

RESPONDING TO COVID-19

Primer, Scenarios, and Implications

April 9, 2020 UPDATE

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EPIDEMIOLOGIC PERSPECTIVES

INTRODUCTION: COVID-19 PRIMER

Context and purpose



The **novel coronavirus** has infected **hundreds of thousands of people globally** and is **taking a severe toll on individuals, families, and economies** as productivity drops and stock markets reflect increased global uncertainty

This document provides some **baseline facts and guidance for business leaders** as to **critical questions to address in the immediate and near-term** to ensure the continuity of their business and the safety, health, and wellbeing of their workforce and customers

What is it?



COVID-19 is the name for the illness caused by the **novel coronavirus** that originated in Wuhan, China in December 2019

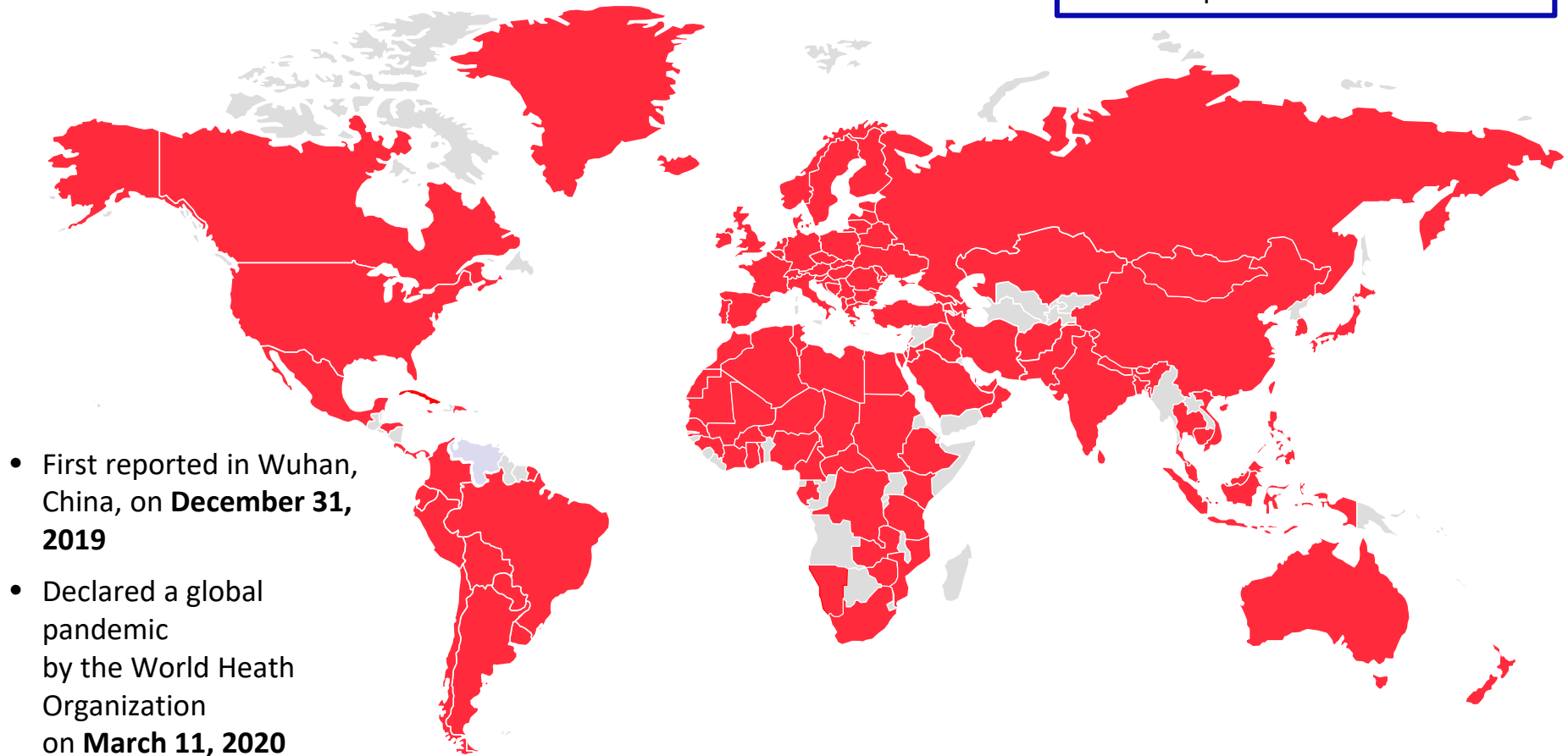
It is from the **same family of viruses that cause some common colds**, as well as Severe Acute Respiratory Syndrome (**SARS**) and Middle East Respiratory Syndrome (**MERS**)

It is considered **similar to other respiratory infections such as influenzas**; symptoms range from fever, cough, shortness of breath to more severe cases of pneumonia and organ failure

COVID-19 SPREAD GLOBALLY

As of April 9th, 2020

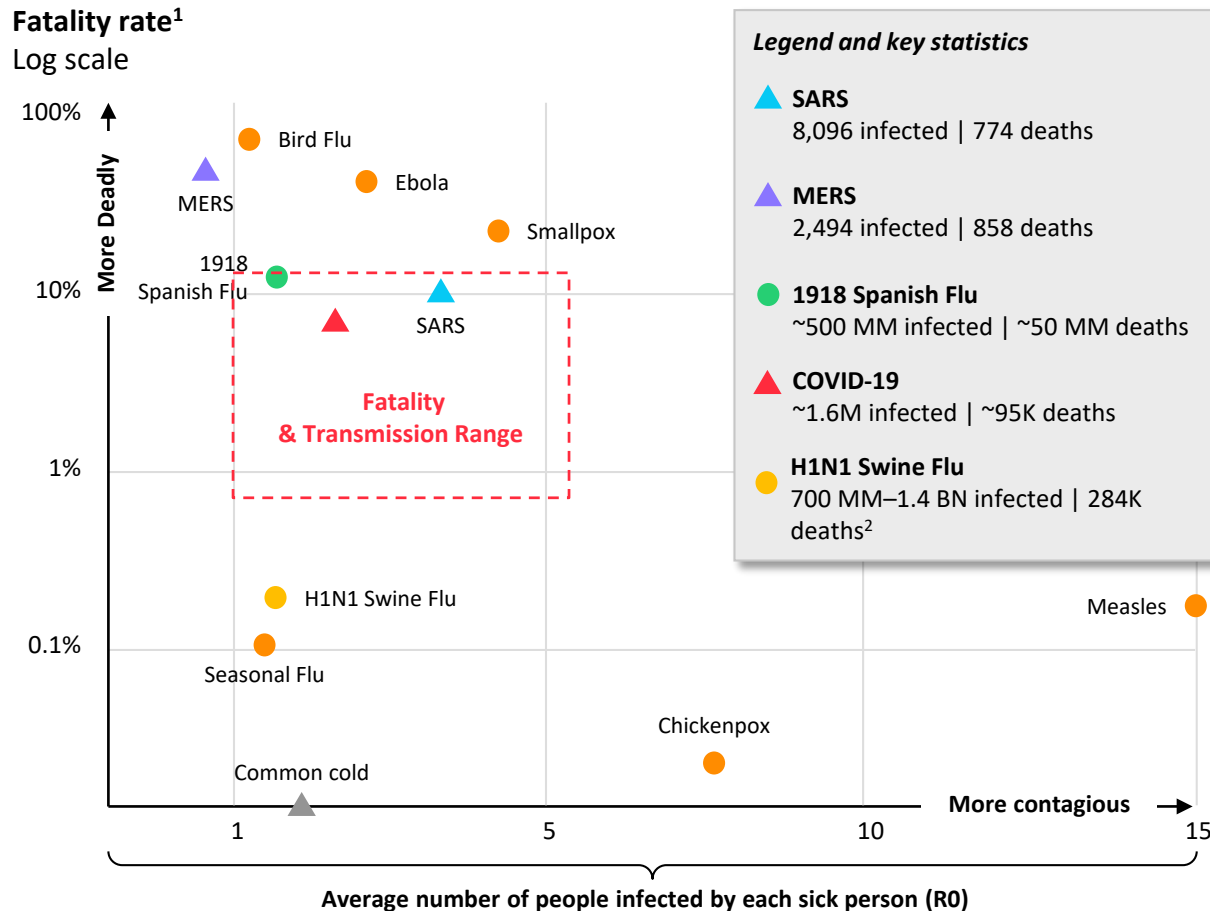
- ~1.6M cases reported in 184 countries and territories
- ~95K reported deaths



1. Countries included: All Countries in "European Region" Sub-region in WHO Situation Report
Source: Map from CDC ([link](#)), Numbers from John Hopkins University & Medicine ([link](#))

HOW DOES COVID-19 COMPARE TO OTHER DISEASE OUTBREAKS? (1 OF 2)

COVID-19 is currently more deadly than the Flu, but the science on transmission and mortality continues to evolve



Additional details

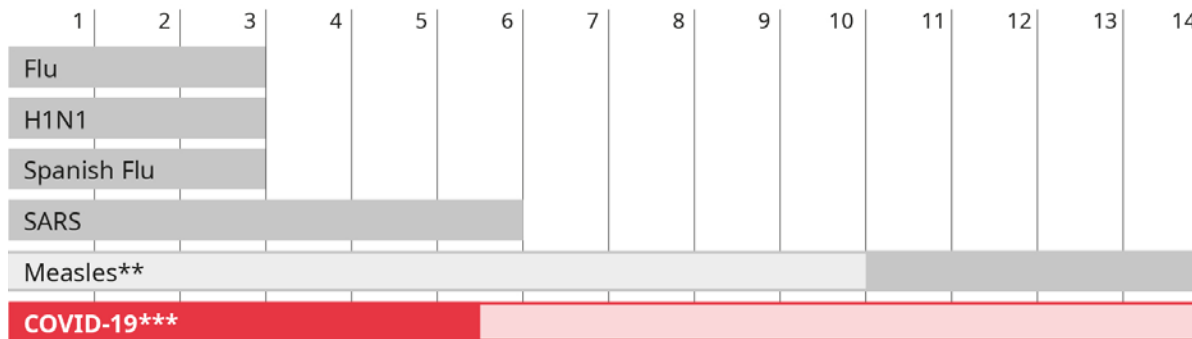
- R-naught (R0) represents the number of cases an infected person will cause
 - Initial estimates suggested COVID-19 R0 is between 2 and 3 (with edge of range estimates closer to 1.4 and 3.6), which means each person infects 2-3 others³; R0 for the seasonal flu is around 1.3⁴
 - New emerging estimates suggest R0 may be closer to 5.7 (edge of range 3.8-8.9)⁶
- The global case fatality rate for confirmed COVID-19 cases is currently 5.98%⁵ according to WHO's reported statistics versus 0.1% for the seasonal flu; the rate varies significantly by country (e.g., Italy – 12.7%, South Korea – 1.9%⁵)
- We expect case fatality rates to fluctuate as testing expands identifying more cases and as existing cases are resolved

1. New York Times ([link](#)) for fatality and R-naught comparisons, CDC timelines for case numbers (selected link: CDC [SARS](#) timeline); 2. Updated CDC estimates ([link](#)); 3. The R0 for the coronavirus was estimated by the WHO to be between 1.4 -2.5 (end of January estimate) ([link](#)), other organizations have estimated an R0 ranging between 2-3 or higher ([link](#)); 4. CDC Paper ([link](#)); 5. Calculated as Number of Deaths / Total Confirmed Cases as reported by John Hopkins University. 6. Emerging Infectious Diseases ([link](#))

HOW DOES COVID-19 COMPARE TO OTHER DISEASE OUTBREAKS? (2 OF 2)

The infectious cycle of COVID-19 is unlike that of any other outbreak we have seen before

Incubation Timeline (Days)*, 1



*All but SARS have the potential for asymptomatic transmission

**Symptoms most commonly appear on Days 10-14

***The median incubation period for COVID-19 is 5.5 days, but symptoms can develop as late as 14 days post exposure

Why does this matter?

- The combination of a longer incubation period with asymptomatic transmission means that there is a longer window of time during which infected individuals are unaware that they are contagious

Why is quarantine 14 days?

- While the median incubation period is 5.5 days, symptoms have been documented to occur over a longer time frame; 14 days should capture 99% of all cases²

What do we still not know?

- We still do not accurately understand the full infectious period for COVID-19

What we know about the infectious cycle?

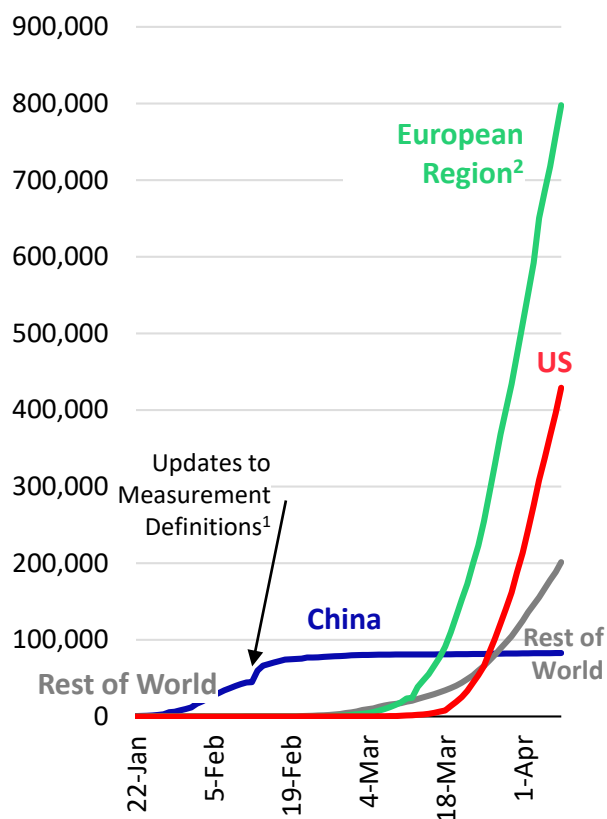
- Multiple sources confirm asymptomatic transmission, but the exact timing of when an exposed individual becomes contagious is not known^{3, 4, 5}
- Initial reports suggest a latency period of 3 days (with substantial variability) prior to an individual becoming infectious⁷
- Viral loads build rapidly and continue to shed until 6-12 days after symptoms have cleared⁶

1. CDC 2. Annals of Internal Medicine ([link](#)) 3. JAMA ([link](#)) 4. NEJM ([link](#)) 5. Science ([link](#)) 6. medRxiv ([link](#)) 7. SARS-CoV2 by the numbers ([link](#))

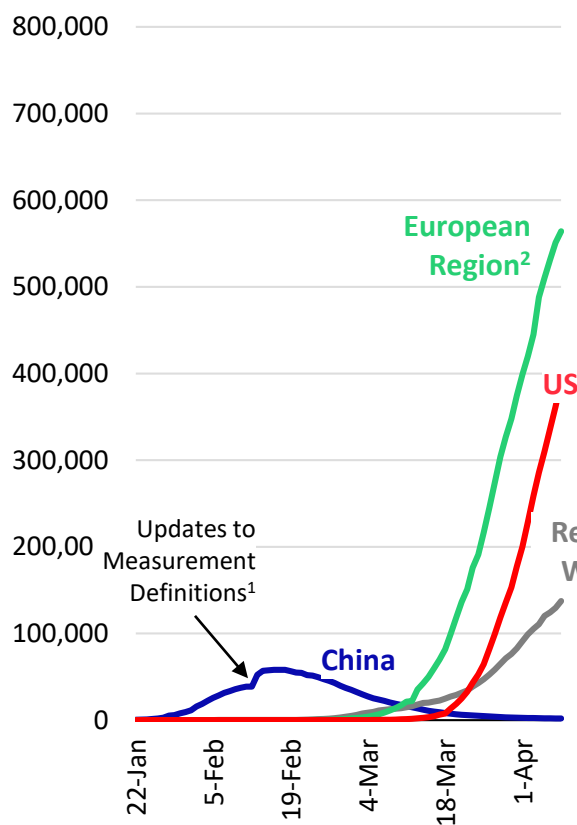
COVID-19 TRENDS AND SPREAD OF THE DISEASE

The number of new cases in China has slowed – likely due to significant containment measures – as the outbreak spreads to other countries

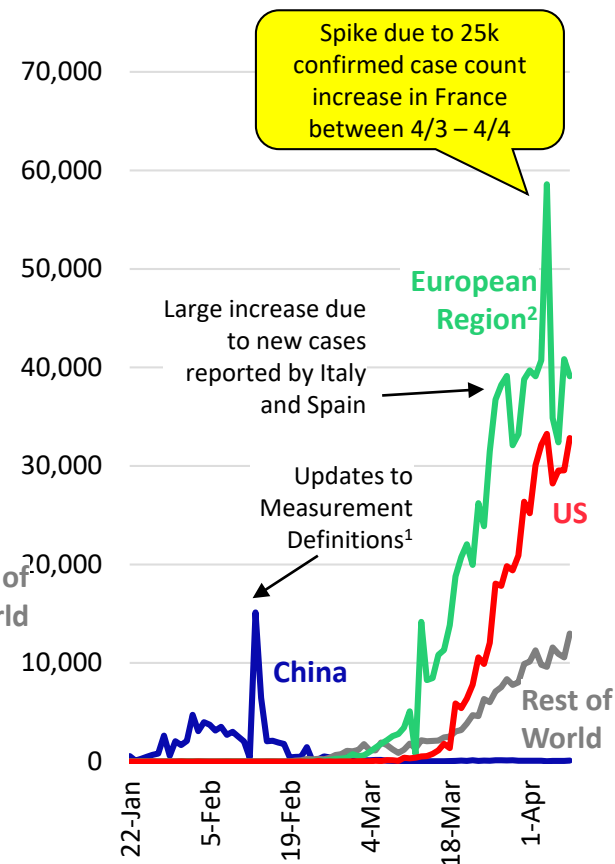
Cumulative Confirmed Cases of COVID-19



Active cases per day of COVID-19



New Cases Per Day of COVID-19



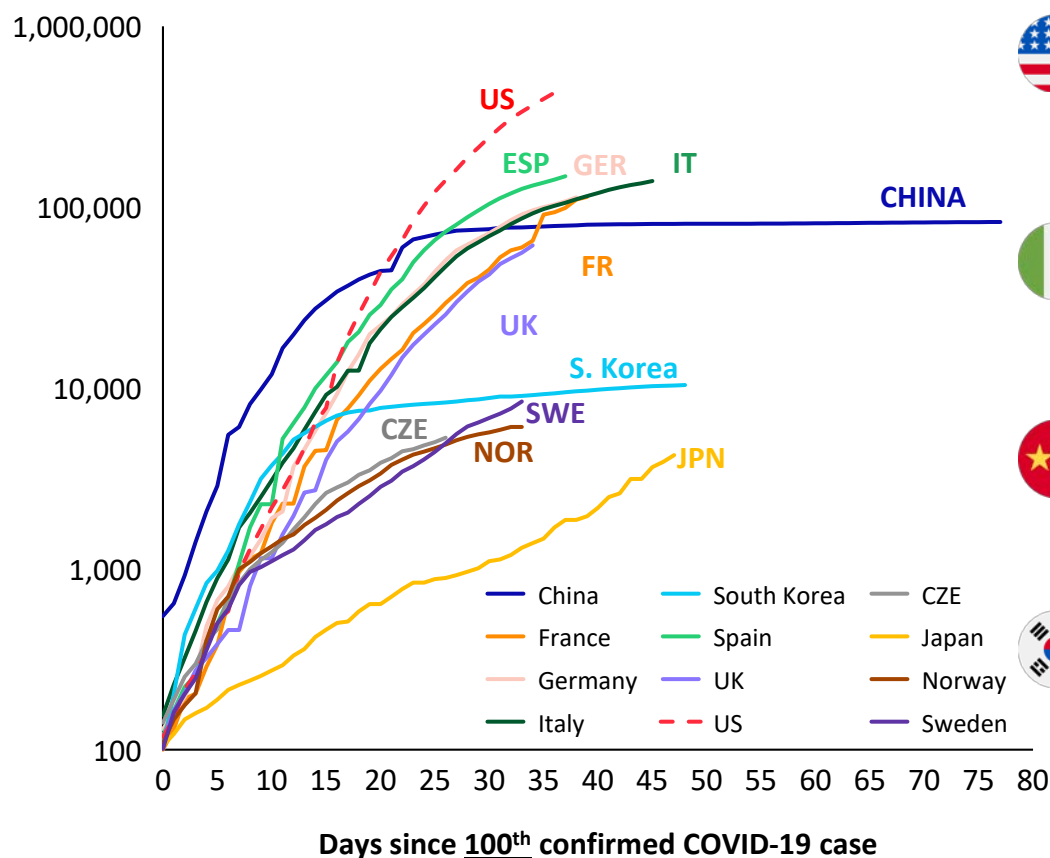
Source: John Hopkins University & Medicine Coronavirus Resource Centre

1. Until February 17, the WHO situation reports included only laboratory confirmed cases causing a spike in total cases. Some sources include this update as of February 13. The jump due to inclusion of non lab confirmed cases is not included in the new cases data in WHO situation reports.; 2. Includes countries categorized under "European region" based off of latest WHO Situation Reports

MOST COUNTRIES – INCLUDING THE US – CONTINUE TO SEE EXPONENTIAL GROWTH; CHINA AND SOUTH KOREA HAVE FLATTENED THE CURVE

Cumulative confirmed cases by country

Log scale



- Lack of broad testing early, followed by rapid ramp-up may explain part of steep growth rate
- Response left largely to individual states
- More than half of states implemented state-wide stay at home orders between March 19 and April 1



- Initial ring-fencing limited to Lombardy, at 8k cases (day 15 in chart), with ongoing travel still permitted
- Broader shutdown at 12k cases (day 17 in chart)



- Enforced city-wide quarantine of Wuhan post-outbreak
- Early containment outside Hubei halted growth
- Mobile monitoring / enforcement (via WeChat, etc.)



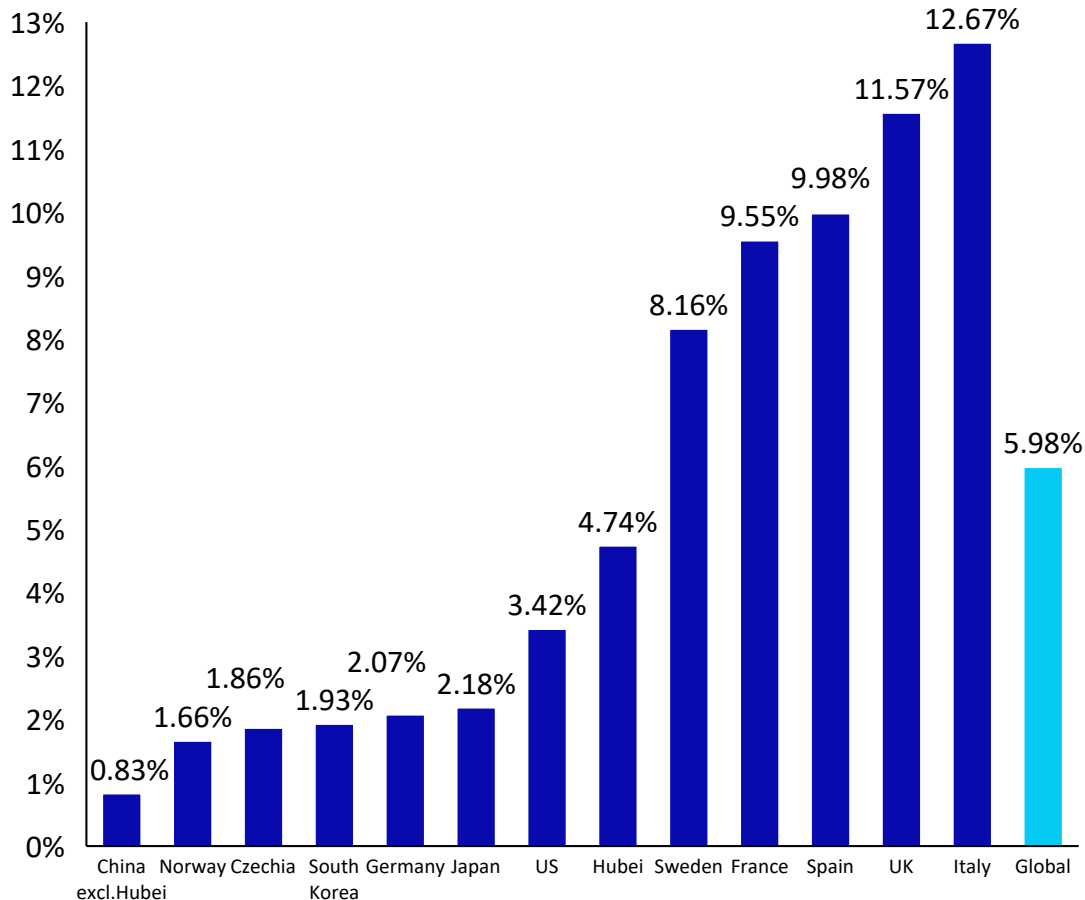
- Massive early testing (as of 3/28, >6.5k tests per million vs. US estimated ~2k tests per million people)
- Quarantined patients monitored via mobile app
- Epidemic response in place from SARS outbreak

Sources: JCSSE (Johns Hopkins), local news and county health departments, as of 3/17. Pre-WHO China data from [NHC](#) Containment sources: [China](#), [S. Korea](#), [US](#) and [testing](#) stats, [Italy](#)
 100th case on: Italy: 2/23, S. Korea: 2/20, US: 3/3, China: before 1/18, UK: 3/5, France: 2/29, Germany: 3/1; Spain 3/2, Czechia: 3/13. Data from JHU 4/8/2020.

CASE FATALITY RATE (CFR) BY COUNTRY

While the global CFR is a useful metric to understand COVID-19, country-specific CFRs range by an order of magnitude

CFR by country¹



What is driving the variation?

- **Position along the trajectory of the outbreak:** For many countries (e.g., Europe, US), the vast majority of cases have not yet resolved and the CFR is changing rapidly
- **Breadth of testing:** Broader testing leads to a larger confirmed base of patients, decreasing CFR
- **Distribution of key risk factors within the population:** Age, gender and pre-existing conditions have a significant influence on mortality (see next page); countries with higher CFRs have a population skewed towards these risk factors (e.g., Italy has the second oldest population on earth)
- **Health system threshold:** Every country has a health system capacity, that when exceeded, will result in the inability to provide sufficient support to all patients thereby resulting in a higher CFR

Note that case fatality rates are still unstable as greater than 80% of cases outside of China are still active

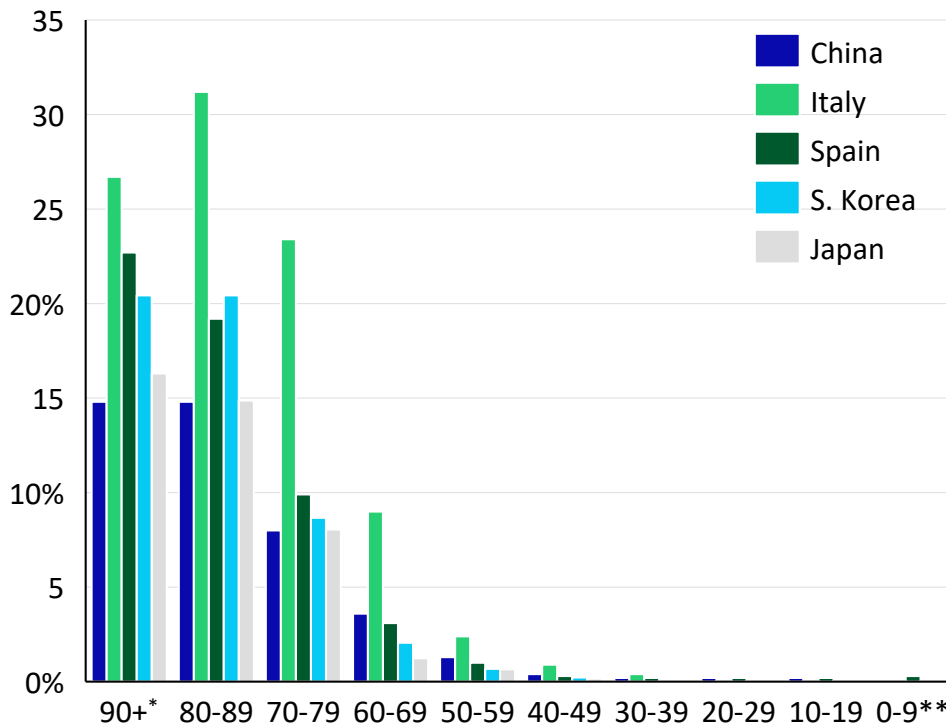
1. Calculated as Number of Deaths / Total Confirmed Cases as reported by Johns Hopkins University

CASE FATALITY RATE (CFR) BY PATIENT CHARACTERISTIC

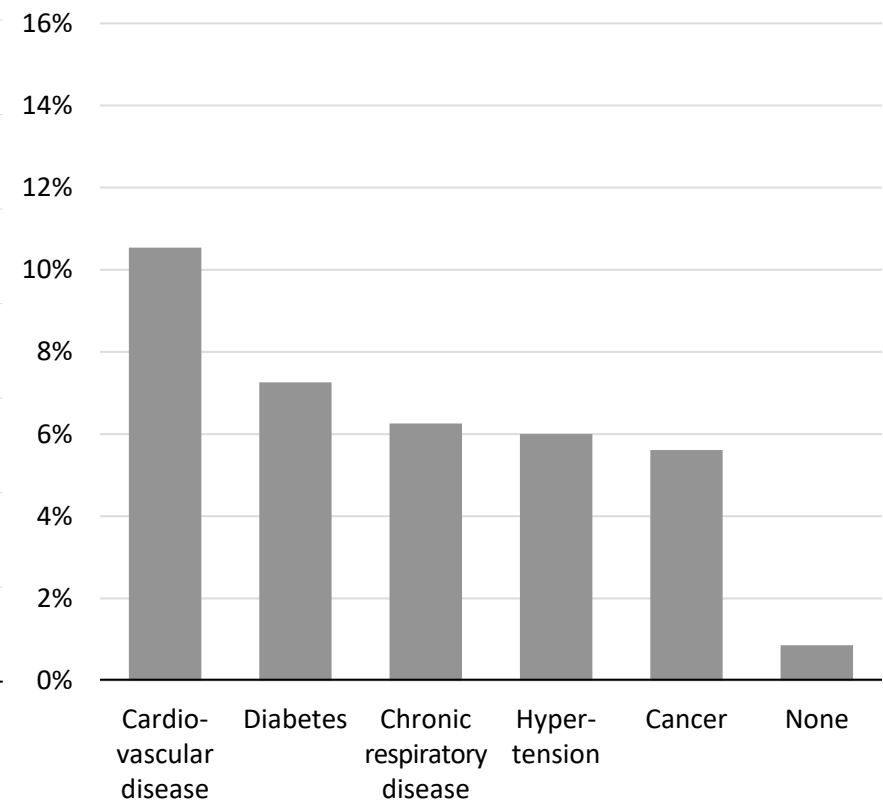
Significantly higher death rates occur among the elderly and those with underlying conditions

Case Fatality Rate by Specific Patient Characteristics

by Age^{1,2,3}



by Comorbid Condition¹



1. China data as of 02/11/2020 ([link](#)) 2. Italy data as of 04/08/2020 ([link](#)) 3. S. Korea data as of 04/08/2020 ([link](#)) 4. Spain data as of 04/08/2020 ([link](#)) 5. Japan data as of 04/06/2020 ([link](#))

Notes: Data from China includes 72,314 confirmed cases reported through February 11, 2020, which is the latest data available as of 04/08/20.

* China and South Korea do not provide data for ages 80+, same percentage has been listed for 80-89 and 90+ for those two countries ** Italy does not provide data for ages 0-9 and 10-19 separately, the same percentage has been listed for both ranges. ***Japan and Italy data includes a small proportion of cases without a specified age, these were not included

EARLY DATA SUGGEST RACE AND GENDER-BASED DISPARITIES

These may arise largely from existing differences in underlying conditions

In the US: African Americans are harder hit

- CDC report covering 3/1-3/30 for 14 states: 33% of COVID-19 hospitalizations are of African Americans, though only 18% of total population in relevant states is African American¹
- Dovetails with earlier piecemeal reports:

For cases in which race is available, % African American:

Region	% of Cases	% of Deaths	% Total Pop
Milwaukee ²	50%	81%	26%
Michigan ²	35%	40%	14%
Chicago ³	Unavailable	70%	29%
North Carolina ⁴	38%	39%	22%

• Likely causes

- Higher proportion of pre existing conditions (*e.g.* 40% of African Americans have hypertension vs. 29% of total pop⁵)
- Lower income and likely to have hourly jobs that do not allow work from home⁶
- Racial bias in treatment: review of lab billing information suggested African Americans with coronavirus symptoms were less likely to be tested⁷

Globally: Men are at higher risk

- Illness rates are higher among men than women globally, though the extent depends on the dataset⁸
 - Chinese CDC reported that 53% of cases are male
 - WHO found 51%
 - Wuhan-specific study found 58%
 - Recent US CDC report noted higher COVID-19 hospitalization rates for males (5.1 vs. 4.1 per 100K population)¹
- An even clearer difference is observed in death rate⁸
 - China saw a 1.7% fatality rate for women vs. 2.8% for men
 - In Spain, men make up 65% of deaths
 - In Italy 8% of male patients died vs. 5% of women
- Likely causes
 - Women often have stronger immune systems potentially mediated by estrogen activity
 - Men may exhibit more behaviors associated with contracting COVID-19 (more travel, more outside-of-home work)
 - Men are more likely to have underlying conditions that increase risk of COVID-19 hospitalization and death

1. [States included CA, CO, CT, GA, IA MD, MI, MN, NM, NY, OH, OR, TN, UT \(Source link\)](#)

2. [As of 4/3 \(Source link\)](#)

3. [As of 4/5 \(Source link\)](#)

4. [As of 4/9 \(Source link\)](#)

5. <https://www.cdc.gov/nchs/products/databriefs/db289.htm>

6. <https://www.statnews.com/2020/04/06/flying-blind-african-americans-disparities-covid-19-data-limited/>

7. <https://khn.org/news/covid-19-treatment-racial-income-health-disparities/>

8. <https://www.statnews.com/2020/03/03/who-is-getting-sick-and-how-sick-a-breakdown-of-coronavirus-risk-by-demographic-factors/>

AT A GLANCE: SUMMARY FACTS

	Key facts	Implications
Contagion	<ul style="list-style-type: none"> Initial estimates suggested COVID-19 R0 is between 2 and 3 (with edge of range estimates closer to 1.4 and 3.6), which means each person infects 2-3 others³; R0 for the seasonal flu is around 1.3⁴ New emerging estimates suggest R0 may be closer to 5.7 (edge of range 3.8-8.9)¹⁴ 	COVID-19 is at least twice as contagious as the seasonal flu
Current human immunity	<ul style="list-style-type: none"> No herd immunity exists yet as the virus is novel in humans 	Social distancing (quarantines, WFH, school closures) is the only “brake” to slow the spread
Incubation period	<ul style="list-style-type: none"> The incubation period is a median of 5.5 days (up to 14 days)^{1, 10}, while the annual flu is commonly a 3-day period¹; data suggests that viral shedding continues beyond symptom resolution⁶ 	People are contagious for longer periods than the flu or other illnesses, requiring longer bouts of quarantine to truly suppress spread
Fatality	<ul style="list-style-type: none"> Case fatality rates are trending at 6.0% globally⁸ (vs. 0.1% for the flu)⁹ Estimates for infected fatality rate are 0.3%-1.3% based on assumptions around the number of undiagnosed individuals¹³ 	Fatality is orders of magnitude higher than typical influenzas
Portion of cases asymptomatic but contagious	<ul style="list-style-type: none"> COVID-19 can be spread asymptomatically⁵ Of those people tested and confirmed positive for COVID-19, experts estimate 18-30% are asymptomatic, with another 10-20% with mild enough symptoms to not suspect COVID-19¹¹ Early indicators from comprehensive testing of small populations (e.g., Vo, Italy; Iceland) suggest as many as 50% of cases could be asymptomatic¹² 	People who feel “fine” are capable of – and are -- transmitting COVID-19 to others
Portion of cases reaching “critical/“severe” infection	<ul style="list-style-type: none"> Approximately 19% of confirmed cases are considered “severe” or “critical”, requiring hospitalization, and 1/4th of those need ICU beds⁷ 	Hospital systems risk being overtaxed (ICU beds, ventilators, PPE) meaning case fatality rates could rise further

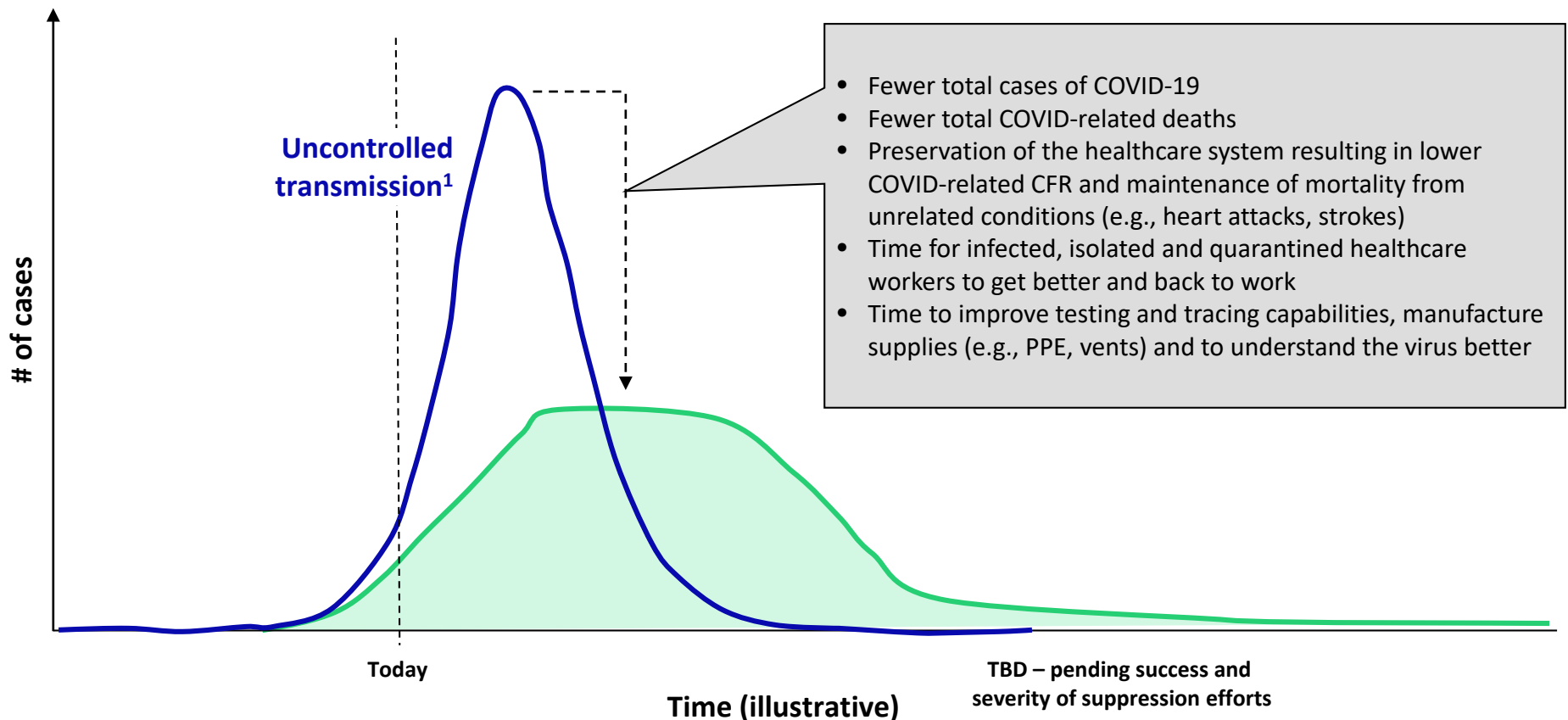
1. CDC. 3. The R0 for the coronavirus was estimated by the WHO to be between 1.4 -2.5 (end of January estimate) ([link](#)), other organizations have estimated an R0 ranging between 2-3 or higher ([link](#)); 4. CDC Paper ([link](#)); 5. JAMA. “Presumed Asymptomatic Carrier Transmission of COVID-19” 6. MedRxiv. “Clinical presentation and virological assessment of hospitalized cases of coronavirus disease 2019 in a travel-associated transmission cluster”. Mar 8. 2020. 7. China CDC, JAMA ([link](#)). 8. JHU. 9. CDC. 10. Annals of Internal Medicine ([link](#)) 11. Nature article ([link](#)), Eurosurveillance Paper ([link](#)) 12. ZMEScience report ([link](#)) 13. SARS-CoV2 by the numbers ([link](#)) 14. Emerging Infectious Diseases ([link](#))

HOW CAN SUPPRESSION MEASURES LOWER THE BURDEN OF THE PANDEMIC?

Leaving the disease unconstrained is not an option; aggressive suppression measures can ease the impact of the disease on health systems

Illustrative COVID-19 transmission with and without suppression measures

Timing and width of peaks may vary between countries



1. Assuming case-based isolation only

Source: Adapted from “How will country-based mitigation measures influence the course of the COVID-19 epidemic”. Lancet. Mar 6 2020. [https://doi.org/10.1016/S0140-6736\(20\)30567-5](https://doi.org/10.1016/S0140-6736(20)30567-5). Concepts sourced from Tomas Pueyo.

WHAT LEVERS CAN HELP SUPPRESS THE PANDEMIC?

Two approaches to initial suppression exist; but given the progression of the disease and the currently available tools the only current option for most countries/ regions is aggressive social distancing

Levers in response to pandemic^{1, 2, 3}



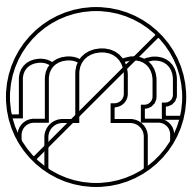
Testing, contact tracing and quarantine of infected

Outcomes

- Delays or prevents full scale outbreak
- Demonstrated to work successfully in S. Korea, Taiwan and China outside of Hubei

Requirements for success

- **Early initiation:** In order to use this lever to prevent an outbreak, the methodology needs to be applied as soon as cases are identified (e.g., S. Korea implemented nearly immediate action after initial case was identified on 01/20/20⁴)
- **Robust capabilities:** Broad testing capacity with rapid results, sophisticated contact tracing and sufficient control over population to ensure quarantine compliance



Aggressive social distancing of entire population

- Decreases R0 of the virus, decreasing daily growth rates and flattening the peak of cases
- Demonstrated to work successfully in Wuhan

- **Decisive, early action:** ‘Wait and see’ or fragmented approaches only worsen outcomes
- **Comprehensive plan:** Closing bars, schools, restaurants, gyms, churches to maintain social distancing, restricting non-essential travel and quarantining all infected patients including asymptomatic ones
- **Compliance (enforced if necessary):** Experience in the US and Europe demonstrates that lack of compliance worsens outcomes

Sources: 1. Adapted from “How will country-based mitigation measures influence the course of the COVID-19 epidemic”. 2. Lancet. Mar 6 2020 ([link](#)) 3. Concepts sourced from Tomas Pueyo. 4. Center for Strategies and International Studies ([link](#))



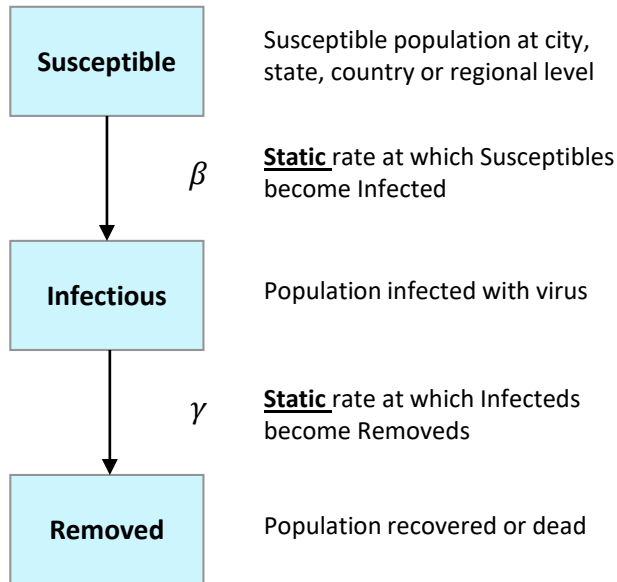
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SUPPRESSION SCENARIOS

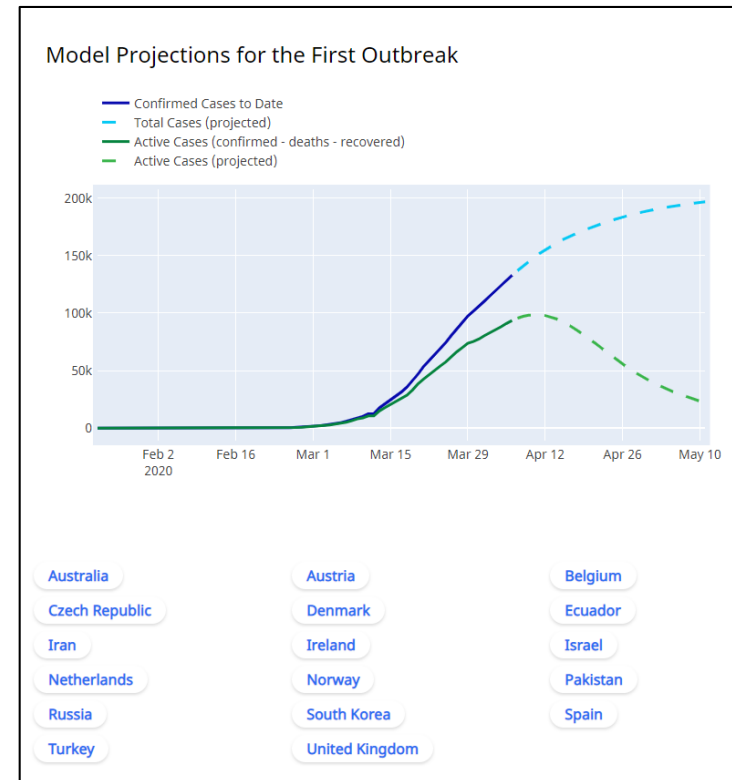
FORECASTING THE PEAK(S)

Determining when we can relax suppression requires a credible forecast of when the peak(s) are likely to arrive

Standard Susceptible, Infected and Removed (SIR) models have a reasonably framework but use static variables to project progression



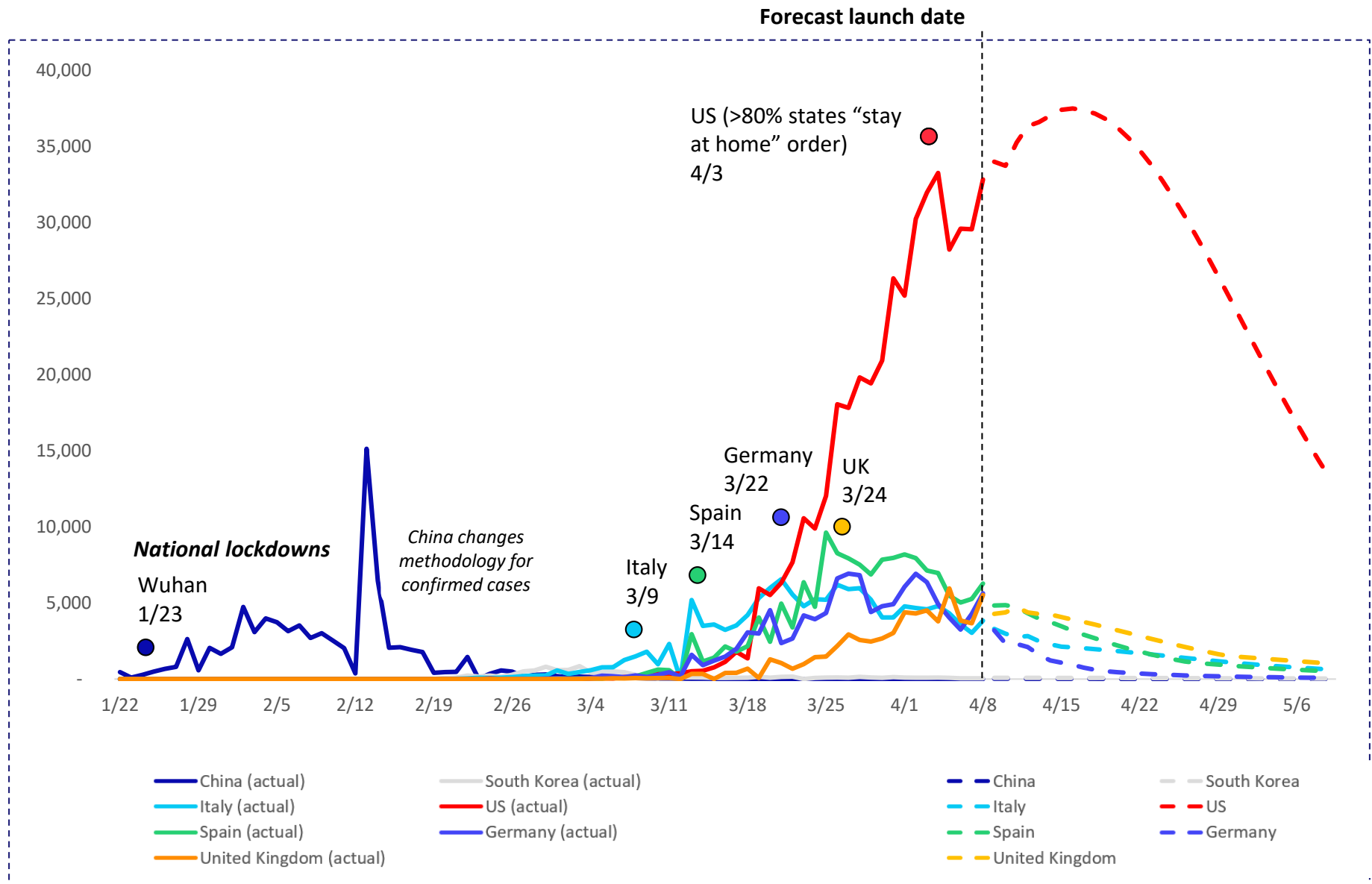
- In contrast, Oliver Wyman's model generates a time series of $\beta(t)$ and $\gamma(t)$ from actual experience of each country or state
- Incorporates virus spread and impact of human/government actions,
- Projects the trends under the same strategy or modeling alternative strategies to manage active cases



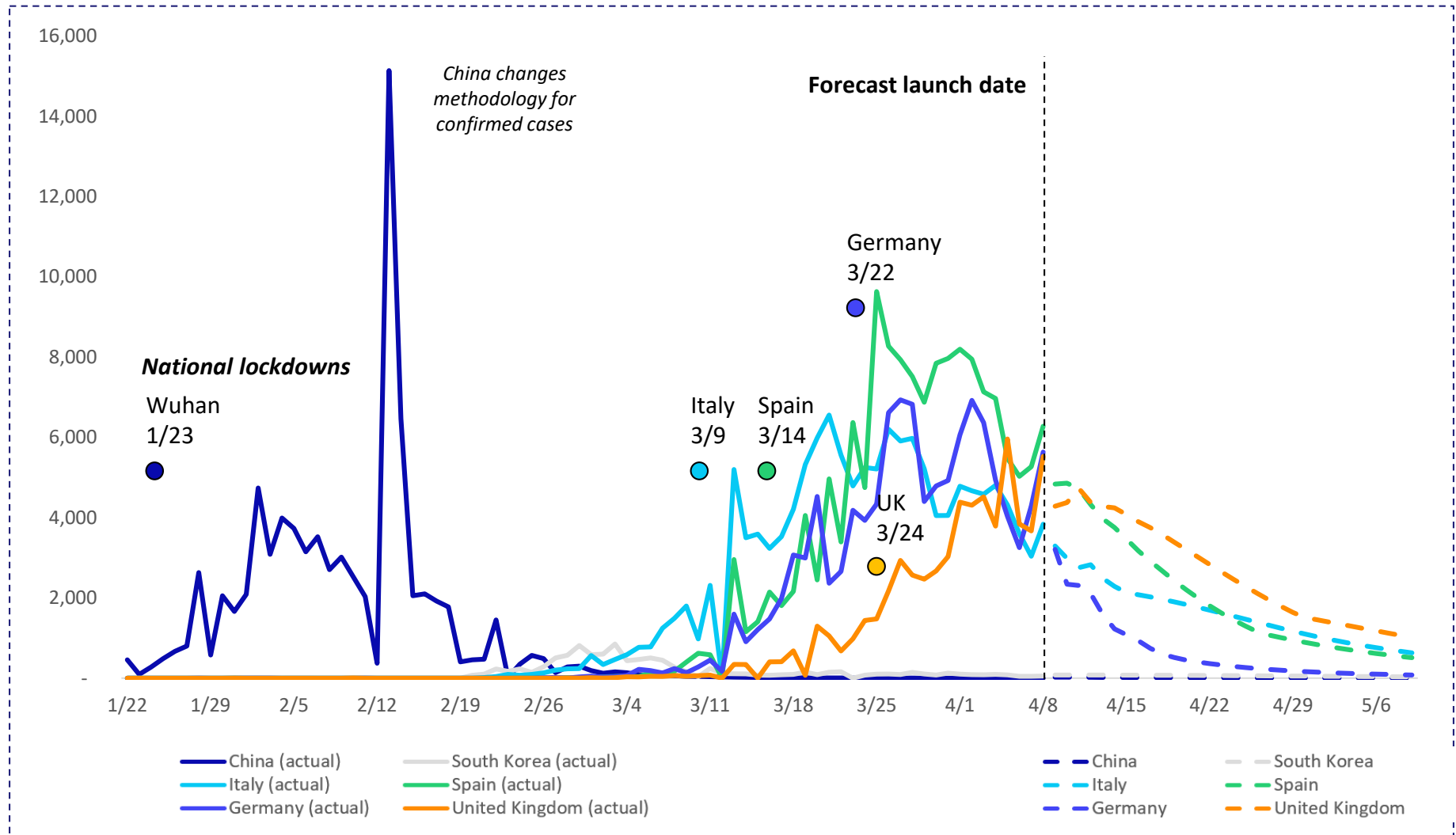
Registration link for new users:

<https://oliverwymangroup.wufoo.com/forms/s12hwj5h0qqcxx1/>

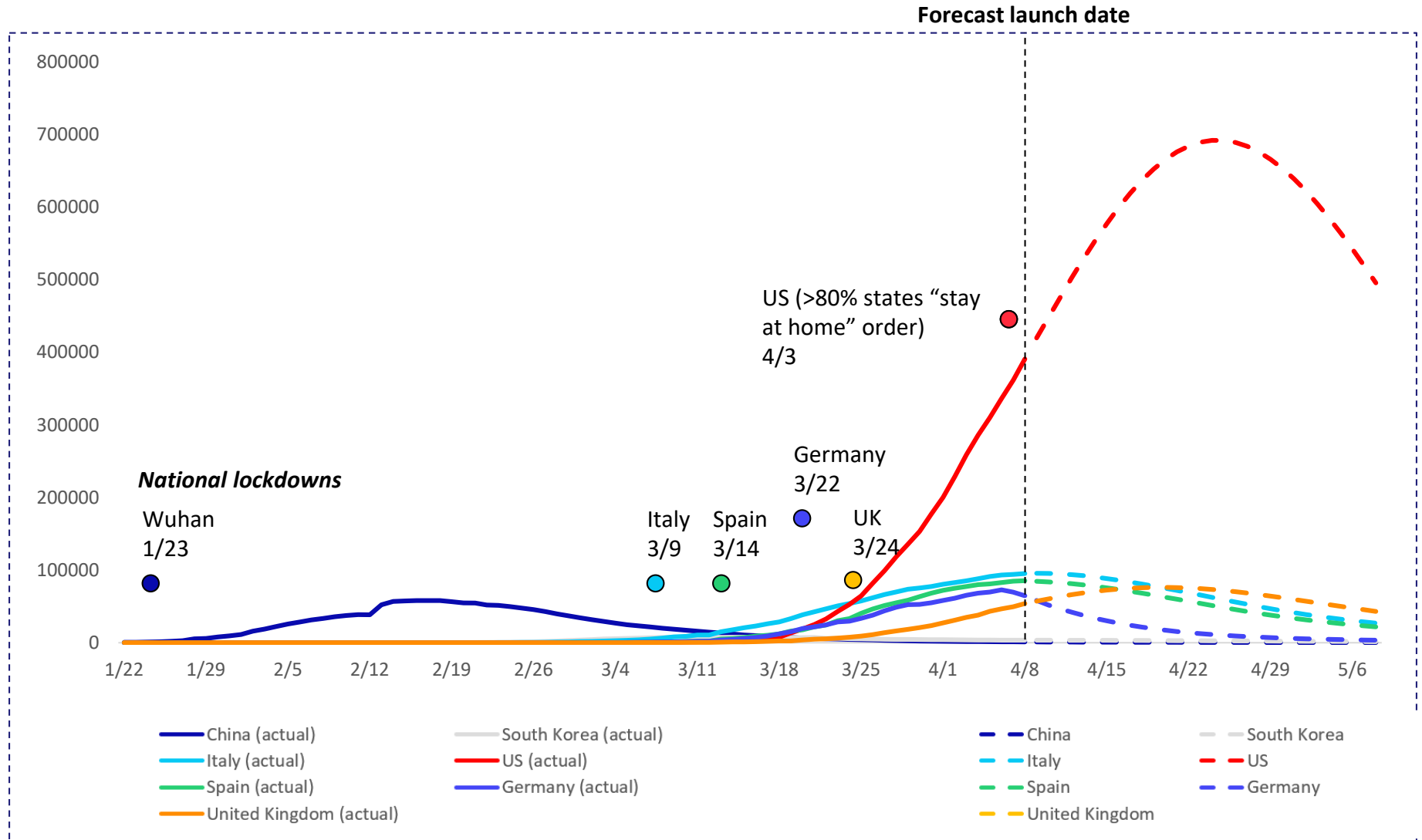
COVID-19 PROJECTIONS— NEW CASES



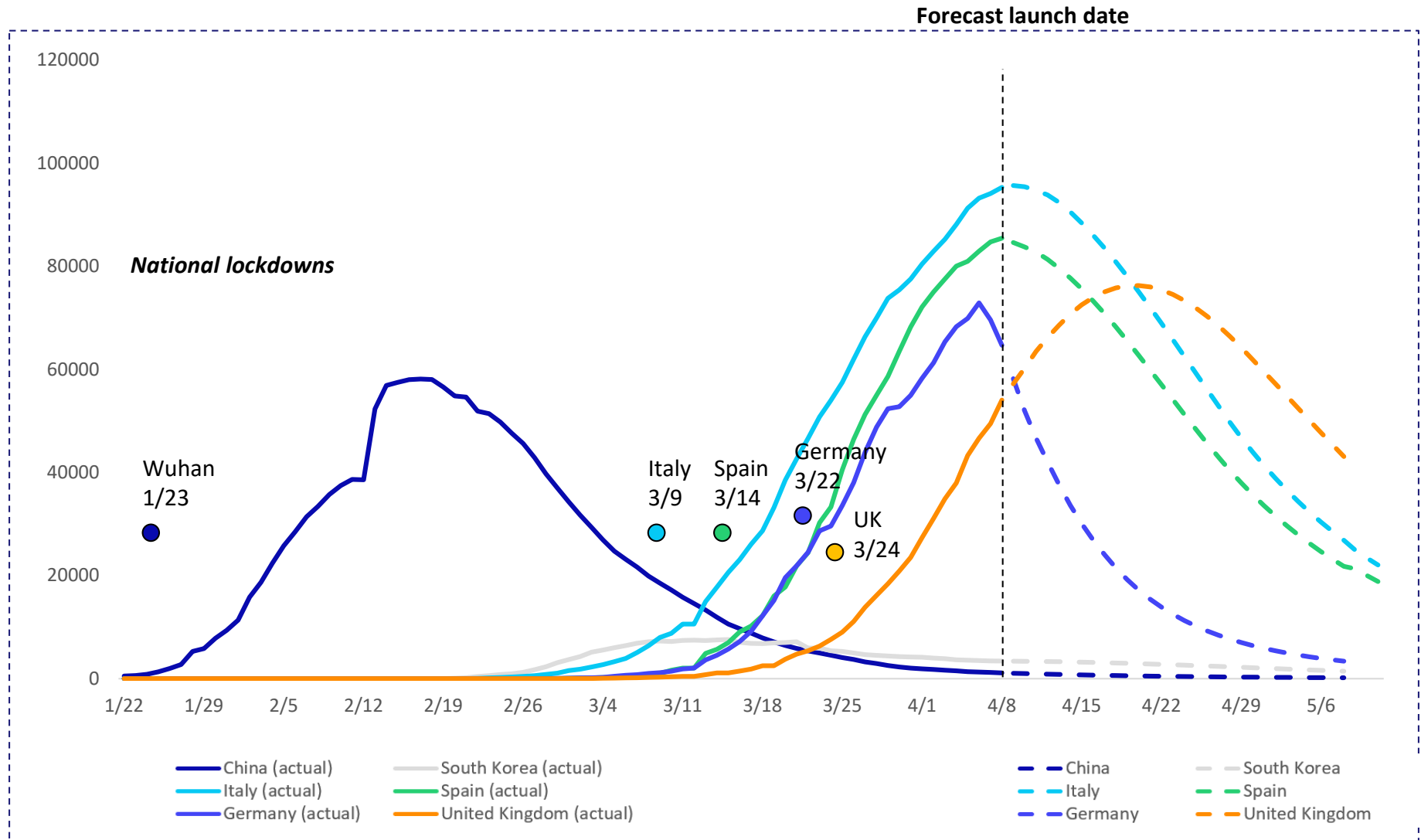
COVID-19 PROJECTIONS – NEW CASES (EXCLUDING U.S.)



COVID-19 PROJECTIONS – ACTIVE CASES



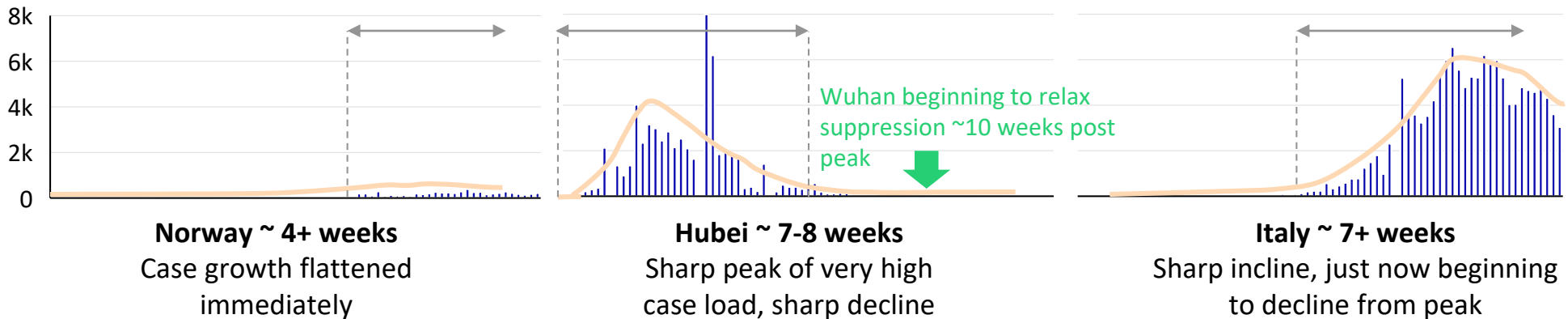
COVID-19 PROJECTIONS – ACTIVE CASES (EXCLUDING U.S.)



HOW LONG WILL SUPPRESSION TAKE? HOW WILL IT PLAY OUT?

There are a number of prerequisites to relaxing suppression

Local pandemic progression examples¹



When is it safe to *begin* relaxing suppression?



Time since peak: bare minimum to ensure infection rates have sustainably slowed

- At a **minimum**, new cases consistently declining for 14 days: this implies R_0 below 1 for a full incubation period
- 14 days represents the earliest point at which *some* measures may begin to relax, not complete ending of suppression
- Hubei did not begin broader relaxation until 10 weeks post-peak, and some suppression measures remain (*e.g.* schools are not yet open)
- Not a one-time process: Multiple cycles of relaxation, new case acceleration, and suppression are likely to be necessary



True rate limiter is latency to build develop necessary capacity/capabilities



Healthcare system capacity

Sufficient beds, personnel, and other resources exist to manage continuing COVID volume and other healthcare demand without reverting to crisis mode



Tools

Capabilities to maintain control over spread and reengage suppression if necessary

1. Example charts are derived from real data as reported by Johns Hopkins University spanning 01/22/2020-04/01/2020. Bars represent new confirmed cases by day. Grey arrows symbolize time span from ramp-up of new case load to point of control and are approximate
© Oliver Wyman



THE HEALTHCARE SYSTEM NEEDS TO RECOVER BEFORE SUPPRESSION IS RELAXED

Timing will vary across regions based on current healthcare system characteristics and the shape of the outbreak but will require at least two weeks post-peak and likely much longer

Clearing the backlog of COVID-19 patients

- The peak of active, hospitalized cases will lag the peak of new cases
- Global hospital length of stay (LOS) has hovered around 12 days for patients who do not need ICU care, and 16 for those who do¹; implying a two week lag before relief is evident in med-surg units, and longer for ICUs
- Further time is required to allow COVID volume to reduce such that there is sufficient capacity to provide a normal or close-to-normal volume of non-COVID care
- Some pent up demand for urgent non-COVID care should also be anticipated; health system capacity must be allowed to return to a state that can manage this short term surge

Healthcare workforce recovery

- Temporarily, much of the healthcare workforce will be exhausted, an immediate return to full capacity is not feasible and risks effective response in the case of resurgence
- Capacity in hard-hit regions will be reduced for some period of time, requiring extra caution when reducing suppression
 - Many clinicians have been infected with COVID-19, resulting in death and disability particularly for older members of the workforce
 - New clinician education has been disrupted

Supply recovery

- Personal protective equipment and other high-demand supplies will need time to be replenished

Capacity re-conversion

- Significant capacity has been converted to manage COVID-19 patients; that capacity will take time to revert
- Some capacity may not be reverted in anticipation of resurgence, meaning overall non-COVID-19 capacity will be reduced and requiring a longer latency before capacity can manage relaxation of suppression

Long-term model changes (suppression can be relaxed in parallel)

- Renovating facilities and staffing models to allow more flexible temporary increases in capacity, and easier sequestration of COVID-19 care will allow faster recovery in future outbreaks
- Further expanding digital models of care will also free up capacity, allow more normal care during future outbreaks, and faster recovery after

Policymakers will need a consolidated view of overall healthcare system resources and readiness to inform when to relax suppression measures and re-impose as necessary

1: Source- Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College COVID Response Team. Ferguson. Mar 16 2020.



THE LAST REQUIREMENT FOR LIFTING SUPPRESSION MEASURES IS A SET OF SCALED, SOPHISTICATED TOOLS TO ENABLE NEAR REAL-TIME MONITORING OF THE DISEASE

NATIONAL SURVEILLANCE SYSTEM

- Comprehensive system that is supported by and coordinated with local public health systems and health care providers
- Tracks the background rate of infection across states and identifies any community spread
- Works in near real-time, such that any upticks in infection can quickly be managed through case-based intervention
- Allows the careful “dance” of loosening and tightening of suppression measures in data-driven fashion
- Hong Kong¹ and Singapore² are examples of highly sophisticated systems

SCALED DIAGNOSTIC TESTING

- Same day, point of care testing across in- and outpatient settings for hospitalized patients, front line workers, close contacts of confirmed cases and anyone with symptoms
- Broad community testing (details on next page)
- Serologic testing to understand not just current cases, but anyone who was previously infected and may be immune
- S. Korea is best in class at scaled, highly effective testing using non-hospital based testing centers, drive through stations and phone booth-like protection for testers

CONTACT TRACING AND SELECTIVE QUARANTINE

- Scaled tracing capabilities (using existing data sources or new technology) and a significantly increased public health workforce
- Rapid data entry and reporting capabilities feeding into the National Surveillance System
- Scaled abilities to enforce and support quarantine (e.g., food delivery, isolation support, community-based treatment for quarantined individuals)
- China, S. Korea, Israel, and Singapore have used highly sophisticated approaches to surveillance and contact tracing (details on page 27)

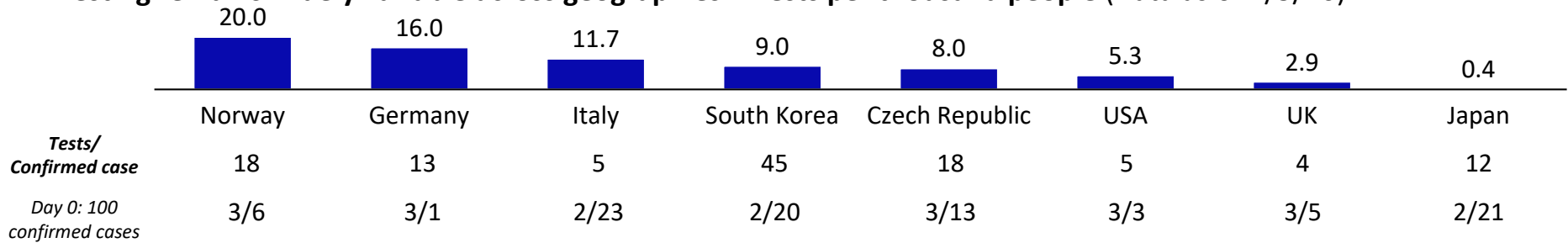
Sources: Adapted from AEI National Coronavirus Response, A Road Map to Reopening ([link](#)) and Tomas Pueyo's The Hammer and the Dance ([link](#))

1. [Link](#) 2. [Link](#)



IN ANY SUPPRESSION APPROACH, TESTING IS A CRITICAL COMPONENT OF A SUCCESSFUL STRATEGY TO PINPOINT INFECTION AND UNDERSTAND SPREAD

Testing remains widely variable across geographies – Tests per thousand people (Data as of 4/5/20)¹



Two types of COVID-19 tests will play a critical role in COVID-19 management

COVID-19 Genetic Material (mRNA) Polymerase Chain Reaction Swab Tests

Description

- **Best for diagnosis** - Used to detect active infections through COVID-19 mRNA identification via PCR tests –

Importance

- Rapid tests to diagnose COVID-19 are needed to allow swift countermeasures
- Widely available and routine testing protocols are needed to identify emerging outbreaks
- Once social distancing has had its effect, testing will be a return-to-normalcy tool

Status

- Testing capacity, effectiveness, and rapidity is increasing
- As of 4/9, 31 companies have received FDA emergency authorization to conduct their rapid tests²

Antibody Serology Test

- **Best to identify prior contraction of disease** - Blood tests to detect antibodies, innately created to fight COVID-19 infections by the body

- Serological tests will elucidate true scope of the pandemic post-hoc – testing gaps and asymptomatic patients to date have stymied understanding
- Will also give insight into what happens to people who have been infected in terms of future immunity and/or infectiousness

- Many companies still in test development
- As of 4/9, only 1 company has received FDA emergency authorization to conduct their rapid tests (Cellex)²



Source: 1. Our World in Data ([link](#)) – testing units vary by country as different types of data are reported. 2. FDA ([link](#)).

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TO AVOID HAVING TO USE BROAD SUPPRESSION MEASURES, A COUNTRY MUST BE ABLE TO TRACE THE CONTACTS OF ANY INFECTED INDIVIDUALS AND ISOLATE THEM

← Most invasive

Least invasive →

Case Study: China¹

- **The Alipay Health Code:**
 - Program originated in Hangzhou, China; as of 2/24 90% of the province's population had downloaded the app and 100 Chinese cities were using it
 - Uses big data to determine if an individual is a contagion risk or not
 - Individuals are assigned a green, yellow, or red color code that indicates health status
 - QR code on phone is required for entry into many common areas, public transportation, health checkpoints, etc
 - App shares personal data including location with the police

Case Study: South Korea²

- **Tracking:**
 - Retrace physical steps of anyone who tested positive
 - Used credit card records, GPS data and security-camera footage
- **Mass messaging:**
 - Emergency cell phone alerts any time there is a confirmed case in individual's district
 - Apps and websites list detailed timelines of infected individuals' travel
 - Anyone having potentially crossed paths with individual urged to go to testing center
- **Quarantine enforcement:**
 - Quarantined individuals required to have cell phone apps that alert officials if they venture out with fines for violations

Case Study: Germany^{3, 4}

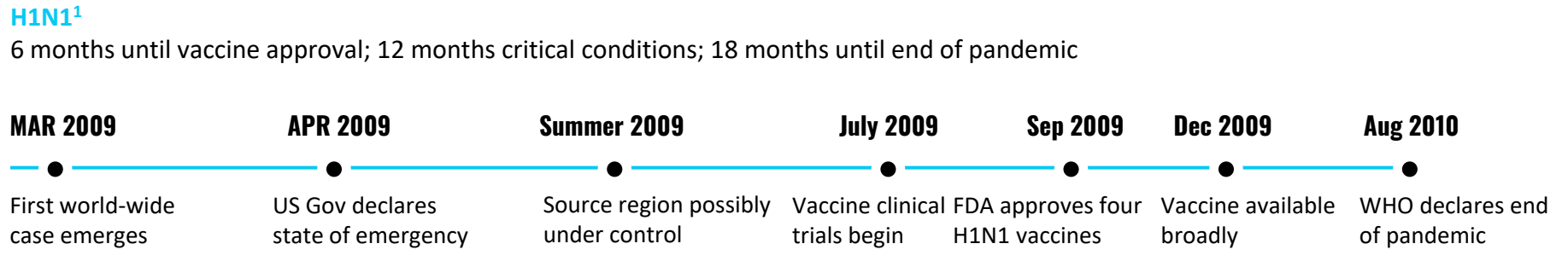
- **Pan-European Privacy Preserving Proximity Tracing (PEPP-PT)**
 - Heavy focus on preserving individual privacy, while allowing tracking and tracing
 - Doctors would get permission from those who test positive and enter their information into a central server
 - System uses Bluetooth to log a user's proximity to other cellphones, without storing data from location tracking
 - Users then receive a message if they have been in close contact with someone who has tested positive for COVID-19
 - The German government is aiming to launch the app by mid-April

HOW AND WHEN WILL WE RECOVER COMPLETELY?

A successful vaccine manufactured and deployed at scale is the only certain path to eradication

How long could that take?

- In short, 18+ months is likely for development, trials, approval and mass production
- The best comparison we have is the development of H1N1 vaccines under similar circumstances:



What is the current status?

- Several vaccine types could be considered for COVID-19: **1) traditional protein-based** (longer development, manufacturing timeframe but proven approach), **2) mRNA-based** (quick to design but less proven technology and efficacy, **3) DNA-based** (quick to design but less proven technology)
- At the outset of the pandemic, multiple biotechs have moved to create a COVID-19 vaccine – the first out of the gate are mRNA varieties
 - **Moderna**, a biotech, is the first to have launched clinical testing of an mRNA vaccine – first patient was dosed on 3/16/20 – but has not yet partnered with a larger, scaled PharmaCo; could potentially be available for high-risk healthcare workers in the fall (emergency use) in parallel with pivotal trials, with commercial availability perhaps as early as Q2 2021
 - **Pfizer and BioNTech** have partnered to test another mRNA vaccine starting in in late April 2020

What are the key issues (aside from the science of producing an effective vaccine)?

- **Large-scale manufacturing capacity** would be needed and is not readily available/scalable (GSK Shingrix example demonstrates multi-year lag between vaccine approval and production scale)
- **Timelines to produce required safety and efficacy clinical trial results** estimated to take 12-18 months, even if ‘fast tracked’

IS THERE ANYTHING THAT MIGHT IMPROVE THIS TIMELINE?

Three categories of therapeutics could speed up eradication or at least lessen the burden of severe disease and mortality

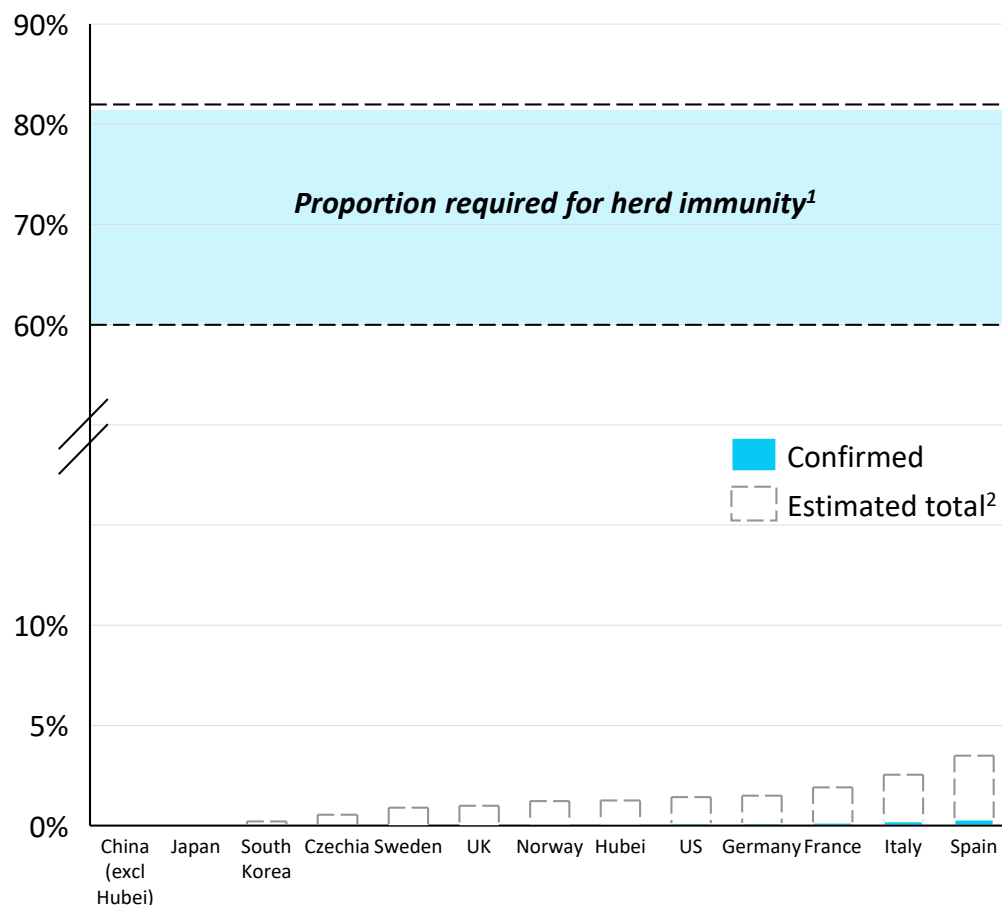
Product type	Description	Examples	Current state
Antivirals and products with antiviral effects	<ul style="list-style-type: none"> Products either directly target the virus or prevent it from targeting / entering cells Many of these products have already been proven safe as a result of clinical trials for efficacy against other diseases These products generally work best when given early in the course of the disease 	<ul style="list-style-type: none"> Remdesivir (Ebola) Chloroquine / Hydroxychloroquine (Malaria) Kaletra (HIV) Favipiravir (Influenza) Avigan (Influenza) Lopinavir (HIV) 	<ul style="list-style-type: none"> Clinical trials on-going with Remdesivir (results in April), Avigan (results April / May) and are planned for Kaletra Initial reports from small studies suggest positive results with Chloroquine (France) and Favipiravir (China) Subsequent physician reports on efficacy of Hydroxychloroquine have been mixed FDA granted emergency use designation for Chloroquine and Hydroxychloroquine (3/31)
Passive immunization	<ul style="list-style-type: none"> Products help the immune system fight the virus This type of product is common in treating cancer, rheumatoid arthritis and Ebola These would be the first generation of therapeutics specific to COVID-19 	<ul style="list-style-type: none"> Convalescent plasma (from recovered patients) Monoclonal antibodies (e.g., TAK-888, Leronlimab, Tocilizumab) Natural Killer cells (e.g., CYNK-001) 	<ul style="list-style-type: none"> Initially positive reports on use of convalescent plasma (China) and multiple on-going trials (e.g., JHU, Mt Sinai) Early clinical trials for many new and existing monoclonal antibodies as well as CYNK-001
Symptom and complication relief	<ul style="list-style-type: none"> A broad category of products that lessen the effect of the disease or the complications resulting from it (e.g., severe inflammatory response in the lungs) 	<ul style="list-style-type: none"> Actemra, Kevzara Sylvant 	<ul style="list-style-type: none"> Phase III clinical trials with Actemra and Kevzara are testing drugs' potential in reducing severe inflammation resulting from COVID-19 infection Clinical trial with Sylvant is testing whether it can reduce need for ventilation and shorten ICU length of stay

Sources: Adapted from Business Insider ([link](#)), Journal of Chinese Medicine Association ([link](#)), Archives of Emergency Medicine ([link](#)), Healthline ([link](#))

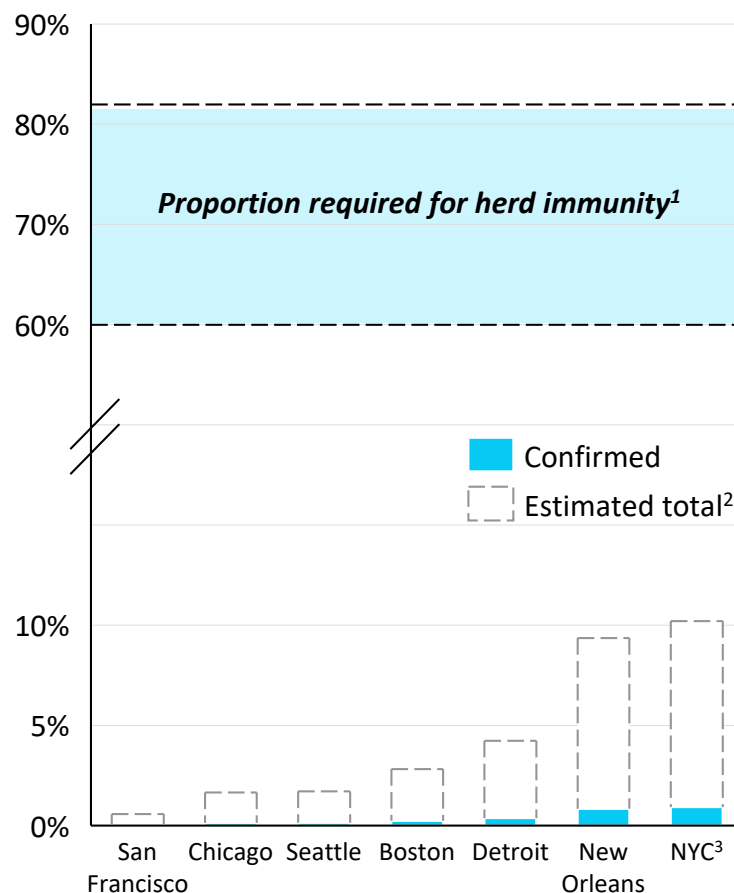
WHAT ABOUT HERD IMMUNITY – CAN THAT HELP?

Herd immunity is a long way off, even in heavily affected epicenters like NYC

Infected proportion of population, by country



Infected proportion of US population, by MSA



Sources: Total confirmed cases by country as reported by Johns Hopkins University as of 3/29/2020; total confirmed cases by US county as reported by USA facts as of 4/8/2020; world population as reported by [link](#); total population for MSAs as reported by Claritas.

1. Estimates for herd immunity for COVID based on R_0 of 2-5.7 and a target of $R_0 < 1$ ([link](#)) and ([link](#)) 2. Estimated total infected based on 5-10x ratio of true infected to confirmed ([link](#) and [link](#)) 3. NYC includes 5 boroughs only, not full MSA

WHAT SHOULD COMPANIES BE THINKING ABOUT RIGHT NOW?



Confirm Business Resiliency

All companies should continue to update and implement business continuity plans to reassure employees and ensure readiness for **supply chain constraints, demand shocks, and impacts to business partners**, prioritizing critical business activities and creating contingency plans for potentially longer durations of disruption



Model Financial scenarios

As containment measures continue in many countries, companies should continue to **re-evaluate their financial outlook, modelling supply and demand** across a number of scenarios, identifying potential interventions and contingency plans for subsequent impacts and/or sustained challenges (e.g. *strategies for managing variable costs, cash flow, liquidity*)



Reassure Customers

Consumer needs and concerns need to be understood, mapped, and incorporated into business continuity and restructuring plans such that consumer needs are addressed and trust is maintained



Move to Digitization Rapidly

Some industries will see a **massive acceleration in the use of digital channels**. Retail, Financial Services, and Healthcare companies have experienced 100–900% growth in key digital channels in China during the outbreak. Customers with positive digital experiences are unlikely to return to analog channels



Prepare for Long Haul

Evaluate strategies to sustain through 9–12 months (or more) of disruption if subsequent demand shocks exist. Companies should consider the nature and required timing associated with more structural changes to their operations



Convene Industry

Companies should consider which industry and government collaborations are necessary to address safety concerns, share best practices, stimulate demand, and rebuild consumer trust

03

CARES AND FED MACRO ROLL-UP

Panelist: Til Schuermann

FISCAL & CENTRAL BANK RESPONSE DESIGNED TO BRIDGE OVER THE WORST

How long should the bridge be, and what's on the other side?



01

Fiscal response

on both sides of the Atlantic has been massive, on the order of 6–10+% of GDP

- Worker protection and support like improved/extended unemployment
- Credit support for business, especially SMEs, through direct grants, subsidized credit
- Targeted support to specific industries (e.g. airlines)

02

Central bank actions are exceeding those from the financial crisis

- Central banks have taken many programs from the financial crisis off the shelf
- Significant intervention to support liquidity and credit formation
- in the face of interest rates that are already near or below zero

03

Banks remain central to effective transmission of monetary and fiscal policy

- In financial crisis they were the problem, now they need to be part of the solution
- While in better shape than 2007, some systems are fitter than others....

US CONGRESS PASSED THE LARGEST EVER PEACETIME STIMULUS PACKAGE – THE \$2.2 TRILLION CARES ACT

Key elements of the Coronavirus Aid, Relief, and Economic Security (CARES) Act

Government Entities



> \$150 BN

Includes:

- \$45 BN in disaster relief for state and local governments
- \$30 BN in emergency education funding
- \$35 BN in emergency transit funding

Hospitals



\$130 BN

Includes:

- \$65 BN directly to hospitals
- \$35 BN to doctors, nurses, and supplies
- The remainder towards Medicare reimbursements and medical research

Distressed Businesses



\$500 BN

For Fed programs

Includes:

- \$454 BN for loans and other investments by the Fed and Treasury to provide liquidity to the financial system
- \$29 BN for direct financial aid to struggling airlines and air cargo carriers

Small Businesses



\$377 BN

Includes:

- \$349 BN in small business loans through the Paycheck Protection Program (PPP)
- \$10 BN for Small Business Administration (SBA) emergency grants

Financial Institutions



Includes:

- Delay to implementation of FASB's Current Expected Credit Losses (CECL)
- Loan modifications related to COVID-19 do not have to be categorized as Troubled Debt Restructurings (TDRs)

Individuals



> \$450 BN

Includes:

- Direct payments of \$1,200 to most Americans¹
- \$250 BN in unemployment benefits
- Payment deferrals for federally backed mortgages and student loans

1. Individuals who earn \$75,000 in adjusted gross income or less would get direct payments of \$1,200 each, with married couples earning up to \$150,000 receiving \$2,400 and an additional \$500 per each child. The payment would scale down by income, phasing out entirely at \$99,000 for singles and \$198,000 for couples without children

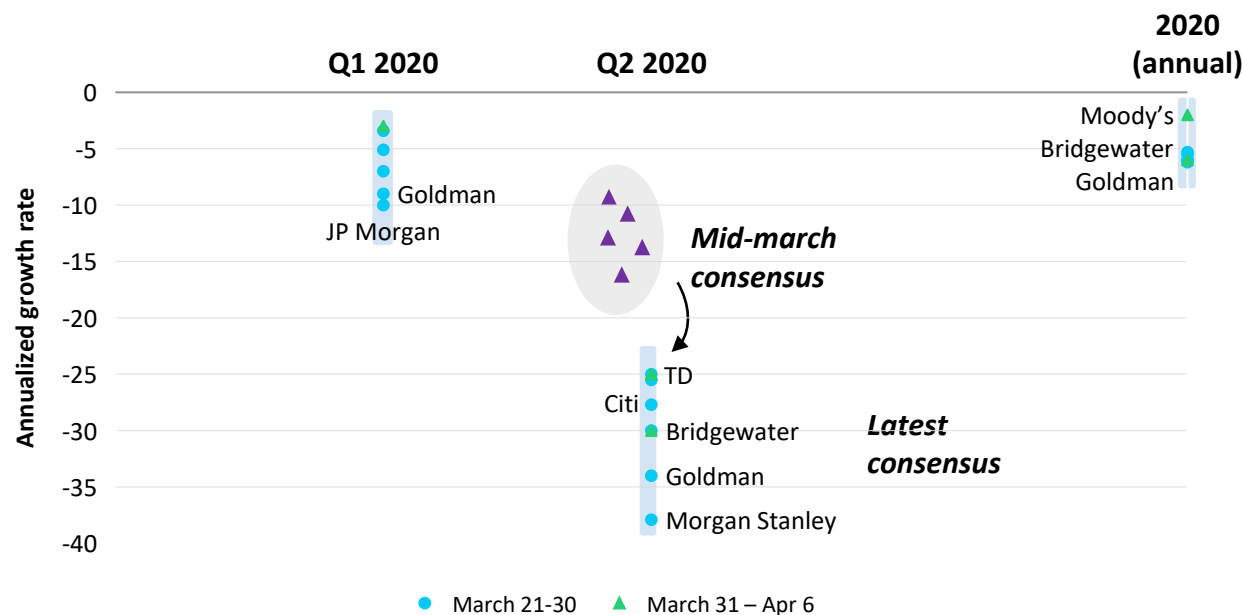
THE FEDERAL RESERVE ACTIONS EXCEED FINANCIAL CRISIS

	Policy Actions	Observations
01	<ul style="list-style-type: none"> • Lowered interest rates by 1.5% to 0 - 0.25% in two steps within less than two weeks • Direct purchases of government and GSE securities at scale • Dollar swap facility with other central banks 	<ul style="list-style-type: none"> • Quickly deployed monetary policy firepower • Signal that Fed plans to flexibly use its balance sheet (already at \$6TN; was at \$4.2TN Mar 4) for market functioning and support • Support for global demand for dollars
02	<ul style="list-style-type: none"> • Re-establish financial crisis era liquidity and credit support facilities, e.g. <ul style="list-style-type: none"> – CPFF for commercial paper – MMLF for money market funds – TALF for asset back securitization 	<ul style="list-style-type: none"> • Took facilities developed during financial crisis off the shelf • Expanded scope, e.g. expand TALF to include new CLOs and outstanding CMBS
03	<ul style="list-style-type: none"> • Establish new facilities for credit support <ul style="list-style-type: none"> – P (S) MCCF for primary issuance and secondary market corporate bonds – MLF for municipal lending – Main Street Business Lending Program – PPPLF to support Paycheck Protection Program • Tolerance for borrower forbearance by banks 	<ul style="list-style-type: none"> • Introduction of new facilities point to much wider support for credit in the economy • \$454BN capital from CARES Act expected to be levered up to support \$3-4+TN in credit (lending) • Expanded credit risk appetite to include fallen angels • Banks are much stronger coming into this crisis making them part of the solution (not problem)

LATEST GDP FORECASTS INDICATE A SEVERE SHOCK IN THE U.S. ECONOMY

The escalation of the Covid-19 crisis has led to significant downward revisions in GDP forecasts globally

U.S. Real GDP Growth Forecasts – Q1, Q2, and annual Annualized growth rate, by select economic analysts (9)^{1,2}



	Q2 2020	Q3 2020	2020 (annual)
Median	-5.1%	-28.9%	-6.0%
Average	-5.7%	-29.4%	-5.3%
Max/Min	-2.2/-10.0%	-25.0/-37.9%	-2.0/-6.2%

Key observations from estimates

- Forecasts have been continuously evolving during the last month – Consensus is that bad news on the virus continues to outweigh good news on policy actions
- Forecasted Q2 qoq annualized growth rate in the US (~25–40% drop) will be the worst since we have quarterly data available
- Key indicators to track include:
 - Trend for percent of U.S. population infected (scenarios ranging up to 80%)³
 - Reliance on “smart” mitigation strategies (e.g., mass testing, use of analytics)
 - Recovery speed in China

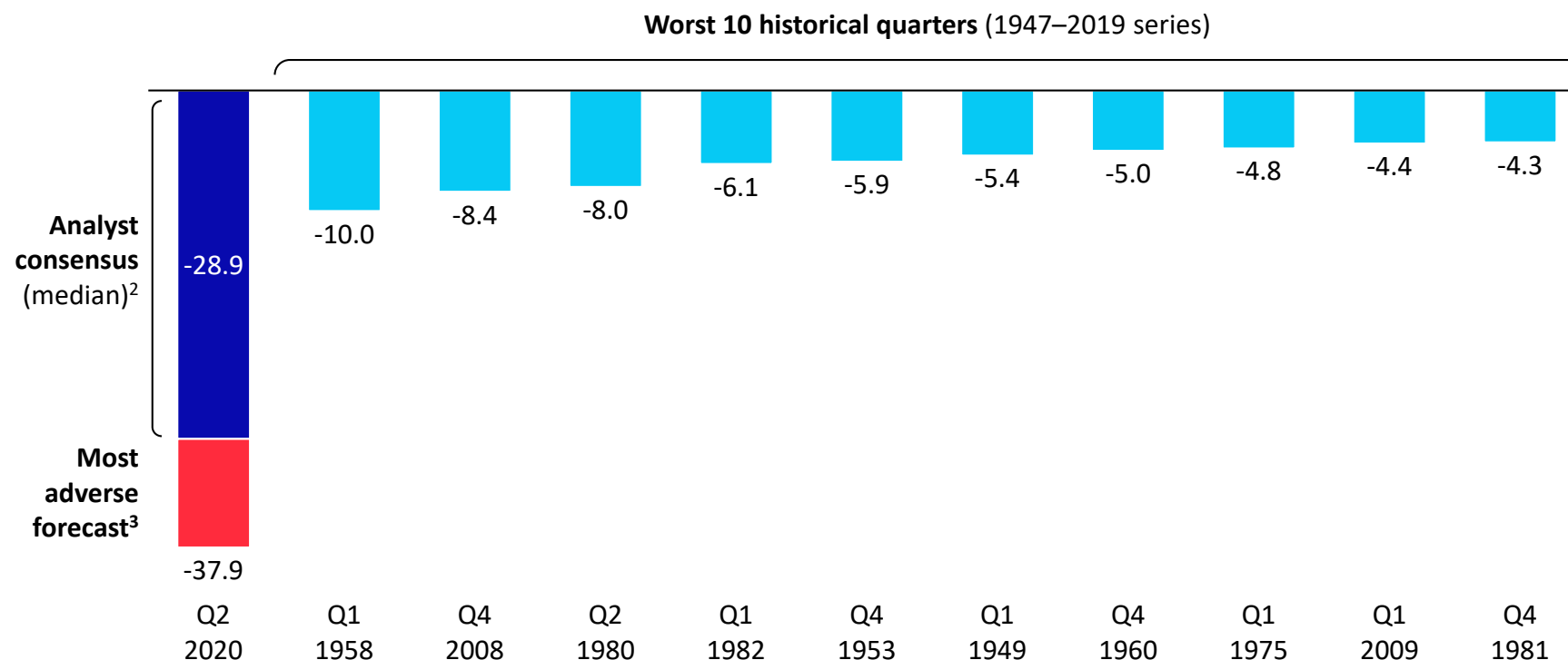
Sources: Bank of America (Apr 2), Moody's (Mar 25), UBS (Apr 2), Goldman Sachs (Mar 31), Bridgewater (Mar 19), Morgan Stanley (Apr 3). TD Securities (Mar 23), UBS (Apr 2), Citi (Apr 3). Quarterly estimates in terms of qoq% seasonally adjusted annual rate (saar) Imperial College COVID-19 response team

Q2 2020 COULD BECOME THE WORST QUARTER IN RECORDED HISTORY

Analysts expect a ~25-40% decline in annualized U.S. GDP in Q2; never observed before in the U.S.

Most severe quarterly declines in real GDP compared to Q2 2020

% Qoq saar (US)¹



1. Saar: Seasonally adjusted annual rate

2. Sources: Bank of America (Apr 2), Moody's (Mar 25), UBS (Apr 2), Goldman Sachs (Mar 31), Bridgewater (Mar 19), Morgan Stanley (Apr 3), TD Securities (Mar 23), UBS (Apr 2), Citi (Apr 3).

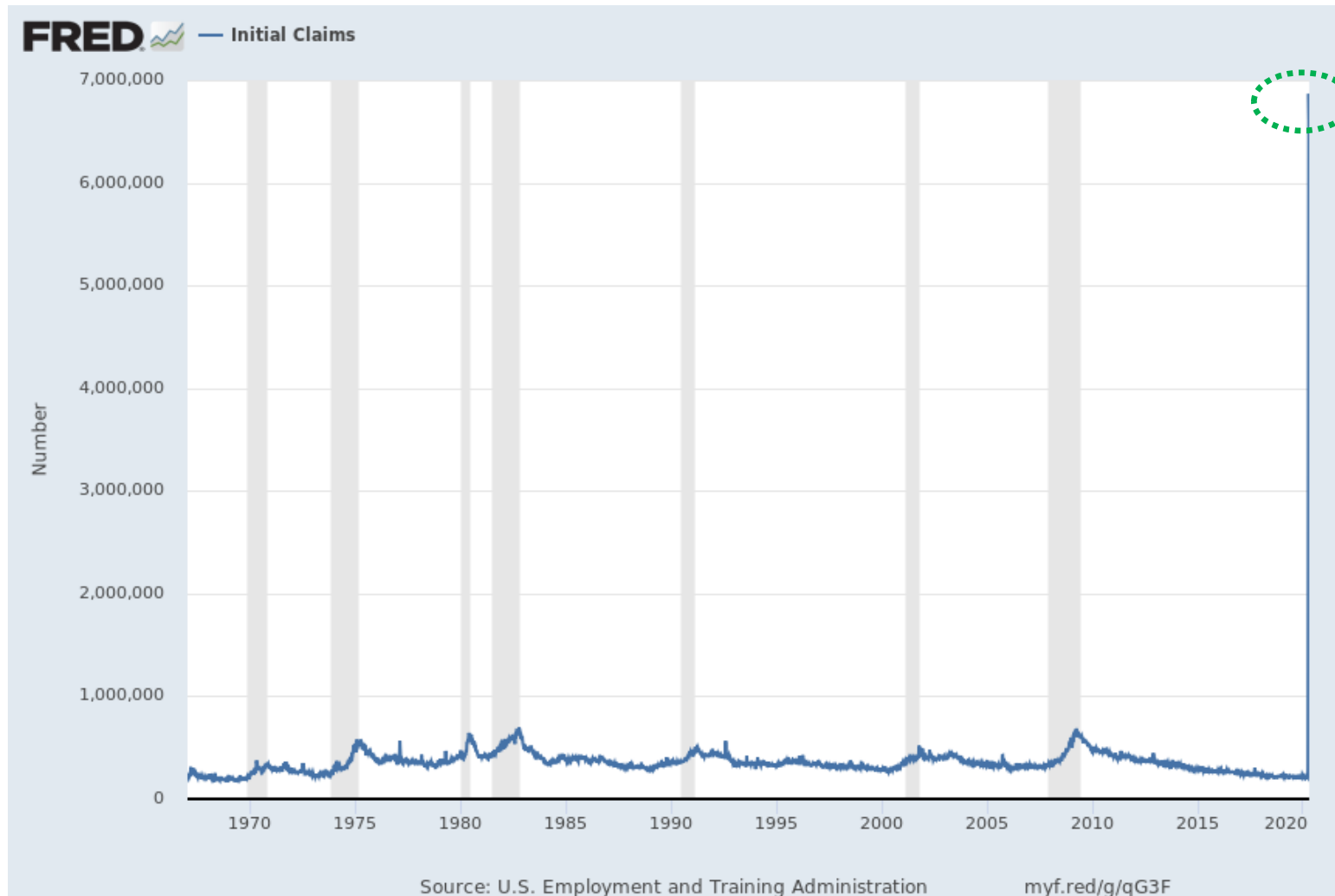
3. From Citibank (Apr-3), Morgan Stanley (Apr-3)

Other sources: BEA, (historical data), Oliver Wyman analysis

UNEMPLOYMENT TO GO TO ~15% AFTER LARGEST JOBLESS CLAIM IN HISTORY

Back in January, unemployment was 3.6% in January, the lowest since 1969

Initial Jobless Claims – 1971 to 2020 (Apr. 4)

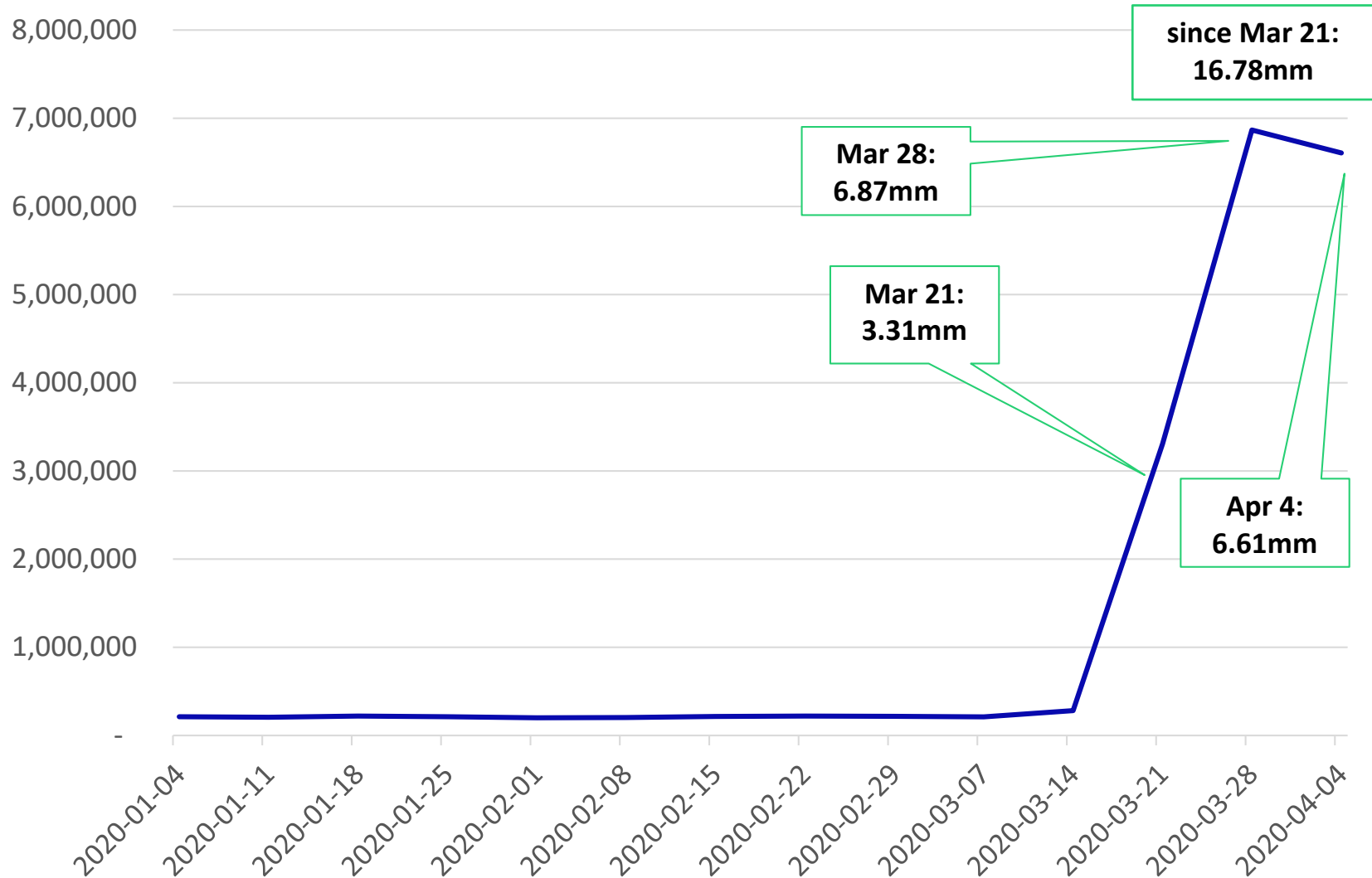


Source: FRED

INITIAL JOBLESS CLAIMS IN 2020: LAST 3 WEEKS ALONE HAVE ADDED 16.78MM

Initial Jobless Claims

Jan 4 - Apr 4, 2020

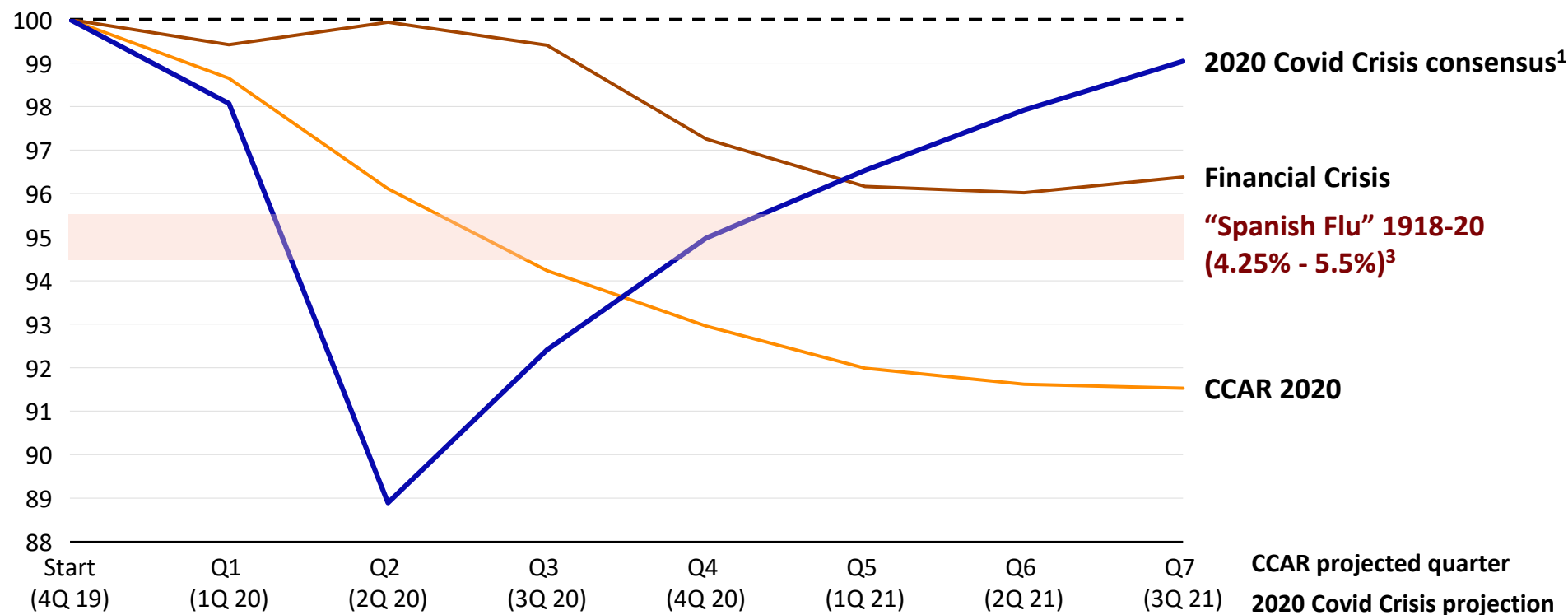


PROJECTIONS FOR THE U.S. ASSUME A RETURN TO PRE-COVID LEVELS BY LATE-2021

We continue observing downward adjustments: as of last week, the expectation was to recover by Q3 2021

U.S. Real GDP relative to Q4 2019 (100) and compared to CCAR and Financial crisis

Estimates as of Apr 3¹, US GDP Indexed to P0 (CCAR 2020)² and 4Q07 (Financial Crisis)



1. Consensus as the average of Goldman Sachs (Mar 31), JP Morgan (Apr 3), and Morgan Stanley (Apr 3) forecasts

2. Source: "CCAR 2020 data release" - Federal Reserve

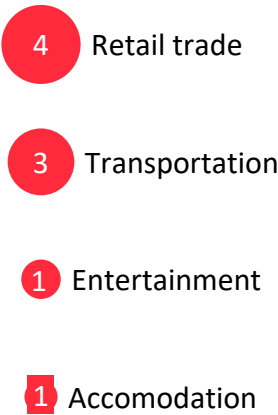
3. Source "Economic Impact of an Influenza Pandemic on the United States" – Federal Reserve Bank of St Louis

IMPACTS ARE UNEVEN ACROSS INDUSTRIES

Highest impacts on industry-level GDP are generally expected in industries that require (or are strongly linked) to in-person consumption

Bubble size represents contribution to U.S. GDP

Large Negative Shock *Up to -90%*



Moderate Negative Shock *Up to -50%*



Modest Negative Shock *Up to -20%*



Positive shock *Up to +20%*



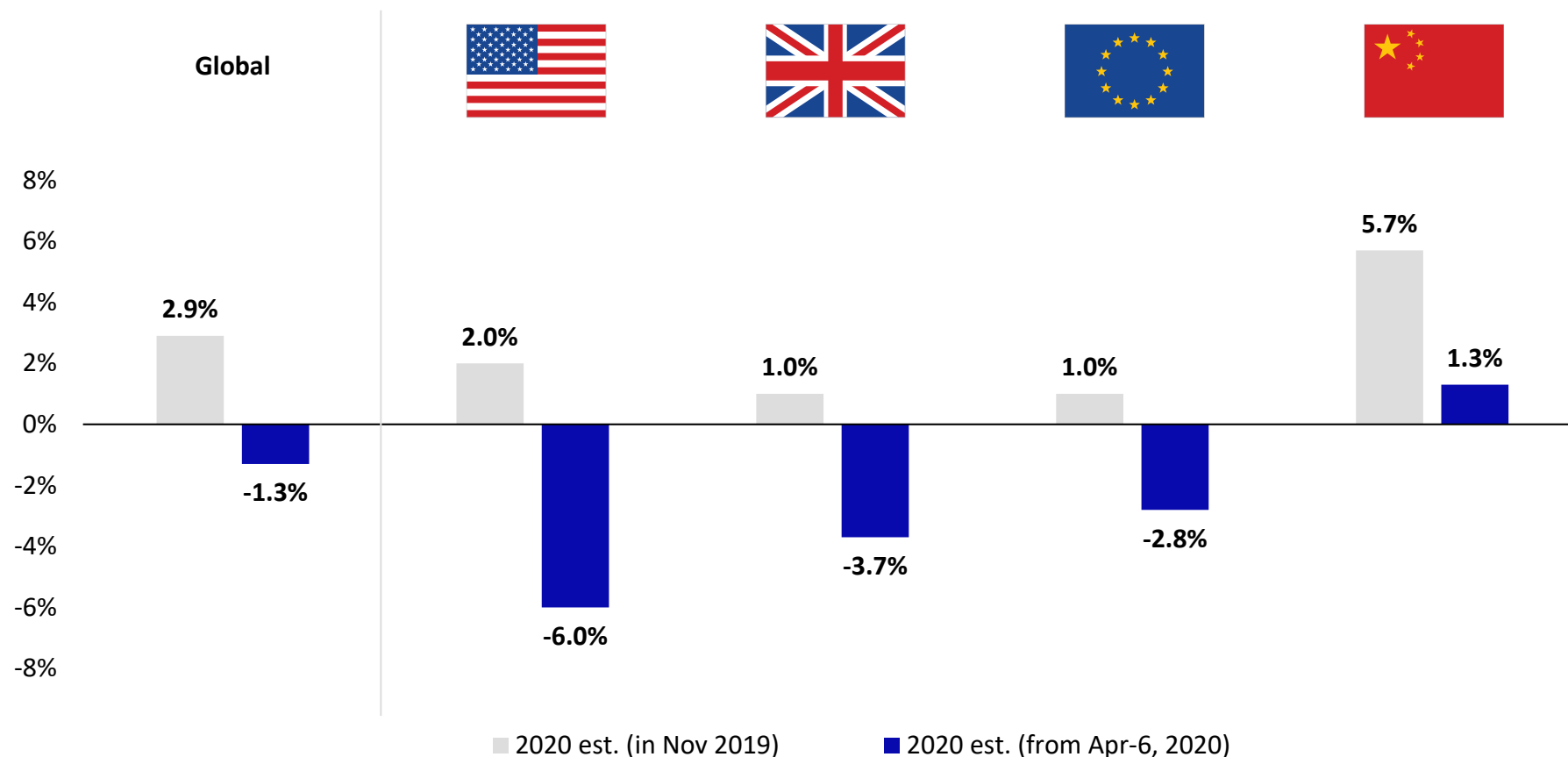
Sources: BofA Global Research, Goldman Sachs Economics Research, Oliver Wyman analysis

LATEST GDP ESTIMATES IN SELECT REGIONS

The escalation of COVID-19 crisis has lead to significant downward revisions in GDP forecasts globally

Consensus 2020 Real GDP Growth Forecasts, Nov 2019¹ vs Apr 2020²

% growth YoY, median



1 Source: OECD.

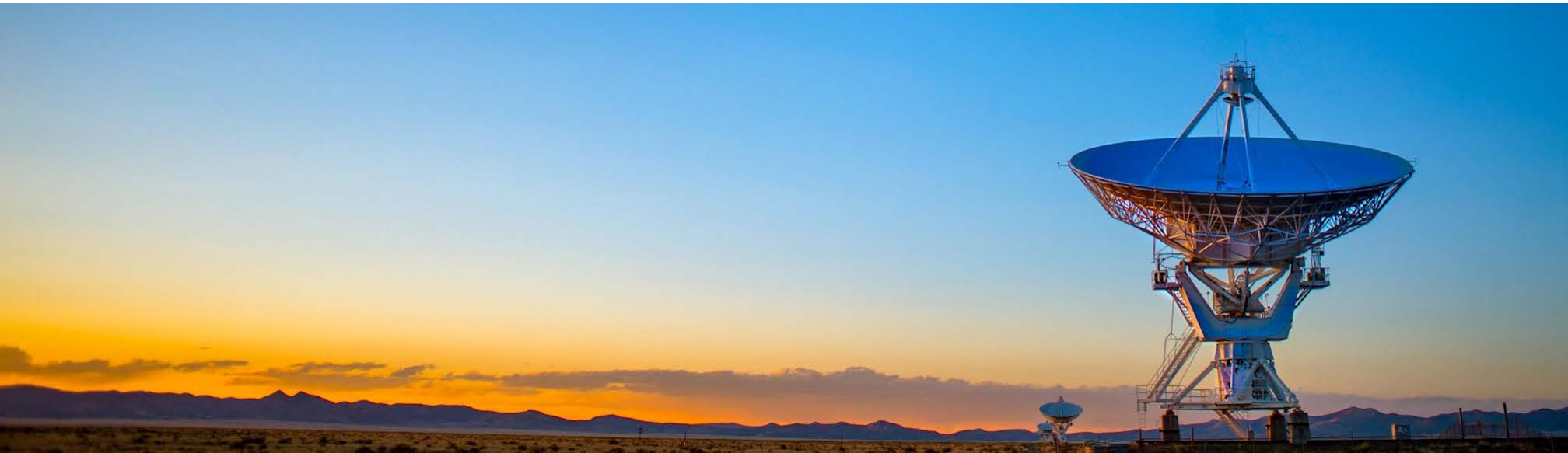
2. Sources: Morgan Stanley (Apr 3), Bank of America (Apr 2), Oxford Economics (Mar 24), Bridgewater (Mar 19), UBS (Apr 2), Goldman Sachs (Mar 31), JP Morgan (Apr 3). GDP growth forecasts obtained as the median of estimates.

READ OUR LATEST INSIGHTS ABOUT COVID-19 AND ITS GLOBAL IMPACT ONLINE

Oliver Wyman and our parent company Marsh & McLennan (MMC) have been monitoring the latest events and are putting forth our perspectives to support our clients and the industries they serve around the world. Our dedicated COVID-19 digital destination will be updated daily as the situation evolves.



[Visit our dedicated COVID-19 website](#)



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