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NAVIGATING THE LONG HAUL TO NORMALCY

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One question seems to be on the forefront of everyone's mind: "When will this pandemic be over? When can we get back to normal?"

In late April, we introduced the concept of The Long Haul of Suppression and suggested that we would all be living in a COVID-19 world with the need for social distancing, personal protection, remote work, and school for the rest of the year and likely into the first quarter of 2021. Many executives at first dismissed this and believed that people would be back in the office and students back at school by the end of the summer. The end of the summer has passed. Eventually, people started to accept that we would likely be in this for a longer period and got comfortable with a mental model of the fourth quarter or year-end.

While there are still many uncertainties about vaccination timeline, efficacy, coverage and distribution speed — as well as government health policy and individual compliance — our recent analysis shows that the Long Haul will be even longer than we first conjectured six months ago. In our discussions with executives, we still see many making planning decisions based on a notion that by year-end 2020, or at least the very beginning of 2021, things will get "back to normal."

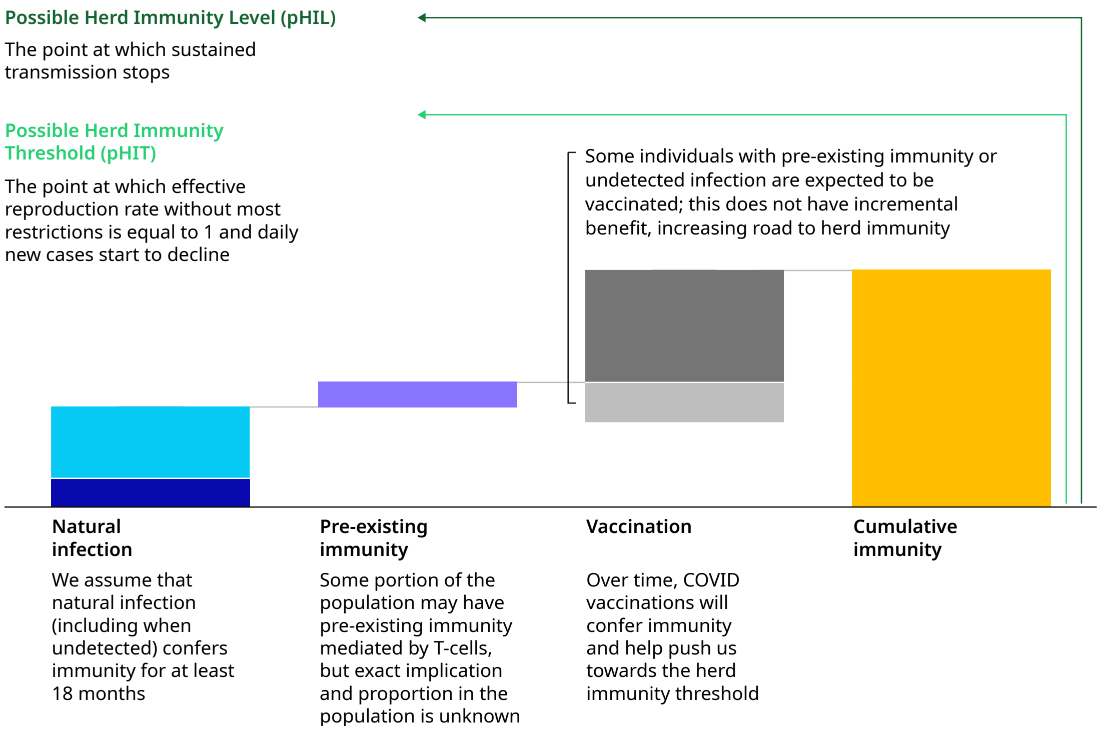
We believe that the fourth quarter of 2021 is likely the earliest we get close to "back to normal" in the US and that companies may need to consider if what has been working for the past seven months can be sustained for the next 12 to 15, and what they may need to adjust.

The key to getting back to normal: Cumulative immunity

There is a lot of misleading and at times conflicting information out there about things like herd immunity or the latest vaccine trial, and sometimes it seems impossible to see the forest for the trees. The simple answer to "when can we go back to normal?" is that natural infections and vaccinations must confer long-term immunity, and we need enough cumulative immunity present in the population to stop the virus from spreading.

Exhibit 1: Cumulative immunity can be conferred in multiple ways

Building blocks of herd immunity



Source: Oliver Wyman analysis

While there is significant debate on how much cumulative immunity is needed, our modeling reveals that the possible Herd Immunity Threshold (pHIT) lies somewhere in the 40 percent to 70 percent range. Based on best existing estimates of the natural reproductive rate of the virus and assuming homogeneous transmission (equally infectious across the population), a traditional infectious disease model would say that the threshold is around 60 percent. However, SARS-CoV-2 appears to have highly heterogeneous transmission, and that means that the overall immunity threshold may be lowered by around 10 percent to 20 percent. Moreover, medical studies reveal that some people may have pre-existing immunity, mediated by T-cells. So, **the good news** is that we may only need around 50 percent of the population to be immune through infections or vaccinations in order to start getting back to normal.

The bad news: Seven months into this pandemic, not even 10 percent of the population in the US has been infected by COVID-19. We don't know the level of pre-existing immunity and still don't have approved vaccines. We will need well over 100 million more people to be vaccinated to get close to the cumulative immunity required. Even with rapid vaccine approvals, prepurchasing of vaccines, and manufacturing that is going on in advance of FDA approvals, it is still almost impossible to pull off vaccinating that many people before well into 2021. This is before you even get to the fact that many Americans are currently unwilling to take a vaccine that was rapidly approved.

At this point, with months of suppressive measures behind us, we need to balance managing the spread of the virus, while trying to keep businesses and schools open, and plan for "getting back to normal" based on a range of scenarios regarding vaccination and immunity assumptions. This article provides a range of possible scenarios and their likelihood of occurring. We will continue evolving these scenarios as additional information becomes available. Our goal is to help executives plan more realistically and better in the presence of uncertainties.

PART 1: ESTIMATING IMMUNITY AND TOTAL VACCINE REQUIRED

For the purposes of this discussion, we will assume that an effective vaccine will eventually be developed and that both vaccination and natural infection confer immunity to reinfection for at least 18 months. **Cumulative population immunity is simply the sum of the population that:**

- has already been infected and has protective immunity
- is naturally immune to infection
- has been effectively vaccinated

In order to determine how much vaccination is needed and how long it will take to vaccinate that many people, the first step is estimating how much immunity already exists in the population and will accumulate in the future due to the natural spread of infection and any pre-existing "natural" immunity.

Natural infection

As of mid-October 2020, we estimate that **about 9.7** percent of the US population have been infected and are presumably immune. **Around 2.3** percent have been confirmed and the remaining 7.4 percent are "undetected" — these are either infected people who were not tested (either asymptomatic or had mild enough symptoms to not warrant testing) or false negatives. If US COVID-19 transmission continued at the same average pace, we could expect to have 17 percent to 24 percent of the population immune by natural infection by the end of the second quarter 2021 and 20 percent to 29 percent by the end of the third quarter 2021. While these ranges are based on the average run rate of transmission in the US over the past seven months, at peak times (75,000 new detected cases per day) the volume of transmission was overrunning some hospital systems across the country. This average run rate sustained through the second quarter and third quarter of next year will result in **about 525,000 to 635,000** total deaths (including around 220,000 deaths already recorded through mid-October 2020) versus **around 385,000 to 445,000** if running at 40,000 new daily detected cases on average (the lower end of the range recorded to date). Our scenarios for what it will take to get back to normal consider such 40,000 to 75,000 daily detected natural infections.

Pre-existing natural immunity

One of the many remaining unknowns is why some people show no symptoms when infected while others suffer severely. A possible explanation is pre-existing immunity, mediated by T-cells. While several publications have demonstrated that a portion of individuals who were never exposed to SARS-CoV-2 have T-cells that are able to recognize the virus, there is not yet scientific evidence that demonstrates what happens in an individual with this “pre-existing immunity.” In these studies, 20 percent to 50 percent of individuals had some level of pre-existing immunity, but we do not yet know how this may translate to actual protection from COVID-19. In our scenarios below we consider the possibility of no natural immunity as well as limited (5 percent to 10 percent) natural immunity.

In the end, at this level of natural infection (20-29 percent) and range of pre-existing immunity (0 to 10 percent), we would still need around 50 million to 115 million effective vaccinations by the end of the third quarter 2021 to hit pHIT. Effective vaccinations are defined as the number of completed vaccinations (both shots in the series) minus unnecessary vaccinations (people who got infected but were not previously detected or those who have pre-existing natural immunity) multiplied by the vaccine’s efficacy. The scenarios below use different assumptions about infection rates and immunity to assess how many vaccinations will be required and what needs to happen in order to have adequate immunity by several discrete dates in 2021.

PART 2: WHAT WILL IT TAKE TO VACCINATE THAT MANY PEOPLE?

The speed at which we can vaccinate enough people depends on several factors:

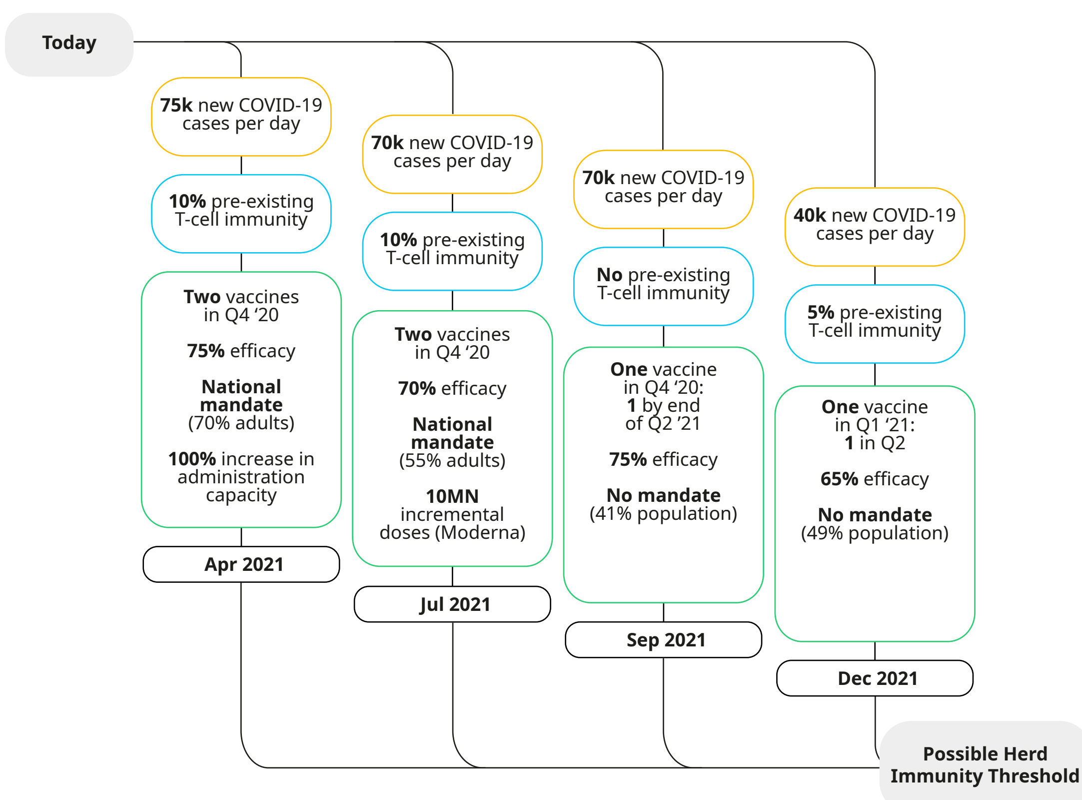
- What gets approved by when: Our scenarios focus on the current front-runners Moderna, Pfizer and BioNTech, and Oxford-AstraZeneca, and do not take into account current efforts in more nascent clinical trials (such as Johnson & Johnson) because these are unlikely to be available until well into 2021. Across all our scenarios, we assume that a pediatric vaccine will not be available for six months after approval of an adult vaccine, consistent with typical vaccine approval patterns and the fact that none of the leading trials currently include children
- Individuals’ willingness to be vaccinated, completion rate of the vaccination series (given front-runner vaccines are expected to be a two-dose regimen), and order in which segments of the population will be vaccinated

- Efficacy of the vaccine (ability to prevent the infection). Of note, as we went to press on November 9th, Pfizer and BioNTech announced early data suggesting its vaccine efficacy is 90%. Our modeling indicates this would accelerate the pHIT by one month on a standalone basis, as the modeling is sensitive to a number of factors as just noted and shown below in Exhibit 2. We will continue to incorporate new data about vaccine approvals and efficacy on a regular basis into our model as well as changes in public demand and relay findings
- Manufacturing, distribution, and administration capacity in the US (or speed at which vaccine can be made available and administered). There are a number of plausible factors or scenarios that could substantially reduce these capacities (for detail, see Notes)

PART 3: SOME US SCENARIOS TO CONSIDER

Exhibit 2: There are many possible paths to the HERD IMMUNITY threshold

Each example below represents only one of many possible pathways to herd immunity threshold; pathways become more distinctive and flexible the further out the target date



Source: Oliver Wyman analysis

SCENARIO 1: BACK TO NORMAL BY APRIL 2021

To get even close to back to normal by next spring, we would need to take the risk of consistently aggressive infection rates in the general population and get very lucky in terms of any pre-existing immunity and vaccine timing and efficacy. To be back to normal by April, the following would have to occur:

- At least two vaccines approved by the end of the fourth quarter 2020
  - Historically, vaccines had significantly longer development timelines and about a 50 percent chance of moving from Phase III trials to approval
- **Securing 43 million to 163 million doses of vaccine (depending on which are approved); a 27 percent increase of our assumed distribution capacity; and a 100 percent increase (doubling) of our assumed administration capacity**
  - Leading candidates expect to manufacture about 900 million total doses by the end of 2020, with the US expected to receive up to around 180 million of those doses, depending on which vaccines are approved. A significant portion of the remainder of these initial doses are likewise allocated, making securing additional doses a significant challenge
  - While theoretically plausible, increasing distribution and administration capacity requires significant effort, given the required logistics for distribution and administration are much more complex than those of a typical vaccine and coincide with flu vaccine distribution and administration
- **Completed vaccination of around 70 percent of the adult US population (178 million people) by the end of April**
  - Would almost certainly require a vaccination mandate as only 38 percent of Americans are currently willing to get vaccinated with first-generation vaccines, given how rushed their development has been
- Vaccine efficacy of 75 percent
  - Flu vaccines typically exhibit 20 percent to 60 percent efficacy annually, while MMR is 90 percent to 95 percent efficacy. The FDA minimum required efficacy is 50 percent. Efficacy in the MMR range is highly unlikely for COVID-19 vaccines due to the expedited development timeline
- A run rate of 75,000 daily new confirmed cases on average for the next six months
  - These are levels that previously were creating hospital capacity challenges in major metros like Houston and Miami and have maxed out hospital capacity in several western states now
  - We have gotten better at managing the disease, which has reduced some of the hospital bed capacity crunch we saw early on, but we are also entering flu season which will potentially cause COVID-19 infection levels like this to overload hospital capacity
  - As of the writing of this article, we breached 120,000 daily cases for the first time since the pandemic began, with hospitals in multiple areas running out of capacity
  - We would also have to be willing to accept an average of 1,200 deaths a day. During the April peak, daily fatalities reached 2,200 and most recently it has been under 800 per day
- A minimum of 10 percent natural immunity in the population
  - While this is possible based on studies to date, there is no scientific evidence yet supporting this level of natural immunity in the population. This would be a highly fortuitous development

Given all the above, and put quite simply, we believe achieving all the necessary conditions would be nothing short of a miracle.

OW Odds: An April 2021 date is not plausible

SCENARIO 2: BACK TO NORMAL BY JULY 2021

This scenario is quite similar to the prior one. We have a little more leeway in how daily run rate, vaccine efficacy, total proportion of the population vaccinated, and pre-existing immunity all come together, but ultimately we still need to get lucky on a number of factors related to vaccination and pre-existing immunity. To be back to normal by July, we would need:

- **At least one vaccine (Oxford, Pfizer, Moderna) approved before the end of this year, with at least one additional vaccine approved in Q1 '2021:** How quickly a 2nd vaccine needs to be approved varies based on which vaccine and in which order, as well as how many adults require vaccination
- **Completed vaccination of more than half of all US adults (more than 129 million) by the end of July**: To achieve this high a vaccination rate, you would have to believe the US would institute a mandate at the national or even state-by-state level, since this range exceeds surveys on US residents' willingness to take a COVID-19 vaccine, peak annual flu vaccination rates in the US, and typical unmandated two-dose completion rates
- **A high efficacy vaccine:** Between 55 percent and 70 percent, influenced by our case run rate and whether we get lucky on pre-existing immunity

In this scenario, our daily case run rate can vary between 40,000 and 75,000, but a lower run rate will require a higher efficacy vaccine, getting lucky on pre-existing immunity, a higher efficacy vaccine, and greater vaccination uptake.

OW Odds: Plausible, but highly improbable, given vaccine mandates are unlikely

SCENARIO 3: BACK TO NORMAL BY SEPTEMBER 2021

By September, we have multiple paths to achieving normalcy. We do not need absolutely everything to go right and have several options for how key variables can come together. This timing will still require significant effort and some luck, however. Every scenario in which we reach pHIT by September requires **approval of at least one vaccine before the end of the year, with at least one additional vaccine approved between February and June.** How quickly a second vaccine needs to be approved varies based on which vaccines are approved and in which order. In addition, **we'd need at least two of the following conditions**:

- **Completed vaccination of at least 45 percent of the US population (more than 145 million individuals) by the end of September:** By September, we assume that a pediatric vaccine will be available as well, broadening the population that can be vaccinated. Without a mandate, we still believe achieving normalcy requires optimistic assumptions about the overall population willingness to be vaccinated and complete the series, with a minimum completion percentage of about 41 percent of the US population by September. Whether mandated or not, we believe in an optimistic scenario, children could begin vaccinations in July, so there would be less of a burden on the adult population to be vaccinated

- **A high efficacy vaccine:** Even with substantial population uptake (through a mandate or otherwise), the approved vaccines need to be fairly effective. Without a mandate, we need more than 75 percent efficacy. Though there is some leeway to lower the efficacy of a vaccine the more people are vaccinated, it would require more stringent (and difficult to enforce) countrywide mandates
- **A daily case run rate of 75,000**

OW Odds: Plausible, but optimistic

Breaking development: Immediately preceding the publication of this article, two noteworthy events occurred with the ability to influence the future path of the COVID-19 Pandemic and timing to possible Herd Immunity Threshold (pHIT) in the United States:

Pfizer-BioNTech announced preliminary efficacy of 90 percent for their vaccine. While this is very promising news, it is preliminary, and final efficacy of Pfizer-BioNTech and other vaccines may prove to be somewhat lower. Also importantly, the duration of immunity due to vaccination is still unknown; we have significant challenges related to distribution and administration; and many people in the US are not convinced of the value of vaccinations. Nevertheless, we studied the standalone impact of 85 percent efficacy across both approved vaccines in our scenarios, and found out that the timing to normalcy would only improve by three weeks, and save ~40,000 additional lives in 2021, compared to 70 percent efficacy. We have to assess the safety of the vaccines and accordingly promote vaccinations heavily to increase intake, and also speed up the vaccine distribution and administration to bring pHIT earlier and save more lives.

If immunity provided by natural infection and/or vaccination is temporary and short term, the value of higher efficacy vaccines is immense: With future re-vaccinations, we will be able to manage COVID-19 cycles in the long term.

Our daily new case rate has topped 100,000 for a week. Hospitalizations have been increasing at an alarming pace, and we want to protect hospitals from being overwhelmed by COVID-19 cases and thus having to ration care. This high daily run rate has the potential to move us towards pHIT faster, but also comes with a significant additional toll. If we were to average 120,000 new cases per day from here on out, the timing to pHIT would improve by about six weeks, but would also result in ~200,000 additional deaths from now until the end of 2021, compared to an average of 70,000 new cases per day. We view this as an upper bound of deaths, we may see IFR decrease if we vaccinate at-risk segments of the population early, as indicated by the CDC's vaccination schedule."

BACK TO NORMAL BY DECEMBER 2021

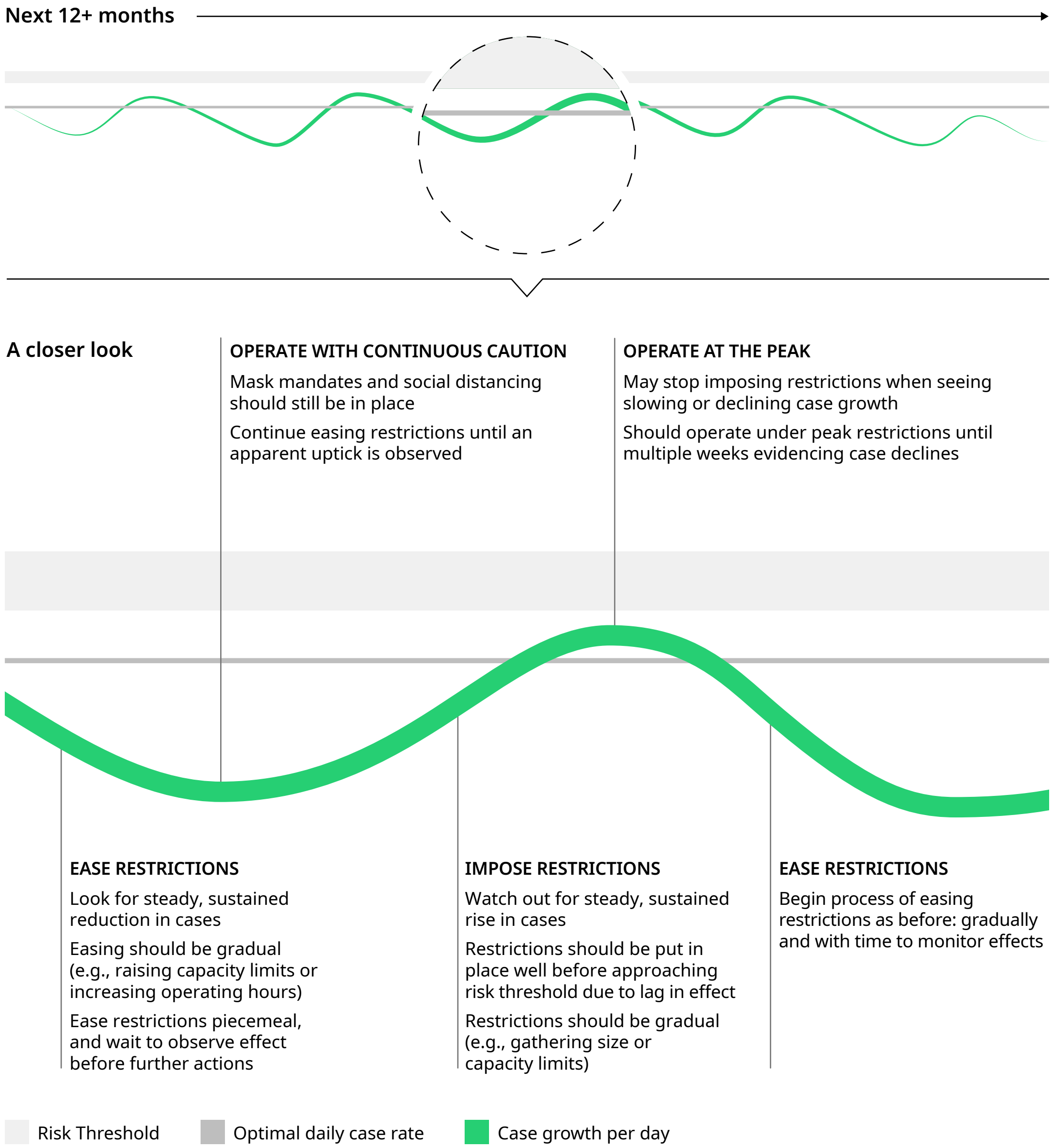
The paths to normalcy become much more flexible and plausible as we reach December. We don't have to rely on the most optimistic vaccine approval scenarios and we likely wouldn't need a mandate. Since the pandemic would have had a couple more months to run its course, we'd be less reliant on a large proportion of the population being vaccinated (just 30 percent to 50 percent uptake), and either a high efficacy vaccine or a high daily case rate.

OW Odds: Plausible, with good likelihood

However, it should be noted that there are scenarios under which the timeline extends well into 2022 (for example, significant breakdowns in vaccine approval, manufacturing, allocation, or distribution; waning immunity requiring increased reliance on vaccination and regular cycles of revaccination). Many of these contingencies are not under our control. However, there are a series of actions that can be taken to help expedite the timeline:

- **Vaccine education and encouragement:** As described above, individual willingness to be vaccinated is a critical factor to protecting the population. Education campaigns driven at all levels (federal, state, individual employer, health system) along with geographically targeted vaccination campaigns will be critical in improving uptake. But for a truly expedited timeline, vaccination mandates may be required
- **Optimal level of "openness":** If we are smart about managing individual behavior (social distancing and mask wearing) we can manage to both keep our economy more open and create a greater feeling of normal life (schools open, restaurants, and retail) for the next twelve months. In doing so, we can not only manage the infection rate responsibly to below ICU capacity, but also increase the natural immunity in the population. This should be done with extremely careful protection of the vulnerable and with the expectation that cycles of easing and tightening restrictions will continue to be required in the interim for regions with outbreaks. The cycles of easing and tightening should be gradual and carefully paced to avoid broad economic disruption like earlier in the pandemic. To that end, easing and tightening should be focused on incremental measures (like reducing business capacity limits, limiting large gatherings, or limiting the number of people one should ideally interact with), with enough time in between changes to understand the effects of doing so
- **Preparing and expanding vaccine logistics:** There are a number of anticipated nuances to the distribution and administration of the front-runner vaccines (such as super-cold refrigeration, the need to use a single multi-batch vaccine vial effectively) that at the very least require immediate planning (such as inventorying appropriate freezers and securing additional supply), but may also require significant expansion of administrative capacities. Public policy officials, providers, and employers alike would be well-served to consider additional sites (ideally some mobile) and staff for administration.

Exhibit 3: Until we reach herd immunity, careful monitoring of metrics and gradual changes to restrictions will prevent jarring stops and starts



Source: Oliver Wyman analysis

PART 4: ADAPTING IN THE MEANTIME

We expect a return to normalcy in late fourth quarter 2021, requiring all of us to adapt to living with COVID-19 for another year or more. This sobering timeline has a significant impact on the approach to planning and decision-making:

- **Financial and strategic planning:** Both should incorporate a full year or more of potential disruptions to supply and demand and be sufficiently flexible to absorb new planning scenarios. It means being able to effectively monitor the evolving COVID-19 situation and vaccine context to help reduce uncertainty and respond with more agility. Executives should also consider whether this extended timeline changes perspective on cost and liquidity management as well as rightsizing their services
- **Rethinking how we work for an extended "long haul":** Given the extended timeline we are predicting for "back to normal," executives may need to reconsider their current work-from-home operating model
  - **Do you need to purposefully implement a hybrid model?** Is what worked for eight months viable for another 12? In some instances, it probably is; in others, there may be a need for more deliberate, scalable solutions to allow onsite collaboration as needed and to ensure that employees feel safe and secure about the option. Are the solutions that you have in place for outbreak prevention, including (as applicable) physical building updates, health screening and testing, and tracing operationally and financially sustainable for the extended long haul?
  - **Making remote more effective and sustainable:** Have you really redesigned work to fit a remote or hybrid model, or are you largely still operating in the same way you have always worked but with video screens in front of you? Is it time to start rethinking the types of meetings you have and how to help make remote meetings and "virtual breakouts" even more impactful than pre-COVID-19 in person meetings? Are you and your employees trained to fully take advantage of how to be even more impactful remotely? Making changes here can not only impact productivity, but also address some of the mental health/COVID-19 fatigue that is settling in. What investments in technology and analytics to support remote collaboration and foster connections across employees, suppliers, and customers might you need to make to support your employees in a much more extended work-from-home model?
  - **Plan for ongoing elevated absenteeism and continued mental health strain:** This will happen as a result of both sickness and care-giving responsibilities. We are already seeing the on-and-off nature of school closures, and we have only begun to see the effects of the flu season and what may happen to hospital capacity in local geographies. Do you feel that the efforts taken to date are adequately addressing the overall mental health of employees and protecting against burnout? This is not just good for employee satisfaction and well-being, but studies show that workers under mental strain are more likely to make mistakes and misjudge risks. Another full year of remote working will no doubt be exacerbating the mental health strain
- **Culture:** Without regular in-person contact, the ties binding employees — a shared experience, common aspiration, and culture may weaken. Knowledge transfer may also slip without the casual interactions in the employee lounge. Have you created any purposeful, new ways for employees to connect informally to guard against this erosion? Finding virtual and hybrid in-person solutions and making them part of your new normal is going to be important if we are in this for another year or more

It is time to stop planning in two to three month windows, hoping that something will fundamentally change. That was understandable in the beginning of the crisis when less was known, but based on what we now know, it is time to take a different approach. Lead with clarity about your intentions.

Be bold. Use this crisis as an opportunity to rethink how you do your work, what makes your culture great, and how to make it and your company better, despite the obvious challenges. We cannot just wait a quarter or two for a silver bullet.

NOTES

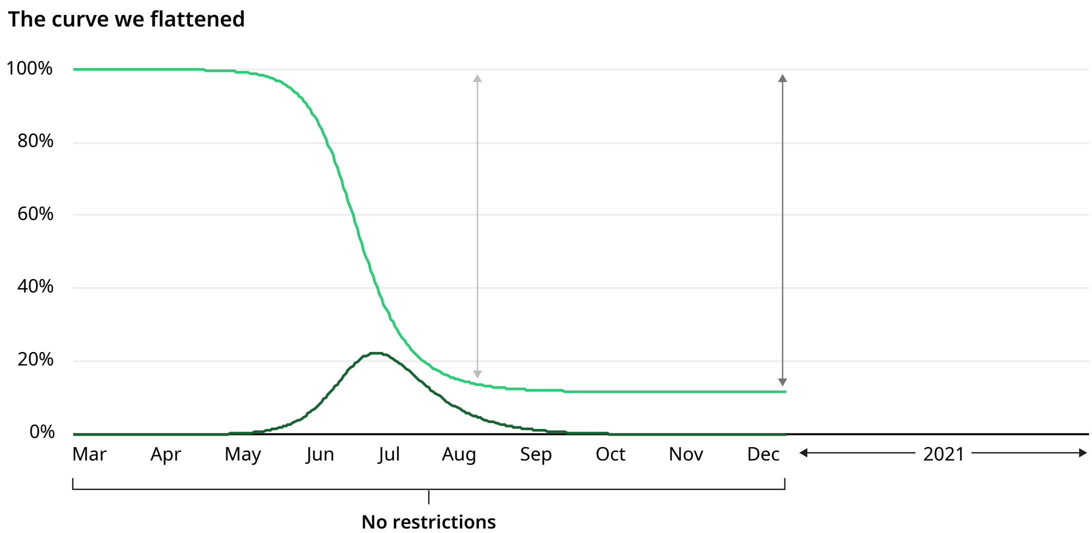
Cumulative population immunity is the percentage of the population that:

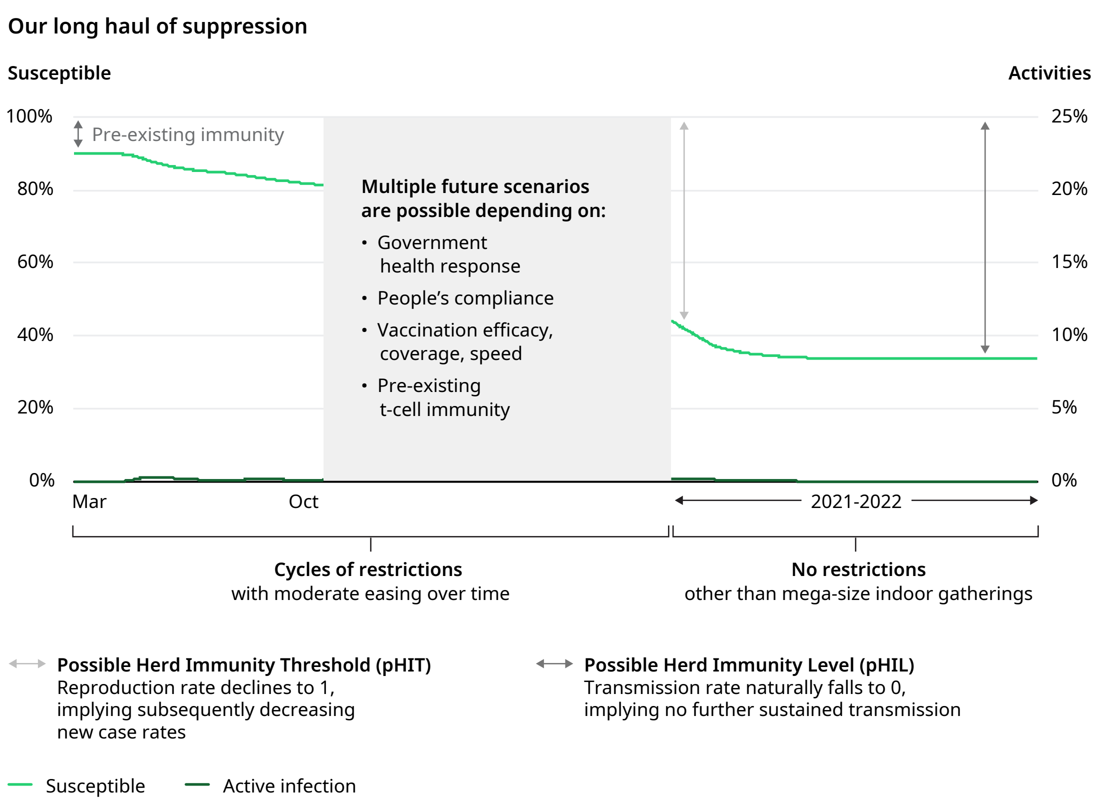
- has already been infected and has protective immunity
- is naturally immune to infection, or
- has been effectively vaccinated

When enough people fall into a combination of these three categories, cumulative immunity is sufficient to slow down the natural reproductive rate of COVID-19; and daily new cases and deaths are on a steady downward trend even when we relax most of the restrictions — we return to normalcy.

A number of factors such as the future effective reproduction rate of COVID-19, influenced by public policy and human response — as well as vaccine availability, efficacy, coverage, and speed of distribution — need to be incorporated into a sophisticated dynamic model to estimate the level and timing of necessary cumulative population immunity. Our normal behaviors led to an exponential growth of COVID-19 spread with an effective reproduction rate higher than 1.0. Restrictions reduced it from very high levels in March and early April (most often cited at R_0=2.4) to current levels, which have been varying within a range of 0.6 to 1.5 in the US since mid-April. By definition, **possible Herd Immunity Threshold** (pHIT) is the point at which cumulative population immunity is sufficient to reduce the instantaneous effective reproduction rate R_e(t) to 1.0 even without most restrictions. While individuals still face the risk of infection, as a society we no longer risk exponential transmission after this point. This bears repeating: We can relax most of the restrictions but for very large gatherings, and those relaxed behaviors might still lead to regional outbreaks but will not drive population average R_e(t) back above 1.0 Pandemic over! There will still be a tail end of transmission (and associated hospitalization and mortality), but the effective reproductive rate will continue to decline until cumulative immunity reaches **possible Herd Immunity Level (pHIL)**, at which point the effective reproductive rate will go to zero and transmission will cease, similar to the end of Spanish Flu of 1918. It's important to note that not only will the value of pHIT and pHIL differ from region to region, but so too will the timeline to achieving herd immunity; achieving normalcy in one state or city doesn't necessarily mean others will be able to let their guard down as well.

Exhibit 4: The return to normalcy timeline is a function of cumulative immunity over time





Source: Oliver Wyman analysis

Possible herd immunity threshold and herd immunity level

We have to assume immunity is conferred by natural infections and vaccinations to discuss pHIT or pHIL. Debate continues about the likely pHIT and pHIL, which are sensitive to how transmission rates, death, and recovery are modelled in epidemiological models.

Simple epidemiological models assume a constant natural reproduction rate of R_0 for the whole society and calculate pHIT as 1-1/R_0. These models estimate R_0 from observed deaths and/or detected cases in early pandemic. We see different estimates of R_0 of COVID-19, while the most commonly cited figure is around 2.4, there are higher estimates, for example 4.0. Inputting an R_0=2.4 and R_0=3 yield pHIT at 58 percent and 67 percent, respectively. After this threshold, the cases and mortality will continue until pHIL is at 88 percent and 94 percent, respectively. Also importantly, such simple models reach pHIT and pHIL in 4.5 and 8.5 months for R_0=2.4. Such simple models and single parameter representation are not adequate for COVID-19 modelling. If constant R_0 was representative of COVID-19, the pandemic would have been over by now.

However, we know that reproduction rate is not constant for the whole society and throughout the pandemic. First, transmission is **heterogeneous**, driven by natural biological differences in susceptibility and transmissive ability (that is, some people are super spreaders, while others infect no one), and differences in behavior either at the individual or geographic level (for example, mandates on social distancing, mask wearing, and business closures). Second, with lockdowns and reopening actions, our responses are time dependent, leading to a reproduction rate that is not constant. Our modeling follows both heterogeneous and nonstationary transmission, which implies a reproduction rate much greater than population average for the most active and susceptible sub-populations and much lower than average for the most reserved and least susceptible sub-populations. Because of burnout of faster sub-populations, heterogeneous model naturally captures the dampening of the average reproduction rate for the population over time and provides lower pHIL and pHIT compared to simple homogeneous models in the order of 10 to 20 percentage points under various heterogeneity assumptions differentiated by age, lifestyle, and susceptibility.

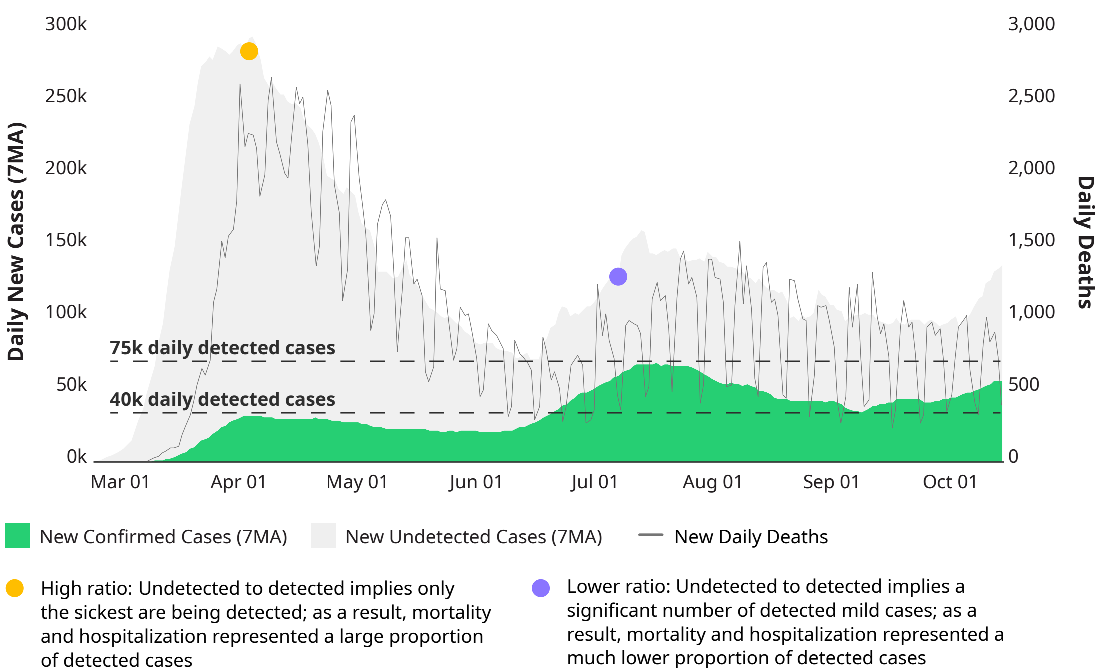
Natural infection

The total number of infected individuals is made up of two subgroups: detected (this is the number of confirmed cases in official records) and undetected (the number of individuals we believe to have been infected but have not been confirmed with a diagnostic test due to lack of symptoms or lack of testing especially in the early months of the pandemic). As of **mid-October 2020 about 2.3 percent** of the US population have been confirmed to be infected. Our best estimate for cumulative undetected cases is roughly another **7.4 percent**, for a total estimate of **9.7 percent** infected individuals. Given uncertainties around modelling undetected cases based on infection fatality ratio and anti-body test results, our high and low estimates for total infections (both detected and undetected) is in a range of **5.7 percent** to **17.6 percent** for the US.

The number of natural infections will continue to grow at a varying rate over time, depending on individual behaviors and how open the economy and society are. In our scenarios below, we consider two different growth conditions with different levels of daily average new cases and some daily random variations around the average rate: 1) A daily average new case run rate of 40,000 detected and 60,000 undetected cases (40,000 per day of detected cases is consistent with June-October average levels), and 2) a much faster daily average new case run rate of 75,000 detected and 112,500 undetected cases (this scenario would involve running at roughly the previously highest single-day peak recorded in the US — this peak occurred in mid-July, during which time several large metropolitan areas reported their hospitals were overrun (for example, Miami-Dade, Houston). We are currently experiencing a peak of similar size (mid-October - early November, and have breached 120,000 for the first time over the course of the pandemic), which is already leading to overrun hospitals in some regions. These different run rates will lead to varying speeds of acquired cumulative protective immunity in the population and alter the timeline to normalcy. Some good news: A consistent run rate maintained over an extended period of time (about six to 18 months) assumes a gradual easing of restrictions over that same period — even without reaching pHIT, as we build cumulative immunity, **we can loosen suppression measures marginally and slightly open up the economy.**

Exhibit 5: How "hot" we run going forward matters — 75 thousand confirmed cases now is not the same as in April

Daily new confirmed cases, daily new estimated undetected cases (both seven day moving average, or 7MA) and daily new deaths in the United States

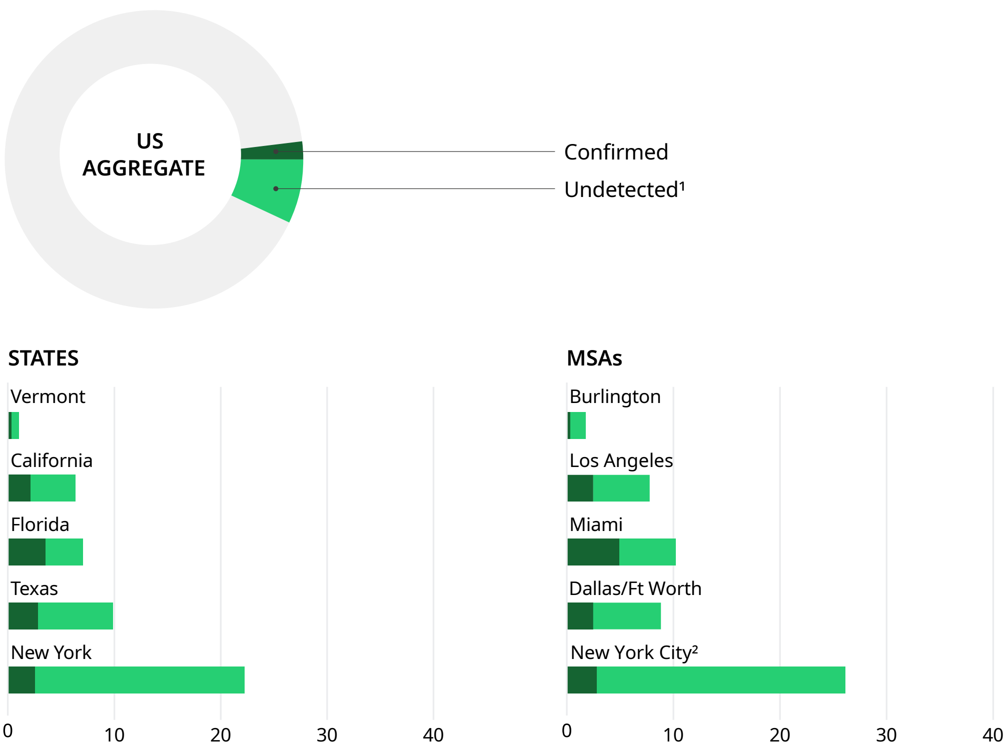


Source: Oliver Wyman analysis

While we summarize our analysis at an aggregate level across the entire US, there are significant variations in the levels of current natural infection that will influence timeline and requirements by state, county, and city. This means that at the time when a vaccine becomes available, regions with lower natural infection will a) have a longer road towards normalcy and b) require more individuals to be vaccinated to achieve pHIT or pHIL.

Exhibit 6: Natural infection varies widely within the United States

Best estimate of infected proportion of population



Source: Oliver Wyman analysis

Regional variation in natural infection will lead to differential timing to achieve PHIT, as well as differential need for vaccinations to reach the threshold

1. Estimated undetected cases based on Oliver Wyman Pandemic Navigator Model

2. NYC includes five boroughs only, not full MSA

An additional consideration — the daily average new case run rate will not be spread evenly across the country at the same rate of 40,000/328 million, but is more likely to occur in seemingly random regional clusters from time to time consistent with what we have observed to date. These micro-clusters will be attributable to large gatherings and lack of compliance to health restrictions and recommendations and can result in significant implications for regional hospital and ICU capacity. Based on the total number of available ICU beds in the US, and the regional and temporal variation in ICU capacity observed over the course of the past six months, we believe that a countrywide average run rate of more than 75,000 new daily cases threatens to breach ICU capacity in some outbreak regions.

Vaccine

Manufacturing, distribution, and administration capacity in the United States could be adversely impacted by:

- Vaccine nationalism: The United States may not be unable to secure any doses manufactured outside of the country, and would therefore be limited to manufacturing capacity from facilities within the US
- Manufacturing disruptions: Faulty batches, facility disruptions (such as fire in a facility), or labor disruptions (for example, workers must quarantine due to COVID-19 exposure) may reduce output beyond current stated production capacity
- Limited supply chain capabilities: Front-runner COVID-19 vaccines require colder temperatures for storage and distribution than most existing vaccines. The US may not have adequate equipment to store and distribute an adequate volume of vaccines at an adequate pace
- Administration time constraints: The vaccines will be stored in vials containing dozens of doses, and will lose their effectiveness after a certain period of time outside of cold storage — without the ability to administer vaccines quickly and effectively, multiple doses per vial could be wasted. Additionally, time to administer will likely be longer than standard vaccines due to additional safety measures required for COVID-19
- Administration labor shortage: Given the US is likely headed towards a winter resurgence, labor will likely be constrained due to A) increased need to care for COVID-19 patients and B) increased numbers of doctors and nurses infected with COVID-19

Safety of vaccine for sub-populations: Given the leading vaccines are new platforms, they may not be applicable to the full population (for example, vaccines with the Adenovirus vector have demonstrated worsening of HIV infection in those patients).

Oliver Wyman is a global leader in management consulting that combines deep industry knowledge with specialized expertise in strategy, operations, risk management, and organization transformation.

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