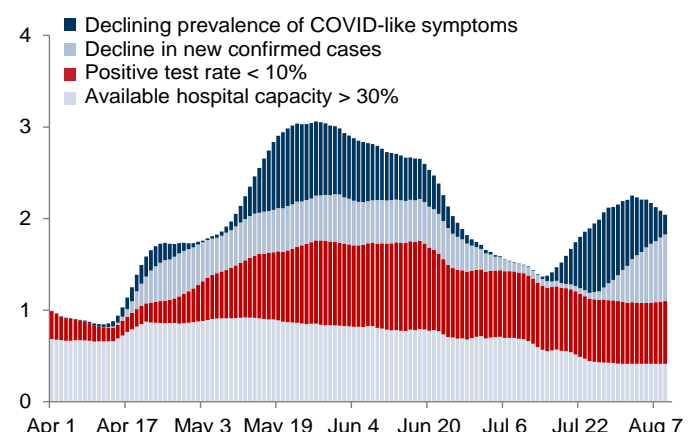
Latest state action; population-weighted share of states, %



Source: Goldman Sachs Global Investment Research.

## ...but more states show declining cases

Population-weighted number of gating criteria met, # of criteria



Source: Centers for Disease Control and Prevention, Carnegie Mellon University COVIDcast, COVID Tracking Project, Department of Health and Human Services, Goldman Sachs Global Investment Research.



# ...in the US pandemic?

## GS state-level coronavirus tracker

Category	Symptoms		Cases				Testing			Hospitalization				Fatalities		Number of gating criteria met
	Doctor visits for COVID-like illness (CLI)		New identified cases per million		Rt - reproductive number		Positive test rate	Change in + test rate, pp (14 day)	Change in test volume	Hospital ICU capacity available (%)	Total Hospital capacity available (%)	Hospitalized for Covid-19 (per mn)	Growth in hospitalizations (14-day)	Fatalities per million per day	Change in fatalities (14-day)	
	Declining over 14 days		Declining over 14 days				< 10%			> 30%						
Units	%	14-day chg (pp)	Cases per mn	7-day chg	14-day chg	Ratio	%	14-day chg (pp)	14-day chg (%)	%	%	#	14-day chg (%)	#	14-day chg (%)	Score
Georgia	11.1	+2.6pp	328	+14	-21	0.91	11.4%	-2.4pp	-4%	26%	24%	290	-3%	6.3	54%	1
Florida	15.6	+5.7pp	319	-21	-156	0.96	17.5%	-1.8pp	-40%	42%	22%	355	-19%	7.5	15%	1
Alabama	8.3	-1.0pp	295	-22	-53	1.00	16.6%	-6.5pp	-18%	26%	12%	321	+2%	5.4	7%	2
Mississippi	11.7	+0.7pp	285	-82	-135	0.91	19.9%	+2.2pp	-49%	40%	27%	396	-2%	8.9	32%	1
Idaho	3.2	+0.7pp	272	+31	+6	1.01	17.6%	-0.6pp	-20%	54%	53%	109	+4%	2.3	-24%	1
Louisiana	12.4	+3.9pp	257	-148	-156	0.91	6.8%	-2.4pp	29%	37%	34%	316	-7%	8.0	22%	3
Tennessee	8.6	+1.4pp	256	-20	-86	0.98	8.3%	-1.4pp	-27%	41%	31%	212	-1%	3.0	10%	3
Nevada	7.2	+1.4pp	240	-83	-89	1.03	15.9%	+2.1pp	-39%	30%	30%	373	+1%	4.9	39%	1
Texas	12.9	+3.4pp	230	-54	-41	1.13	33.9%	+21.7pp	-23%	30%	24%	292	-22%	6.0	-36%	1
Arkansas	8.6	+1.7pp	227	-25	-43	0.99	11.3%	-0.4pp	-13%	37%	33%	171	+8%	3.0	19%	2
California	11.7	+4.1pp	220	+54	-10	0.96	7.0%	-0.3pp	4%	31%	32%	191	-14%	3.4	10%	3
South Carolina	8.4	+0.7pp	207	-59	-91	0.99	15.7%	+0.7pp	-10%	22%	24%	285	-15%	6.9	-24%	1
Oklahoma	4.6	-0.8pp	174	-40	-90	0.96	7.8%	+1.3pp	-37%	44%	33%	163	+6%	1.6	-10%	4
North Dakota	1.7	-1.3pp	171	+16	+10	1.07	8%	+0.9pp	-10%	37%	59%	55	-26%	2.2	100%	3
Missouri	10.3	-0.2pp	171	-31	-72	1.04	10.7%	-5.5pp	-14%	44%	35%	144	+1%	1.3	-29%	3
Iowa	2.4	+0.3pp	142	-3	-13	0.99	10.0%	+0.4pp	-27%	43%	41%	79	+7%	2.4	33%	2
Arizona	14.8	+5.2pp	141	-130	-203	0.82	12.3%	-8.3pp	-15%	27%	25%	267	-34%	8.1	-14%	1
Kansas	5.3	+1.2pp	139	+9	-13	1.01	11.0%	-33.1pp	6%	47%	51%	123	N/A	1.2	-11%	2
Indiana	7.5	+0.5pp	139	+18	+19	1.02	9.0%	+0.9pp	-16%	43%	38%	137	+6%	1.7	14%	2
Illinois	10.6	+4.2pp	137	+8	+25	1.03	4.1%	+0.3pp	3%	46%	50%	122	+5%	1.3	-3%	2
North Carolina	8.3	+2.8pp	136	-18	-42	0.98	5.2%	-1.4pp	-24%	26%	30%	111	-2%	2.8	31%	2
Kentucky	7.4	+1.0pp	134	+6	+1	0.94	8.1%	-0.3pp	-24%	39%	25%	139	+7%	1.2	-19%	1
Wisconsin	7.7	+2.5pp	130	-14	-22	0.97	6.7%	-0.4pp	1%	41%	48%	44	+38%	1.0	-11%	3
Nebraska	5.3	-0.9pp	129	-23	-13	0.99	8.6%	-0.7pp	0%	46%	40%	78	+21%	1.2	23%	4
Virginia	8.5	+2.9pp	125	+7	-2	1.07	7.4%	+0.8pp	-18%	43%	37%	153	+7%	1.3	5%	3
Utah	3.0	-1.5pp	122	-16	-38	0.98	9.5%	-0.4pp	-39%	47%	45%	69	-12%	1.1	-25%	4
Hawaii	3.0	+1.7pp	121	+30	+77	1.29	12.0%	+8.8pp	67%	35%	44%	97	+254%	1.1	N/A	1
Maryland	13.4	+5.4pp	117	-28	-27	0.95	5.2%	-1.5pp	0%	32%	32%	92	+5%	1.8	4%	3
Minnesota	9.0	+2.1pp	114	-8	-12	1.18	8.2%	+3.4pp	-29%	36%	35%	54	+8%	1.4	46%	3
Montana	0.8	-0.9pp	112	+11	-3	1.09	7.6%	+2.5pp	3%	41%	45%	74	+46%	2.0	N/A	4
South Dakota	2.0	+0.5pp	104	+19	+13	1.14	9.1%	+10.8pp	-30%	45%	51%	49	-14%	1.6	N/A	2
Ohio	5.8	+2.3pp	97	-6	-15	0.96	5.2%	+0.0pp	-13%	38%	42%	86	-9%	1.7	-26%	3
Rhode Island	8.0	+3.9pp	87	-4	-12	1.03	5.0%	-0.7pp	6%	6%	15%	75	+18%	0.8	-40%	2
Washington	4.6	+2.6pp	86	-9	-21	1.09	N/A	N/A	N/A	23%	15%	56	+10%	1.9	15%	1
New Mexico	4.0	-1.2pp	85	-12	-72	0.85	2.6%	-1.5pp	-1%	36%	37%	63	-25%	1.9	-32%	4
Alaska	2.9	+1.4pp	84	-43	-46	0.85	1.8%	-1.3pp	4%	47%	50%	52	+6%	0.4	-33%	3
Oregon	4.4	+0.8pp	69	-7	-10	0.95	5.0%	-0.9pp	-34%	17%	25%	54	+1%	1.2	-8%	2
Michigan	8.2	+2.3pp	69	-2	-6	1.02	2.5%	+0.2pp	-2%	38%	30%	69	+2%	0.9	79%	3
Delaware	6.0	+1.8pp	69	-33	-50	0.96	3.7%	-1.3pp	-18%	33%	35%	48	-16%	0.7	-91%	3
West Virginia	2.4	-0.3pp	68	-2	-17	0.91	2.6%	-1.1pp	-11%	34%	28%	64	+31%	2.3	190%	3
Colorado	10.9	+4.6pp	68	-10	-33	0.97	6.9%	-1.2pp	-18%	44%	45%	58	-5%	0.6	-53%	3
Pennsylvania	5.9	+1.9pp	61	-0	-14	0.96	5.0%	-1.1pp	-14%	33%	28%	50	-13%	1.4	34%	2
Massachusetts	14.9	+9.9pp	43	-19	-6	0.97	2.4%	-0.4pp	18%	36%	49%	57	-26%	1.9	-18%	3
New Jersey	12.2	+3.9pp	42	-2	-6	1.00	1.3%	-17.1pp	9%	30%	59%	88	-10%	0.7	-53%	2
Wyoming	1.9	+0.5pp	40	-33	-44	0.90	4.3%	+1.8pp	2%	64%	59%	28	+7%	0.5	100%	3
New York	13.6	+7.0pp	33	-1	-2	0.95	0.9%	-0.2pp	2%	35%	40%	29	-20%	0.3	-57%	3
Connecticut	14.9	+8.0pp	19	-8	-33	0.96	0.7%	-0.8pp	28%	29%	52%	17	-18%	0.5	-32%	2
New Hampshire	4.7	+1.4pp	18	-4	-5	0.96	1.5%	-0.7pp	11%	39%	52%	17	-4%	0.2	-78%	3
Vermont	1.8	-0.3pp	10	+3	+0	1.00	0.7%	+0.1pp	-14%	38%	43%	14	-25%	0.2	N/A	3
Maine	3.5	+1.6pp	8	-6	-7	0.84	+0%	-46%	-15%	39%	36%	7	-17%	0.2	-33%	3
USA total	10.0	+3.2pp	160	-11	-37	0.99	12.0%	+4.1pp	-11%	35%	34%	161	-6%	3.1	4%	2.2
Ex- Tri State* Area	9.7	+2.9pp	174	-12	-40	0.99	13.1%	+5.0pp	-12%	35%	32%	174	-5%	3.4	10%	2.2
Tri State* Area	13.4	+6.2pp	34	-2	-6	0.96	1.0%	-4.9pp	7%	33%	47%	44	-17%	0.4	-53%	2.6

\*New York, New Jersey, and Connecticut

Note: Data as of August 13, 2020.

Special thanks to Blake Taylor

# Key facts: virus spread and control

Since the first global infection wave in the winter and early spring, we have learned that broad and economically costly lockdowns are not the only way to lower coronavirus spread significantly. Drawing on academic reviews of the scientific research literature and some of our own econometric work, we outline six key facts about virus spread and their implications for future, lower-cost virus control measures.

## 1. Social distancing significantly lowers infections

*Evidence:* A review in the [Lancet](#) finds that COVID-19 infection risk is 7 times smaller when the physical distance exceeds 1 meter. For every additional 1 meter away in distancing, the relative effect doubles.

*Implication:* Social distancing policies are effective and can (partially) substitute for full lockdowns, which have large negative effects on GDP.

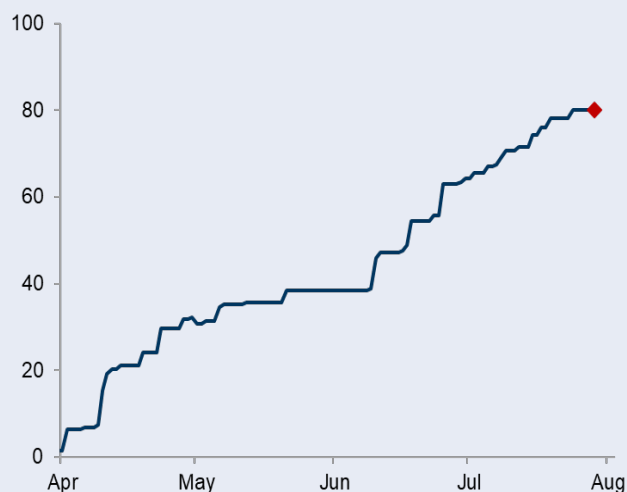
## 2. Mask wearing significantly reduces infections

*Evidence:* We have found that face masks are associated with significantly lower infections and fatalities in a US regional panel, a large country-level cross section, and a smaller country-level panel.<sup>7</sup> A review in the [Lancet](#) finds that infection risk is 3 to 7 times lower when wearing a face mask.

*Implication:* Mask mandates are effective and can (partially) substitute for broad lockdowns. The adoption of US state- and city-level mask mandates this summer has been associated with increased mask wearing, especially in the Sun Belt where symptoms and case growth are now declining from very high levels.

### US face mask wearing has increased...

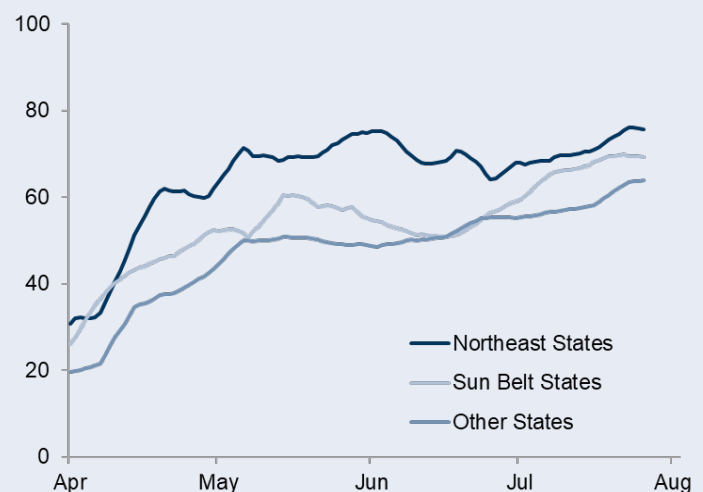
Population of the US under a mask mandate, % of population



Source: YouGov, Goldman Sachs Global Investment Research.

### ...with use rising across all US regions

The share of "always" wearing a face mask in public, % of population



Source: YouGov, Goldman Sachs Global Investment Research.

## 3. The virus spreads largely indoors, likely also through tiny droplets

*Evidence:* A [review](#) of 201 transmission events finds that clusters predominantly occurred indoors, including in restaurants, bars, senior housing, food plants, religious venues, offices, and dormitories. A detailed analysis from [Japan](#) estimates that the infection odds are nearly 19 times greater indoors compared to outdoors. We have also found a strong positive correlation between virus spread and summer restaurant activity across US states and in the Sun Belt, where hot weather drives customers inside.

Relatedly, 238 scientists have [emphasized](#) the potential for the virus to spread in tiny droplets called aerosols that can accumulate in poorly ventilated areas. Airborne transmission is increasingly seen as an important source of virus spread, in addition to larger droplets generated by coughing, sneezing, and talking. In contrast, a recent comment in the [Lancet](#) [argued](#) that the chance of transmission through surfaces is very small.

*Implications:* Moving activities such as dining, drinking and gyms outdoors is likely effective. Upgrades to ventilation and AC systems are likely also effective.

<sup>7</sup> See Jan Hatzius, Daan Struyven, and Isabella Rosenberg, "Face Masks and GDP", Global Economics Analyst, 29 June, 2020.

#### 4. Super spreaders account for most infections

*Evidence:* Super spreader events—in which one person infects a disproportionate number of other individuals—likely play a major role in virus spread. Around 10% of infected individuals account for 80% of secondary infections, according to the median estimate from our literature review. We have also found that attendance of crowded public places sharply and significantly increases infections.

*Implications:* Restrictions on mass gatherings and contact tracing of super spreaders are effective. Large-scale [pooled testing](#)—mixing samples from multiple individuals and testing as one—to identify super spreaders who often have high viral loadings could also be effective<sup>8</sup>

#### 5. Virus spread usually occurs early on in the illness

*Evidence:* A [review](#) of 97 studies concludes that virus loads are elevated only in the first week of illness, with an early peak at symptom onset to day 5 of illness.

*Implications:* Rapid testing, case identification and isolation are effective. According to Harvard epidemiologist [Michael Mina](#), most tests are given “long after the infected person has stopped transmitting the virus.” Instead, he proposes much faster mass testing, even if it increases the share of false negatives: “Everyone must be tested, every couple of days with \$1, paper-based, at-home tests.”

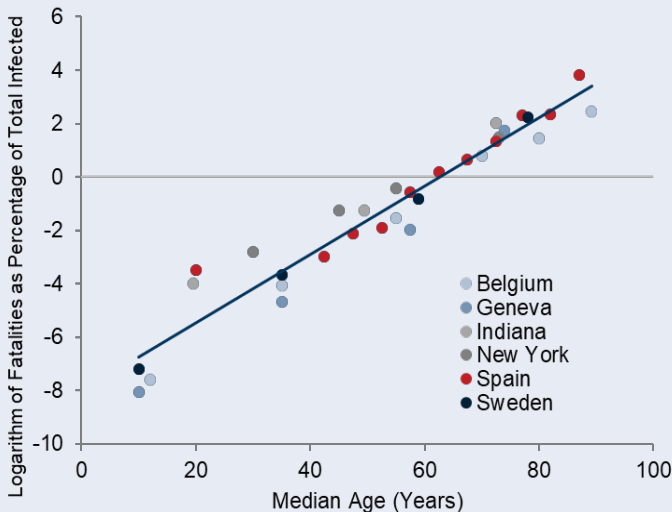
#### 6. The risks of infection and especially fatality are significantly higher for the elderly

*Evidence:* A recent [review](#) by Marc Lipsitch and co-authors finds evidence for “elevated susceptibility to infection in adults aged over 60 compared to younger/middle aged adults” (and significantly lower susceptibility for children under 10). The relationship between age and the infection fatality rate—the ratio of deaths to the total number of infected individuals—is particularly striking. Summarizing six large-scale studies of random population samples, Andrew Levin and co-authors [find](#) that the infection fatality rate rises exponentially with age from close to zero for children and young adults to double digits for ages 80 and above.

*Implications:* [Age-targeted](#) policies combined with measures that reduce interactions between age groups are likely effective. For instance, a recent study [estimates](#) that eliminating staff linkages between nursing homes could reduce infections in nursing homes by 44%.

##### Fatality risk rises sharply with age...

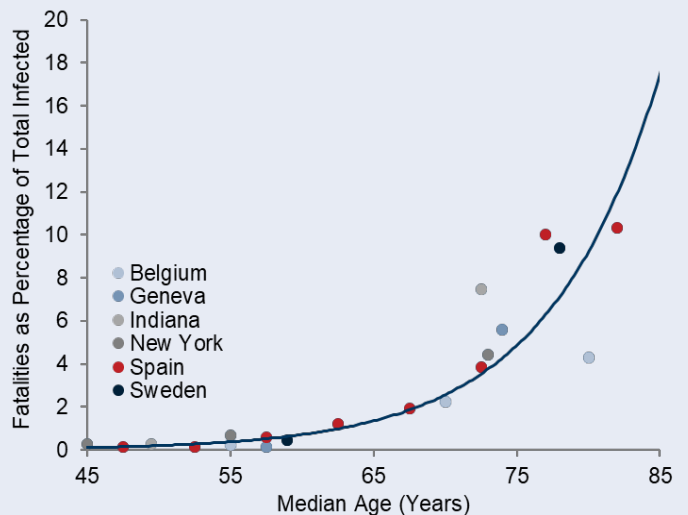
Log. of fatalities as percentage of total infected vs. median age



Source: Levin et al. (2020), Goldman Sachs Global Investment Research.

##### ...and rises to double digits for ages 80 and above

Fatalities as percentage of total infected vs. median age



Note: The chart focuses on the 45-85 median age range.

Source: Levin et al. (2020), Goldman Sachs Global Investment Research.

Daan Struyven, GS Economics Research

<sup>8</sup> MIT economist Glenn Ellison [shows](#) that heterogeneity also implies that standard models underestimate how quickly herd immunity might be reached.

# School reopening risks

David Choi and Joseph Briggs argue that the success of school reopenings in the US will depend crucially on how well virus spread is managed among the broader US population

With the upcoming school year fast approaching at a time when virus spread is still very high in the US, it is unclear if schools will be able to safely reopen. While reopening carries significant virus risks, the costs to the economy and students of keeping schools closed are also substantial, making the reopening of schools a difficult choice for policymakers. We expect a staggered reopening of schools at best, with the degree of success likely ultimately dependent on the ability to manage virus spread among the broader US population.

### Economic costs of school closures

Employment in the education industry collapsed in the spring as schools shifted to remote virtual learning in response to the pandemic, accounting for roughly 1.2mn of the 22.2mn decline in nonfarm payrolls in March and April. Initial job losses in the education industry were broad-based across occupations, including teachers and administrators, as well as lower-skilled workers such as cafeteria workers and custodians.

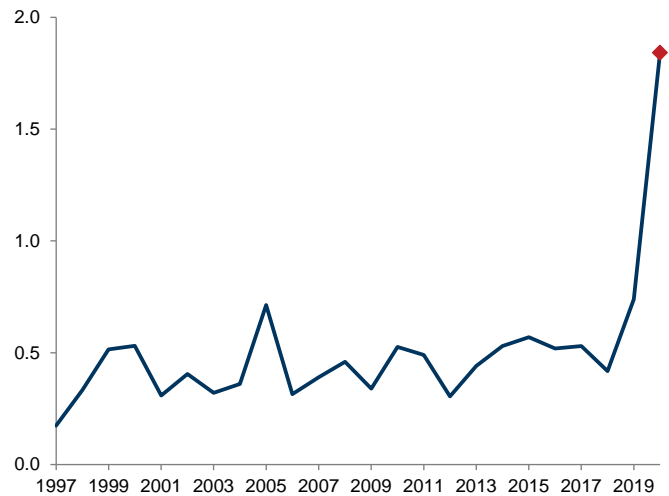
Beyond these labor market losses, we estimate that shutdowns in the education sector directly subtracted roughly 2.2pp from annualized US real GDP growth in Q2, accounting for a sizable portion of the overall decline. But these estimates only take into account personal and state/local expenditures on education; the impact may have been far larger when considering other parts of the economy that are closely tied to the education sector, such as food providers for meal programs and businesses in college towns.

With the new US school year upon us, the level of employment of teachers is now back to pre-pandemic levels, but employment of lower-skilled workers in the education industry has been much slower to recover as schools face the prospect of continued virtual learning. If lower-skilled workers are not re-hired, we estimate that could increase the unemployment rate by roughly 0.2pp.

School closures may also affect overall labor supply beyond the education sector and businesses closely tied to it if workers drop out of the labor force entirely or are unable to fully return to work because of child care needs. Academic research suggests that these effects could be large, with child care policies historically having a meaningful impact on labor force participation, particularly for women.

Today, survey data suggest that child care needs due to the pandemic have significantly disrupted labor supply. According to the Census Household Pulse Survey, child care responsibilities accounted for roughly 14% of virus-related reasons for not working since May, with about seven million workers a week unable to work due to caring for children who were not in school or daycare. And we find that among workers absent from work, the share citing child care as the primary reason for such absence has surged to historically high levels in the months immediately following school closures.

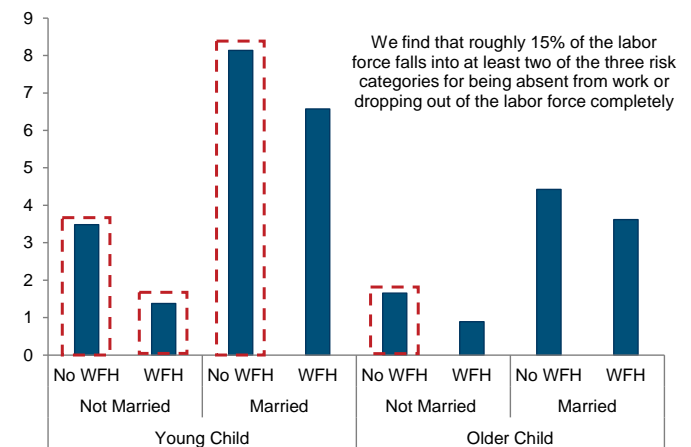
Child care needs have prevented many from working  
Share of workers absent from work due to child care, %



Source: US Bureau of Labor Statistics, Goldman Sachs GIR.

To assess the potential impact on labor supply from school closures in the upcoming year, we look to see how many workers might be affected due to increased child care needs. Our analysis shows that parents who are single, have younger children, or are less able to work from home are more likely to either be absent from work or to drop out of the labor force altogether due to child care needs. We find that roughly 15% of the labor force, or around 24mn workers, fall into at least two of the three risk categories.

A significant share of workers requires child care support  
Share of labor force, child care need proxies, %



Note: Chart breaks down the labor force into three categories, grouping workers based on whether their youngest child is younger or older than 10, whether they are more or less able to work from home, and whether they are single or married; dashed lines indicate workers that fall into at least two of the risk categories.

Source: US Bureau of Labor Statistics, Federal Reserve Bank of Dallas, Goldman Sachs Global Investment Research.

While the approximately six million workers not working today due to child care needs might serve as an approximate upper bound for the labor supply impact of school closures, the labor market effects could still be felt by many other workers through either lower productivity or a reduction in hours worked. The extent to which these workers will cut back on their labor will likely also depend on factors such as whether child care centers open or federal support for child care needs is provided.



In addition to these short-term economic costs, school closures may have significant long-term costs. These costs may include negative effects on students and the economy from lower quality education, the lack of social and emotional skill development, increased rates of depression and anxiety, food insecurity, worsening income inequality if lower income households are less able to work from home, and worsening educational inequality if poorer households have less access to virtual learning. All of these costs may have very important and long-lasting societal consequences.

### Virus risks of school reopenings

Given the large number of people in close proximity indoors, schools are in theory a natural breeding ground for virus spread. However, some evidence suggests that children may be less likely to become infected than adults, and it is now clear that children are much less likely to suffer serious symptoms of the coronavirus, with a fatality rate close to zero for school-aged children. This suggests that the reopening of schools may not pose a very high risk for schoolchildren themselves.

Much less is known, however, about how easily children transmit the virus to others, such as fellow students, teachers, and family members. Other respiratory viruses like influenza are known to spread easily among schoolchildren, and a key concern is that outbreaks in schools will eventually spill over into outbreaks in the broader population that is at greater risk.

The evidence on this risk so far is mixed. A large study based on comprehensive contact tracing in South Korea found that children under 10 were roughly half as likely as adults to transmit the virus to others, while children between the ages of 10 and 19 transmitted the virus at similar rates to adults. Other studies have also suggested that young children are less likely to spread the virus. However, a recent study found large outbreaks in a Georgia summer camp even among younger children, while another recent study has shown that children may carry high viral loads.

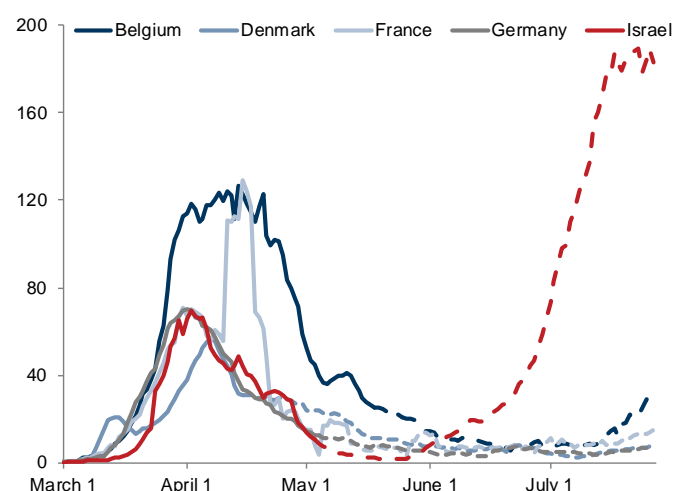
That said, countries that have reopened schools generally show that it is feasible to do so without triggering a spike in overall virus cases or among students and school staff, by taking a very cautious approach that includes limiting class sizes, starting with younger children, putting in place sanitizing and mask wearing requirements, and spacing out desks. A notable exception to school reopening success has been Israel, where schools quickly returned to full class sizes of up to 40 students with few precautions in place, causing a large number of schools to close again. Most importantly, however, countries that reopened schools successfully had relatively low local infection rates at the time of reopening. This poses a challenge for reopening in the US, which is suffering from nearly 10x higher daily case numbers per million than most countries that successfully reopened schools, suggesting that any school reopenings in the US should be done very cautiously.

### The outlook for school reopening

While there are large individual and societal costs of keeping schools closed, many states are still suffering from very high levels of new daily cases, and these states face much higher risks if they reopen schools too early.

### Most other countries have not seen a spike in virus cases after reopening schools, with the exception of Israel

7-day moving average of new cases, cases per million



Note: Dashed lines denote periods after schools reopened. Source: JHU CSSE, Goldman Sachs Global Investment Research.

Parents may also feel uncomfortable sending children to school if they perceive it to be dangerous, with many stating that a surge in cases would make them reconsider sending their children to school. We therefore expect the school reopening process in the US to be staggered. In fact, some states that planned to reopen schools as scheduled have already pushed back start dates of for in-person instruction given a deteriorating virus situation. As with many other areas of economic activity, the trajectory of school reopenings will depend—crucially—on whether the virus spread among the broader population is first managed.

### States have pushed back school reopening plans and have provided guidelines for reopening

<b>Hawaii</b>	Delaying start of the school year until August 17
<b>Minnesota</b>	County must have fewer than 9 cases per 10k residents over a 14-day period to fully reopen
<b>Oregon</b>	Counties must have 10 or fewer cases per 100k residents for 3 weeks to fully reopen
<b>New Mexico</b>	Schools will not be able to open for in-person instruction until after September 7
<b>New Jersey</b>	Parents can opt into fully online instruction
<b>Arizona</b>	Will not require schools to reopen for in-person learning as expected in mid-August
<b>Iowa</b>	Students must spend at least half of their schooling in-person
<b>California</b>	Counties on coronavirus watch list will begin the school year with online education only
<b>Currently allowed to reopen</b>	Alabama, Delaware, Indiana, Iowa, Montana, Nevada, New York, North Dakota, West Virginia, Wyoming

Note: Table reflects changes to school reopening plans since mid-July. Source: Ballotpedia, Goldman Sachs Global Investment Research.

### David Choi, Senior US Economist

Email: [david.choi@gs.com](mailto:david.choi@gs.com)  
Tel: 212 357-6224

Goldman Sachs and Co. LLC

### Joseph Briggs, Senior US Economist

Email: [joseph.briggs@gs.com](mailto:joseph.briggs@gs.com)  
Tel: 212 902-2163

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# School reopening studies: inconclusive

Study	Sample	Findings
<a href="#">Park et al.</a>	59,073 contacts of 5,706 coronavirus patients in South Korea.	Found high coronavirus rates in contacts of children aged 10-19 (18.6%), but relatively low rates in contacts of children 0-9 years (5.3%). However, this was measured in the middle of school closure, and only 57 contacts of young children were traced.
<a href="#">Armann et al.</a>	1,500 students and 500 teachers in Saxony, Germany after schools reopened.	Coronavirus cases were detected in 3 of the 13 schools surveyed, but the infection did not spread throughout the school or the nearby community. Only 12 out of 2,000 individuals came back positive for antibodies, indicating a low level of community infection. Overall, the study found little evidence that schoolchildren pass on the virus to each other.
<a href="#">Fontanet et al.</a>	Twin studies of high schools and elementary schools in a town in France.	In high schools, antibody testing showed that 38% of students, 43% of teachers, and 59% of non-teaching staff were infected. In elementary schools, the study identified three students in three different elementary schools who attended classes with acute coronavirus symptoms; no evidence of any spread to other students.
<a href="#">Zhu et al.</a>	Meta-analysis of studies from China, Singapore, South Korea, Japan, and Iran.	Concludes that data suggests that children have not played a substantive role in intra-household transmission of the coronavirus, in contrast to other viruses such as H5N1.
<a href="#">Li et al.</a>	Review of 16 studies across countries that investigated the role of children in the transmission of COVID-19.	Preliminary evidence from large and targeted, population, and school studies suggest that children may be less likely to infect others.
<a href="#">Viner et al.</a>	Meta-analysis of 18 contact-tracing studies.	Clear evidence that children have a lower susceptibility to the virus, but weaker evidence that children play a lesser role in transmission.
<a href="#">National Centre for Immunisation Research and Surveillance</a>	735 students and 128 staff that were close contacts of 9 students and 9 staff with COVID-19 in Australian schools.	No teacher or staff member contracted COVID-19 from any of these initial cases; two students may have contracted COVID-19 from the initial cases.
<a href="#">Heavey et al.</a>	Contact tracing of six infected people in schools, including two high school students, an elementary school student, and three adults in Ireland.	No confirmed secondary cases from the three students, including the 924 child contacts and 101 adult contacts identified in a school setting.
<a href="#">Danis et al.</a>	Study of a cluster of cases in France.	A 9-year old boy was found to have exposed over 80 classmates at 3 schools, but no secondary contacts became infected despite numerous influenza infections within the schools.
<a href="#">Posfay-Barbe et al.</a>	Families of 40 children under the age of 16 with COVID-19 in Geneva, Switzerland.	In only 3 cases was a child the suspected initial case; in all other households, the child developed symptoms after an adult in the family.
<a href="#">Public Health Agency of Sweden</a>	Comparison between Finland and Sweden, who applied different measures regarding school closures.	Found no difference in the lab confirmed cases of school-aged children in Finland or Sweden, and little transmission in both countries to teachers.
<a href="#">Szablewski et al.</a>	Roughly 600 staff and children in a summer camp in Georgia.	Of the 344 staff and children with available test results, 260 (76%) tested positive. 51% of children aged 6 to 10 were infected, while 44% of those aged 11 to 17 were infected. Attack rates increased with increasing length of time spent at the camp.

Source: Goldman Sachs Global Investment Research.

	Date reopened	New cases per million when reopening	Precautions	Transmission
Belgium	5/18	25.1	Started with younger students, with children alternating days and maximum 10 students a class.	No significant increase in coronavirus cases after reopening schools.
Denmark	4/15	30.6	Started with younger students, limited class size to 12. Social distancing requirements and hourly handwashing enforced.	No significant increase in coronavirus cases after reopening schools.
France	5/11	16.9	Started with younger students, Limited class size, with facemask requirements in secondary schools.	No significant increase in coronavirus cases after reopening schools.
Germany	5/4	12.2	Started with older kids, limited class size to 10. Desks spaced 6 feet apart.	Large study of 1,500 students and 500 teachers showed very little virus transmission, with only 12/2000 having antibodies. Another study showed increased transmission among students, but not school staff.
Greece	6/1	0.6	Started with younger students, limited class size to 15.	No significant increase in coronavirus cases after reopening schools.
Israel	5/3	10.9	Did not limit class size. After a phased return, few restrictions on schools, and classes quickly returned to full size.	Outbreaks that infected at least 1,335 students and 691 staff.
Japan	4/24	3.0	Varied between schools, but students generally wore facemasks and observed social distancing.	No significant increase in coronavirus cases after reopening schools.
New Zealand	5/14	0.2	Initially partially reopened schools on 4/28 to children of essential workers before opening to all students on 5/14. Imposed social distancing measures.	No significant increase in coronavirus cases after reopening schools.
Netherlands	5/11	16.7	Started with younger students, halved class sizes.	No significant increase in coronavirus cases after reopening schools.
Norway	4/20	15.1	Started with younger students, limited class size to 15.	No significant increase in coronavirus cases after reopening schools.
South Korea	6/8	0.9	Limited class size to around 50%; face masks, social distancing, and temperature checks required.	No significant increase in coronavirus cases after reopening schools.
Sweden	Did not Close	N/A	Never closed schools.	Study showed that antibody prevalence in children and teenagers was 4.7% compared with 6.7% in adults.
Switzerland	5/11	6.2	Started with younger students, limited class size to 50%, alternated days.	No significant increase in coronavirus cases after reopening schools.
Taiwan	2/25	0.1	Facemasks required, temperature checks.	No significant increase in coronavirus cases after reopening schools.
Vietnam	5/18	0.1	Facemasks required, temperature checks.	No significant increase in coronavirus cases after reopening schools.

Source: University of Washington Department of Global Health, Goldman Sachs Global Investment Research.





# Glossary of GS proprietary indices

## Current Activity Indicator (CAI)

GS CAIs measure the growth signal in a broad range of weekly and monthly indicators, offering an alternative to Gross Domestic Product (GDP). GDP is an imperfect guide to current activity: In most countries, it is only available quarterly and is released with a substantial delay, and its initial estimates are often heavily revised. GDP also ignores important measures of real activity, such as employment and the purchasing managers' indexes (PMIs). All of these problems reduce the effectiveness of GDP for investment and policy decisions. Our CAIs aim to address GDP's shortcomings and provide a timelier read on the pace of growth.

For more, see our [CAI page](#) and [Global Economics Analyst: Trackin' All Over the World – Our New Global CAI, 25 February 2017](#).

## Dynamic Equilibrium Exchange Rates (DEER)

The GSDEER framework establishes an equilibrium (or "fair") value of the real exchange rate based on relative productivity and terms-of-trade differentials.

For more, see our [GSDEER page](#), [Global Economics Paper No. 227: Finding Fair Value in EM FX, 26 January 2016](#), and [Global Markets Analyst: A Look at Valuation Across G10 FX, 29 June 2017](#).

## Financial Conditions Index (FCI)

GS FCIs gauge the "looseness" or "tightness" of financial conditions across the world's major economies, incorporating variables that directly affect spending on domestically produced goods and services. FCIs can provide valuable information about the economic growth outlook and the direct and indirect effects of monetary policy on real economic activity.

FCIs for the G10 economies are calculated as a weighted average of a policy rate, a long-term risk-free bond yield, a corporate credit spread, an equity price variable, and a trade-weighted exchange rate; the Euro area FCI also includes a sovereign credit spread. The weights mirror the effects of the financial variables on real GDP growth in our models over a one-year horizon. FCIs for emerging markets are calculated as a weighted average of a short-term interest rate, a long-term swap rate, a CDS spread, an equity price variable, a trade-weighted exchange rate, and—in economies with large foreign-currency-denominated debt stocks—a debt-weighted exchange rate index.

For more, see our [FCI page](#), [Global Economics Analyst: Our New G10 Financial Conditions Indices, 20 April 2017](#), and [Global Economics Analyst: Tracking EM Financial Conditions – Our New FCIs, 6 October 2017](#).

## Goldman Sachs Analyst Index (GSAI)

The US GSAI is based on a monthly survey of GS equity analysts to obtain their assessments of business conditions in the industries they follow. The results provide timely "bottom-up" information about US economic activity to supplement and cross-check our analysis of "top-down" data. Based on analysts' responses, we create a diffusion index for economic activity comparable to the ISM's indexes for activity in the manufacturing and nonmanufacturing sectors.

## Macro-Data Assessment Platform (MAP)

GS MAP scores facilitate rapid interpretation of new data releases for economic indicators worldwide. MAP summarizes the importance of a specific data release (i.e., its historical correlation with GDP) and the degree of surprise relative to the consensus forecast. The sign on the degree of surprise characterizes underperformance with a negative number and outperformance with a positive number. Each of these two components is ranked on a scale from 0 to 5, with the MAP score being the product of the two, i.e., from -25 to +25. For example, a MAP score of +20 (5;+4) would indicate that the data has a very high correlation to GDP (5) and that it came out well above consensus expectations (+4), for a total MAP value of +20.

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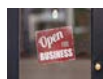
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