COVID-19 Future Path Modelling – Phase 2 report

Commissioned by National Association of Funeral Directors

Europe Economics

Andrew Lilico, 5 May 2020

This is the presentation of the second phase of a two-phase project modelling the evolution of the COVID-19 epidemic in UK regions and its implications for demand for funerals

Phase 1:

- Core models, showing total deaths (COVID-19 plus other)
- Evolution over next few weeks under lockdown

Phase 2:

- Scenarios analysis

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Core principles for the modelling

- Rely on high-quality published evidence as far as possible
- Present the uncertainty scientific assumptions without attempting to arbitrate where there is genuine scientific disagreement BUT do not become sidetracked into scientific minutiae
- Add value through regional breakdown

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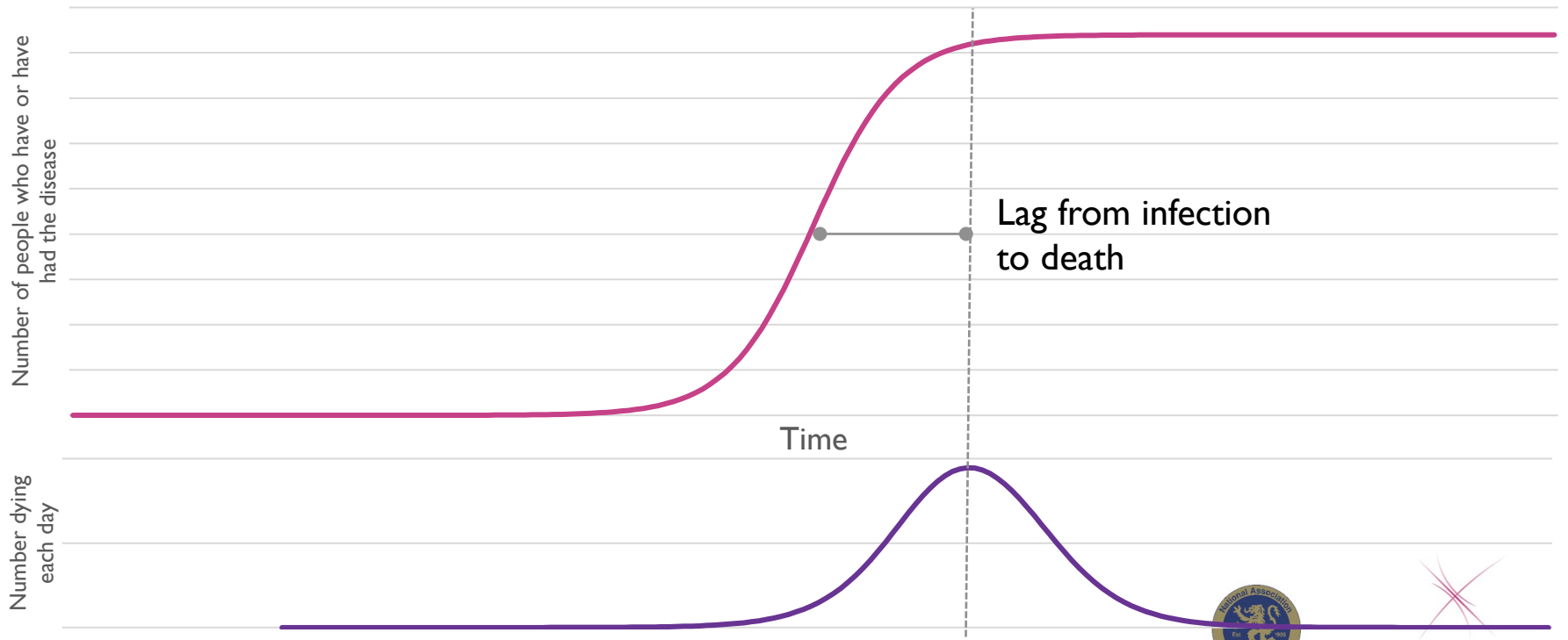
An unrestricted epidemic exhibits two well-established mathematical patterns: an S-curve in cases & a hump curve in deaths



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Jargon (For Reference)

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Jargon:

We shall not seek to set out every mathematical detail of the models in what follows, but certain points of jargon need to be available for reference or exposition

- The "**infection fatality rate**"(IFR) – The % of people who have a disease who die.
  - For some diseases this differs very significantly by the characteristics of sufferers (e.g. age) and IFRs can be broken down accordingly.
  - (NB Not the same thing as the "case fatality rate"!)

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Jargon:

- The "**basic reproduction number**" (R_0) – The average number of people infected by each infected individual when the population has no immunity.
- This is closely related to the rapidity with which cases escalate. For simplicity, we assume the average new transmission is 8 days after a person is infected, so the daily rate of growth is simply the 8^{th} root of the R.
- R changes over the progression of an epidemic, both naturally (eg falling as the virus runs out of new people to infect) and artificially (e.g. with lockdowns).

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Jargon:

- The "**lag**" – The average number of days from infection to death.
  - NB: When transmission is rapid (or very slow), the average "forward lag" from a given infection to death is not the same as the average "backwards lag" from an observed number of deaths to inferred infections.

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Jargon:

- "**Herd Immunity**" – As people contract a disease, if they become immune the number of people available to become infected falls and the reproduction number drops. When the number reaches 1 or below, that is termed "herd immunity".
  - Herd immunity does not mean a disease becomes extinct, but it does mean the epidemic ends.
  - Herd immunity does not require individual immunity to be permanent.
  - Infection-acquired COVID-19 immunity is not expected to be permanent. Vaccine-induced immunity may be.

Key assumptions

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There are three major uncertainties regarding the path of deaths following lockdown:

1. The Infection Fatality Rate
2. The reproduction number ("R") post-lockdown
3. Non-COVID-related excess deaths

There is genuine and significant disagreement in the scientific community about the infection fatality rate, and that has implications for post-lockdown transmission

Orthodox/Imperial View

- Infection fatality rate is around 0.6-1% across regions (depending on demographics).
- The number of people infected at the time of lockdowns was modest and is currently around 5% in the UK.
- Lockdowns have reduced the rate of transmission. If lockdowns were released the R would rise above 1 again.
- The UK government is following this view.

We shall present models based on both infection assumptions. The mathematics of the models are ours, however.

Oxford/Swedish/Stanford view

- Infection fatality rate is not materially higher than severe flu and may be lower. (IFR ≈ 0.1%)
- The spike in deaths is driven by the speed of transmission of the virus not a high IFR.
- By the point of lockdown, large numbers had already been infected and herd immunity has either been achieved or is near.
- If lockdowns were released, R would continue to fall since the number not yet infected is low.

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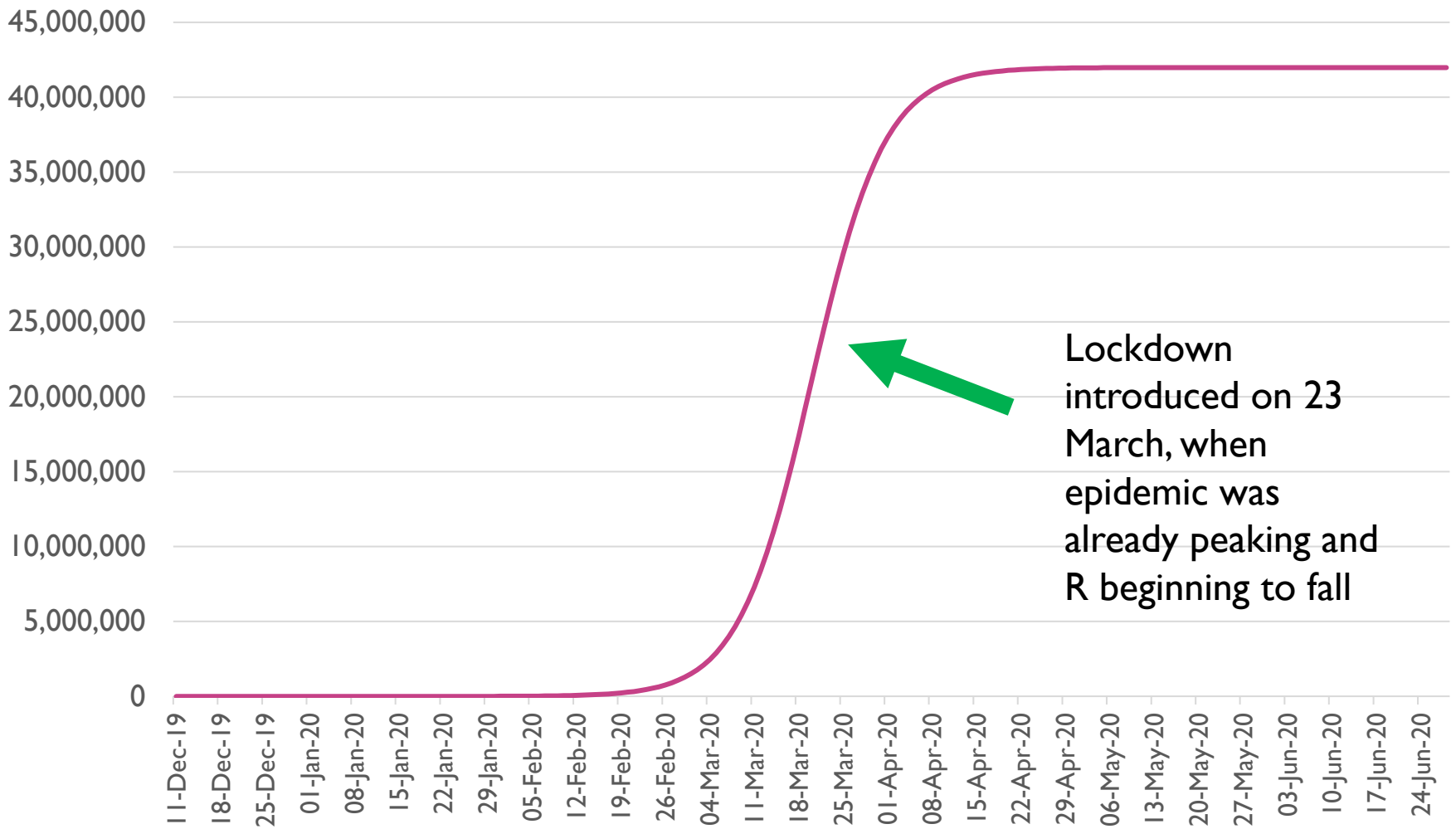
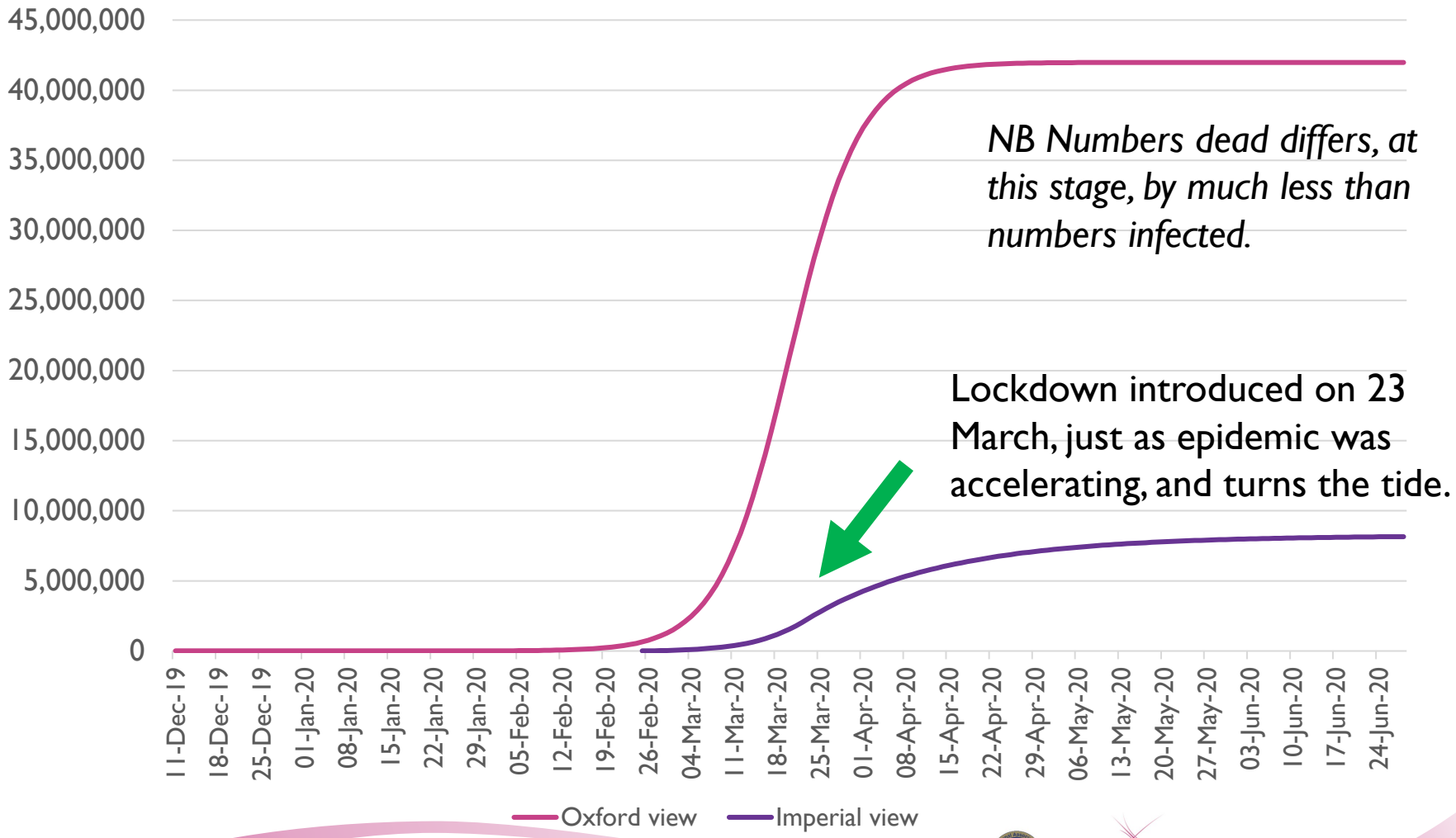
"Oxford view" model (I): Number of people who have or have had COVID-19



Imperial view model (I): Number of people who have or have had COVID-19



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Even under an "Imperial view" assumption about the fatality rate, there is uncertainty as to how the reproduction rate will respond post-lockdown.

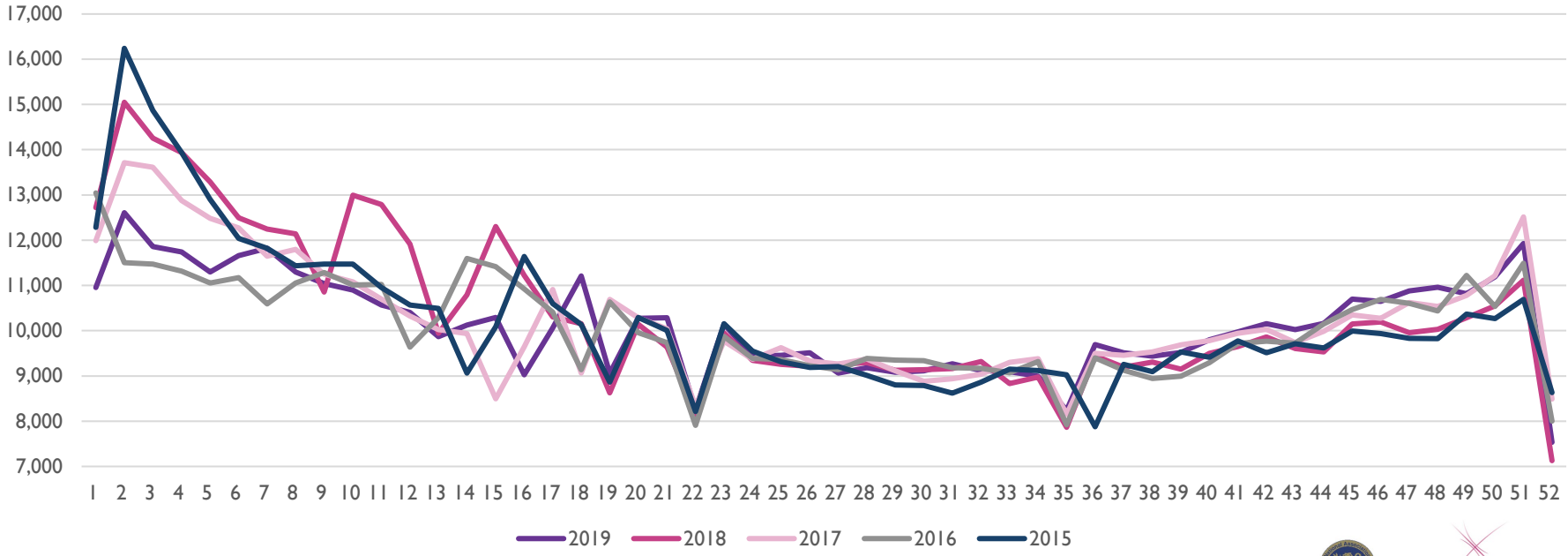
*We thus do not model a "herd immunity strategy" scenario.

- We assume lockdown ends on 31 May 2020 and that the UK government aims to keep R below 1 thereafter*. But will it succeed?
- Even if it does succeed at a national level, might R be greater than 1 in some regions? Could some regions have a (perhaps lower) "second peak"?
- Even if R0 were above 1 in a region, could some regions have high enough infection rates that their R would fall anyway, post-lockdown, because the virus does not have enough new people to infect?

What will happen to non-COVID-19-related "excess deaths".

*England and Wales definition

Deaths are fairly similar in the same week each year, especially after about week 20* (this year, w/e 15 May). Differences from the trailing 5 year average are termed "excess deaths".



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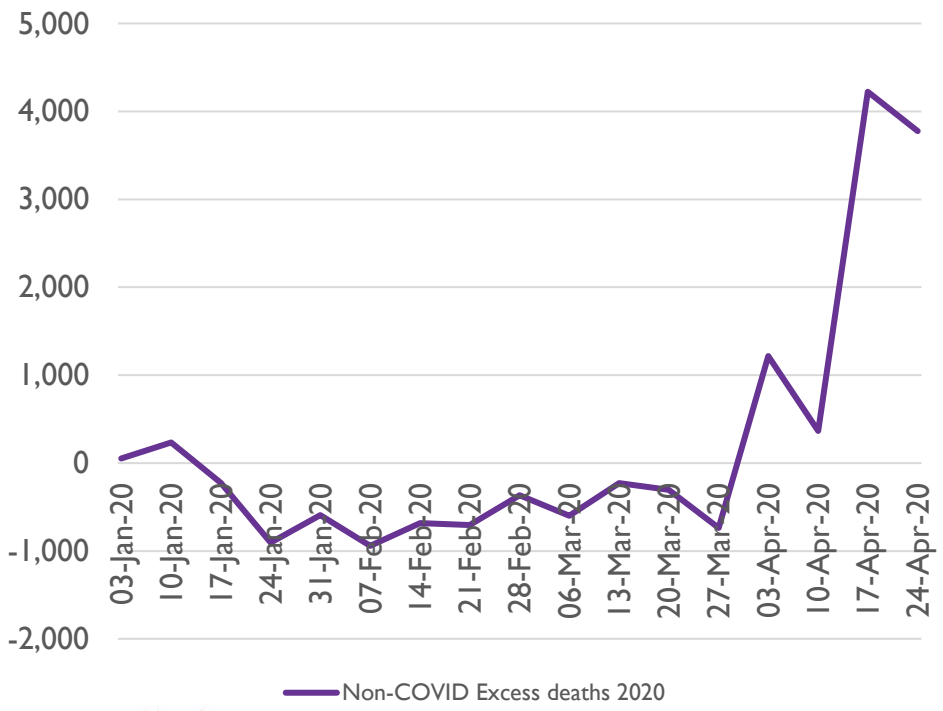
Excess deaths not attributable to COVID-19 have been unusually high recently. US & Spanish studies suggest patients not presenting with other conditions (eg heart problems) are an important factor. Non-COVID-19 excess deaths are currently around 30-40% as high as COVID-19 deaths.



How will such deaths evolve later?

- Just a lockdown factor so end with lockdown?
- Persist for many months?
- Evolve proportionately with COVD-19 deaths?

We shall assume they persist as long as lockdown persists, then end. But this is as significant and material a source of modelling uncertainty as the IFR or R.

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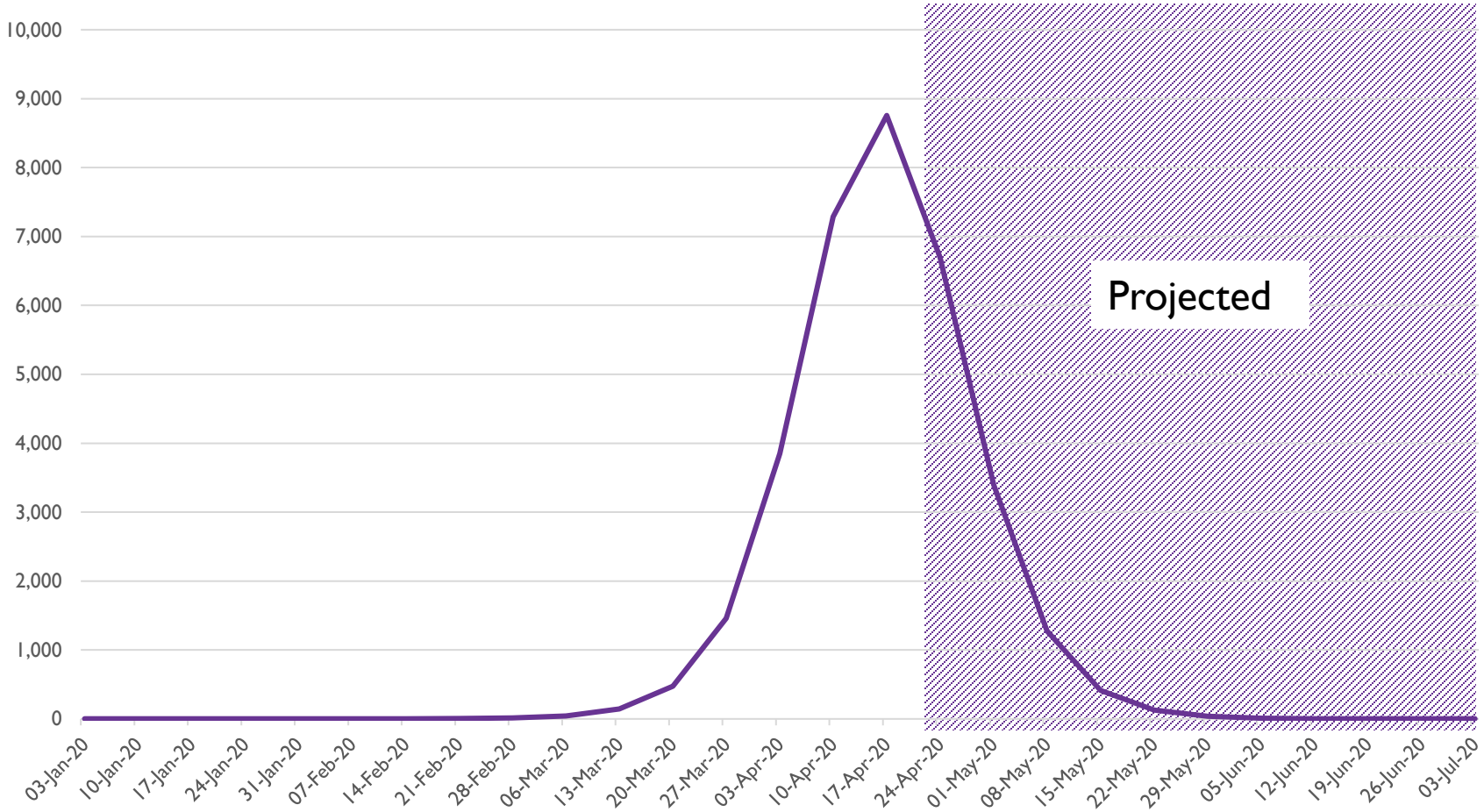
"Oxford view" model (II): Number of people dying each week with COVID-19



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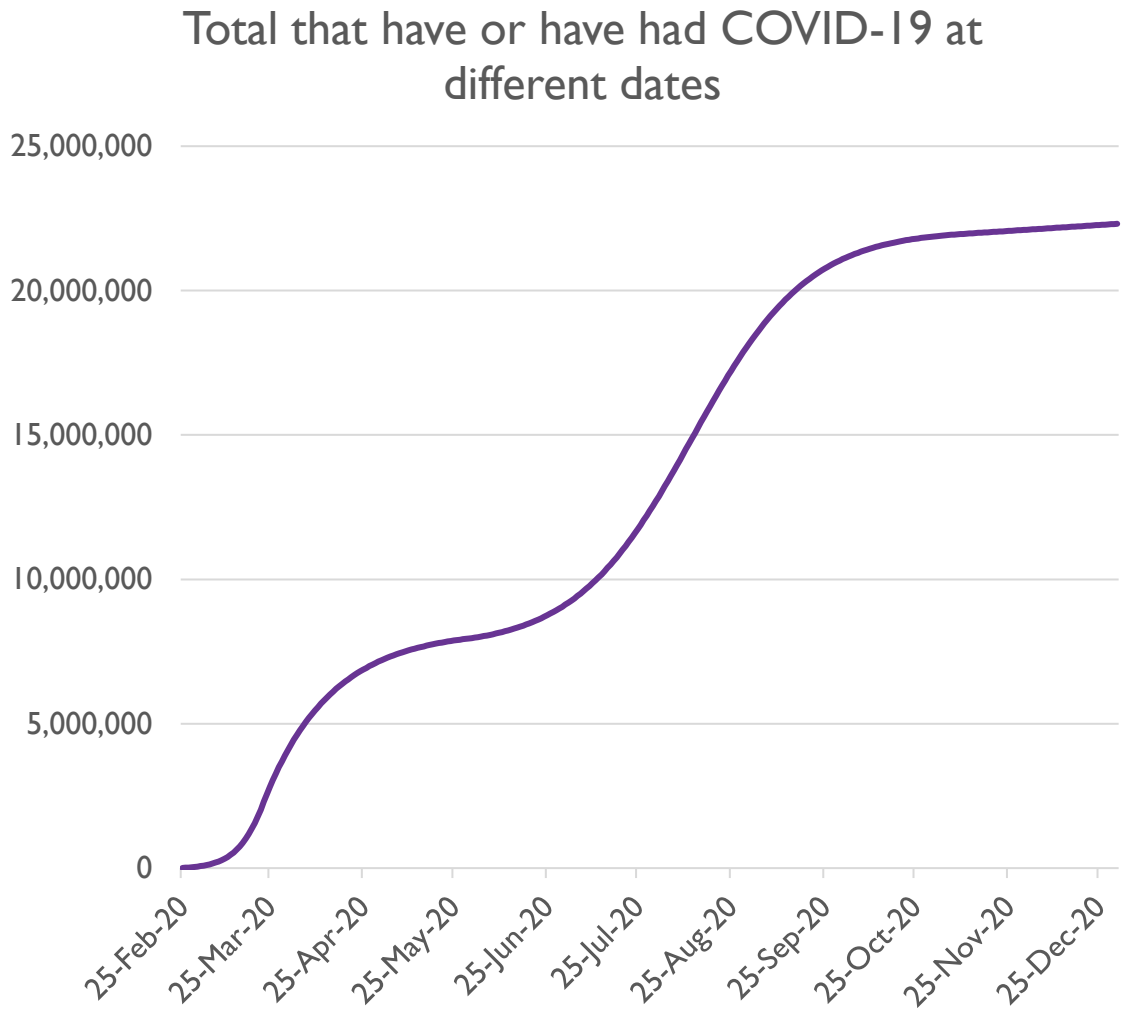
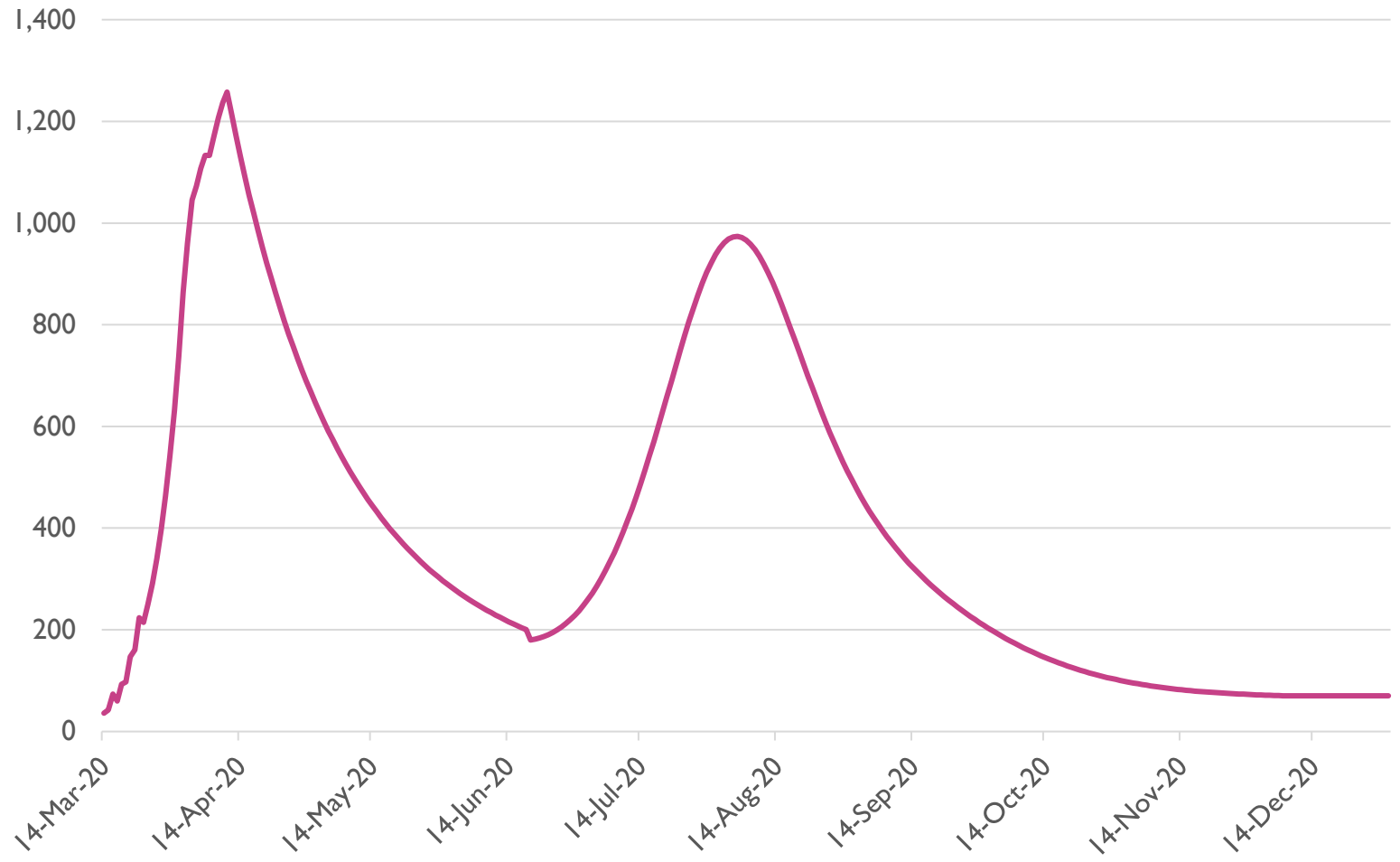
Our "Interrupted Logistic" model based on Imperial view fatality assumptions



- There is a phase of exponential growth, then R0 drops dramatically in lockdown
- Post-lockdown the logistic progression re-starts based on the number infectious, the number still available to be infected, and the post-lockdown R0, when lockdown is relaxed.

Evolution of daily COVID-19 deaths across the UK if the government is only partially successful in keeping R under control post-lockdown



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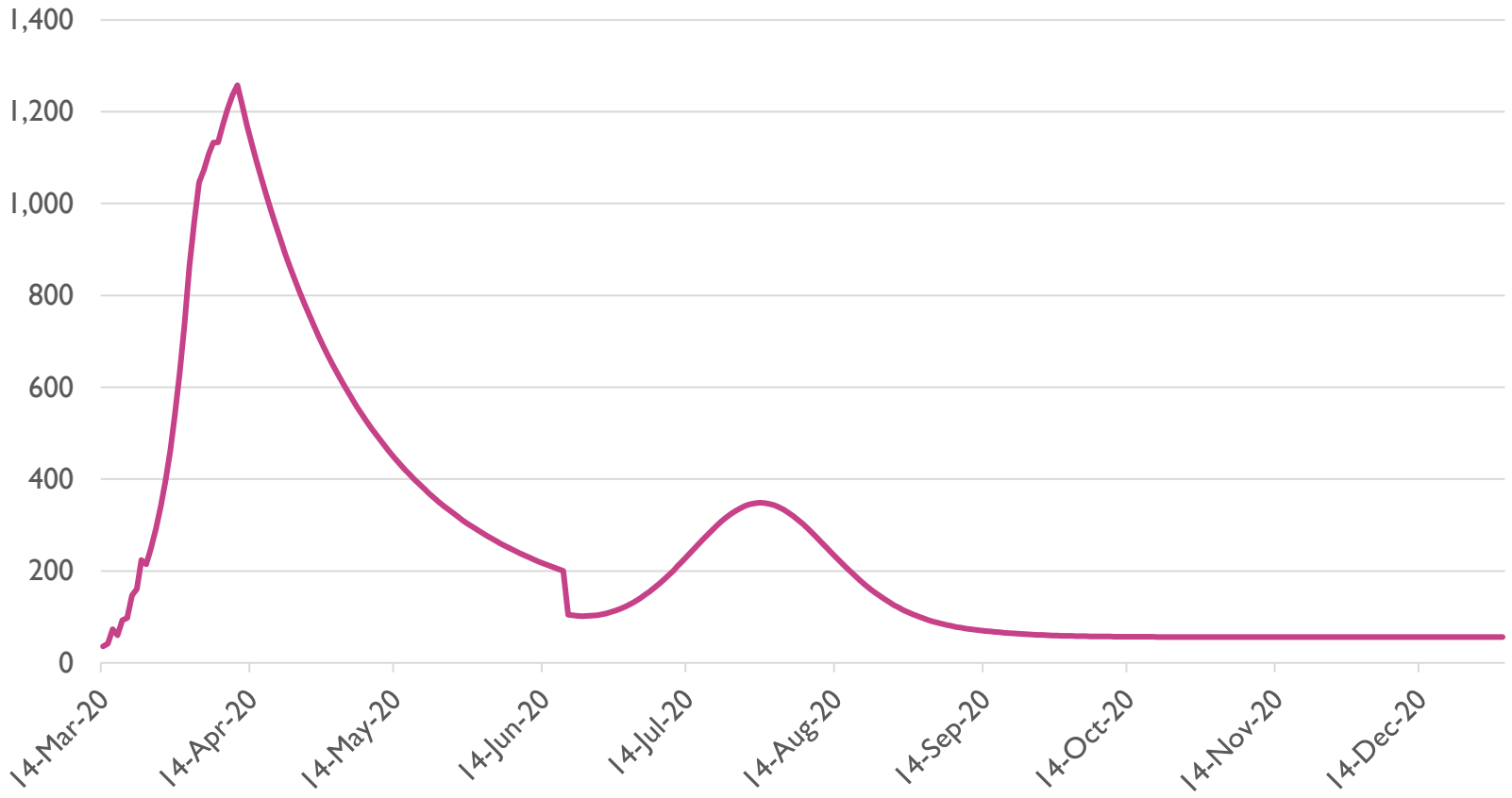
Evolution of daily COVID-19 deaths across the UK if the government is more successful in keeping R under control post-lockdown



Regional models

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Disclaimer and caveats

The charts that follow and the accompanying data sheet are intended to provide the NAFD and its members with an approximate indication of the range within which deaths in their areas might lie, under a set of plausible scenarios reflecting the very considerable scientific and policy uncertainty at this time. The models use epidemiological and other scientific assumptions drawn from the current literature. However, we do not endorse any specific such assumptions and we have sought to acknowledge and reflect the very considerable scientific debate there is about many aspects of these matters at present.

Our models are not intended to be used to guide NHS planning or government policymaking regarding future phases of the coronavirus crisis. Had our models been designed for that purpose they would have required additional features (eg analysis of ICU usage).

It is both the strength and the weakness of regional modelling that it is more local. It is a weakness in that data is less certain and ranges of uncertainty are higher than for more aggregated analysis. It is also a weakness in this case in that there may be interactions between regions (eg transmission of infection) that we have not modelled explicitly. Key strengths include information for local decision-makers and a recognition of the possibility of localised epidemics even if spread is controlled at a national level.

Our regional models allow for a wide variety of region-specific factors

- Different demographics lead to different fatality rates (eg under the Imperial view ranging from 0.6% in London to 1% in the South West).
- Epidemics start at different dates and spread at different speeds.
- The R0 in lockdowns are different.
- Post-lockdown R0s are different, & hence the post-lockdown logistic progressions (the mathematical shapes of new infections) are different.
- We use not-fully-binding regional herd immunity thresholds.

NB All projections are to the final week of September 2020

East of England total deaths, all causes

London total deaths, all causes

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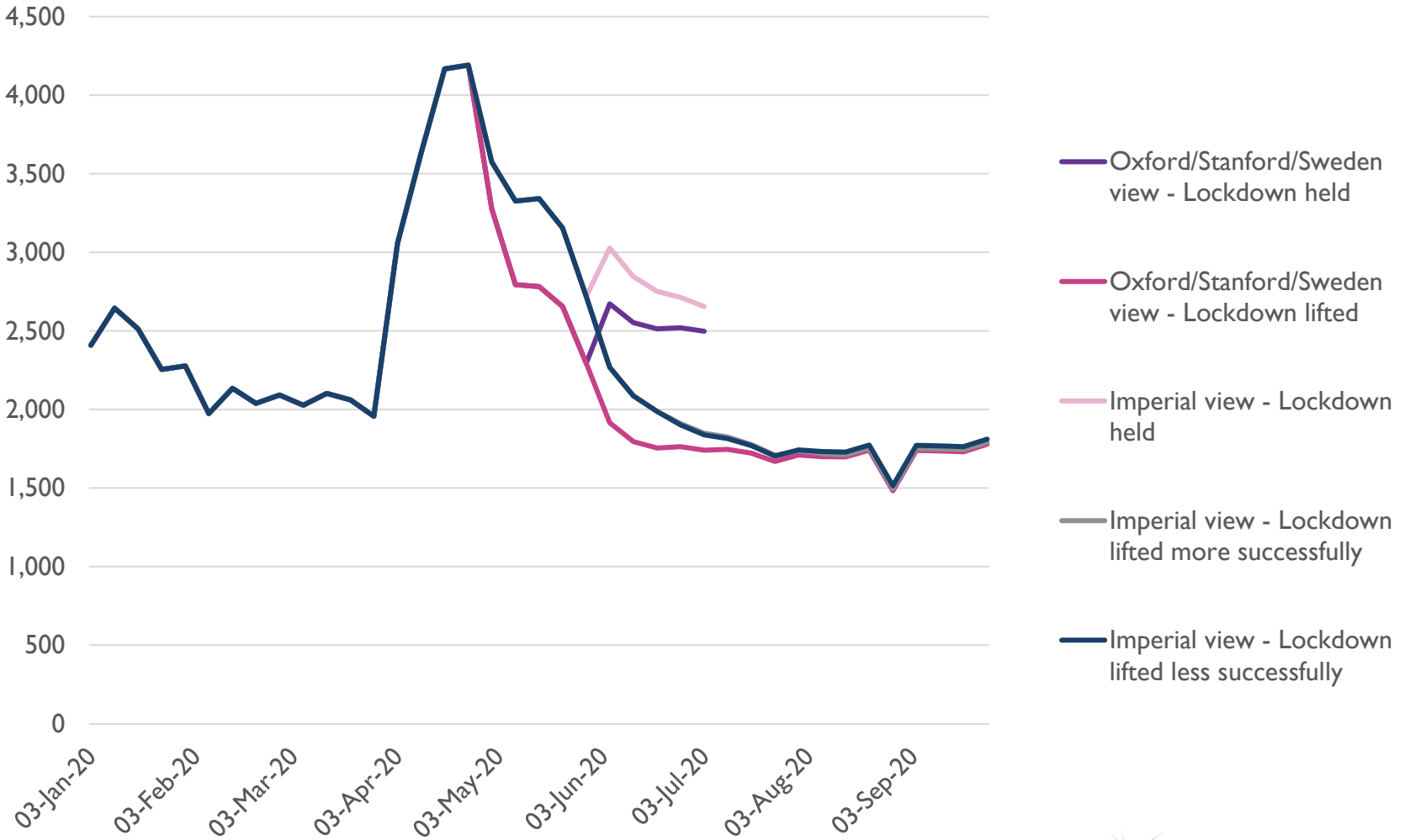
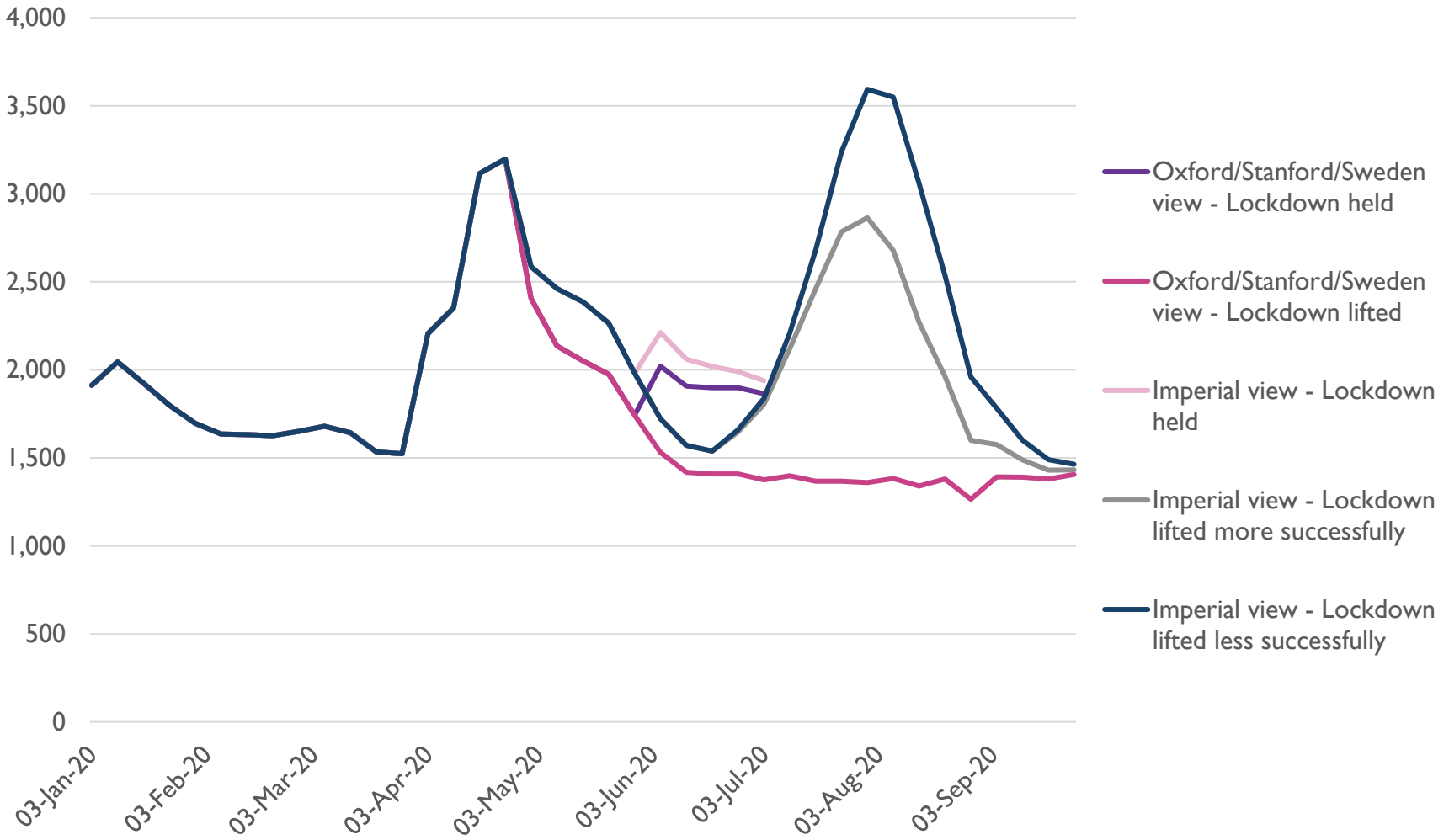
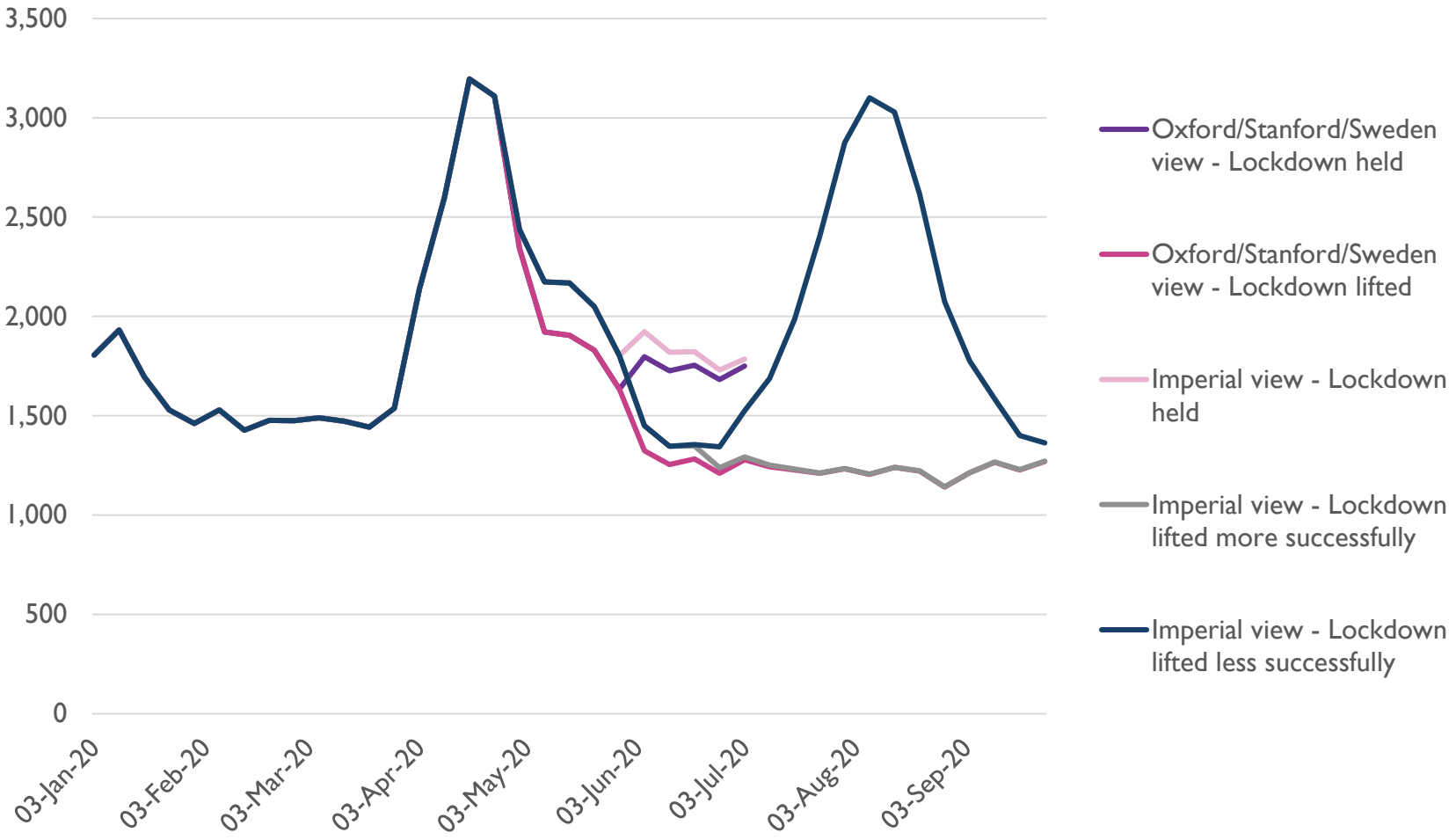
Midlands total deaths, all causes



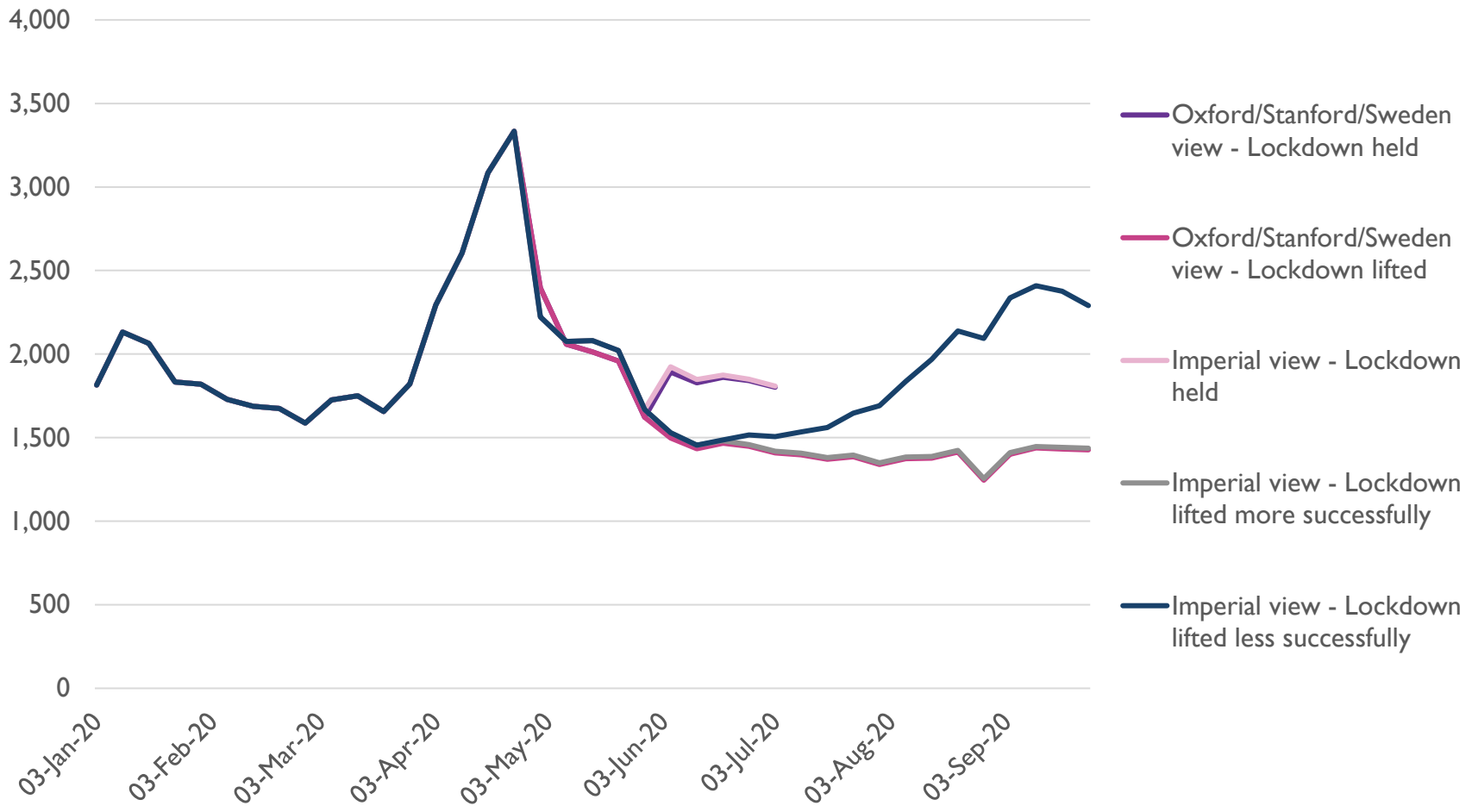
North-East and Yorkshire total deaths, all causes



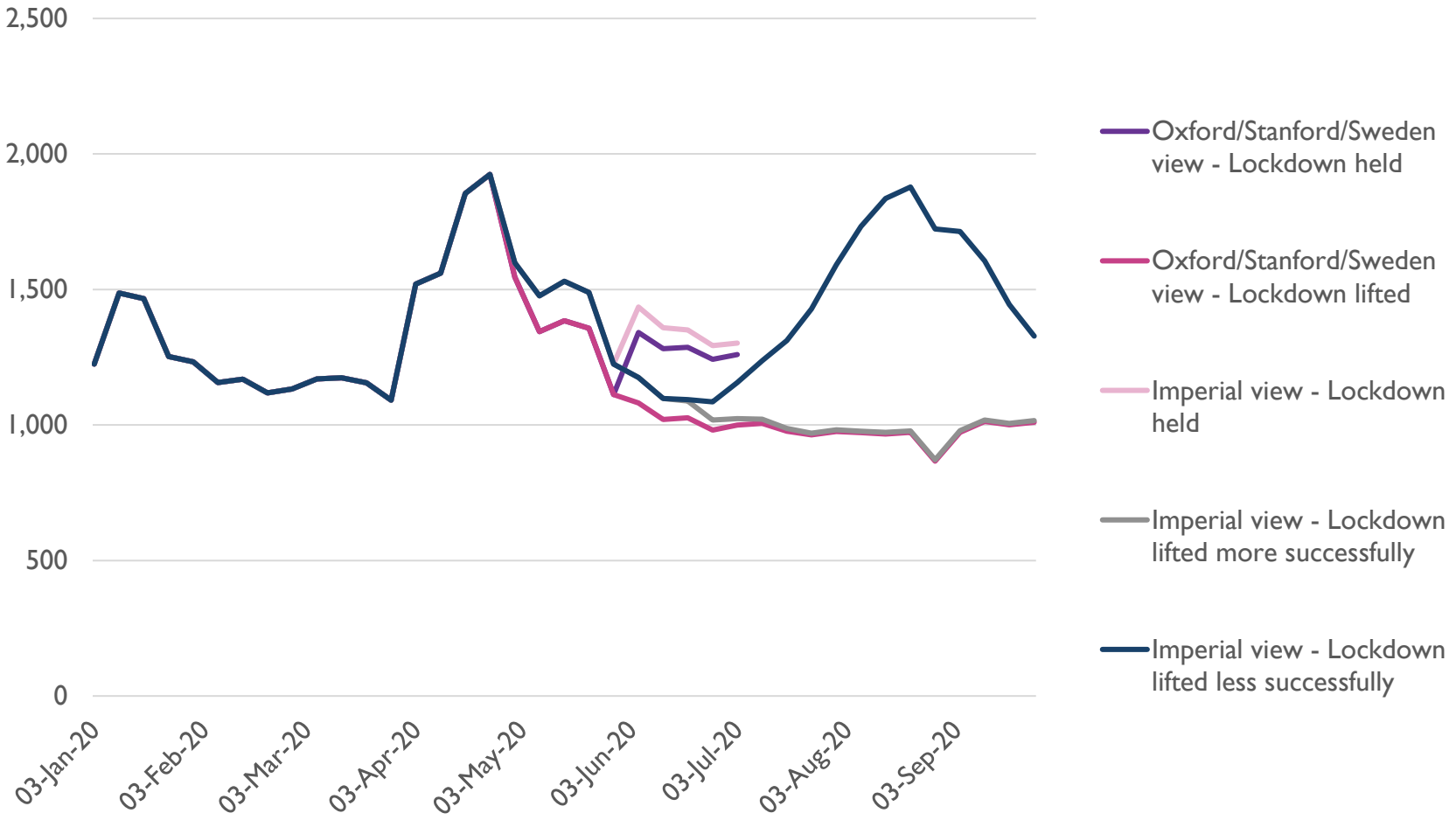
North West total deaths, all causes



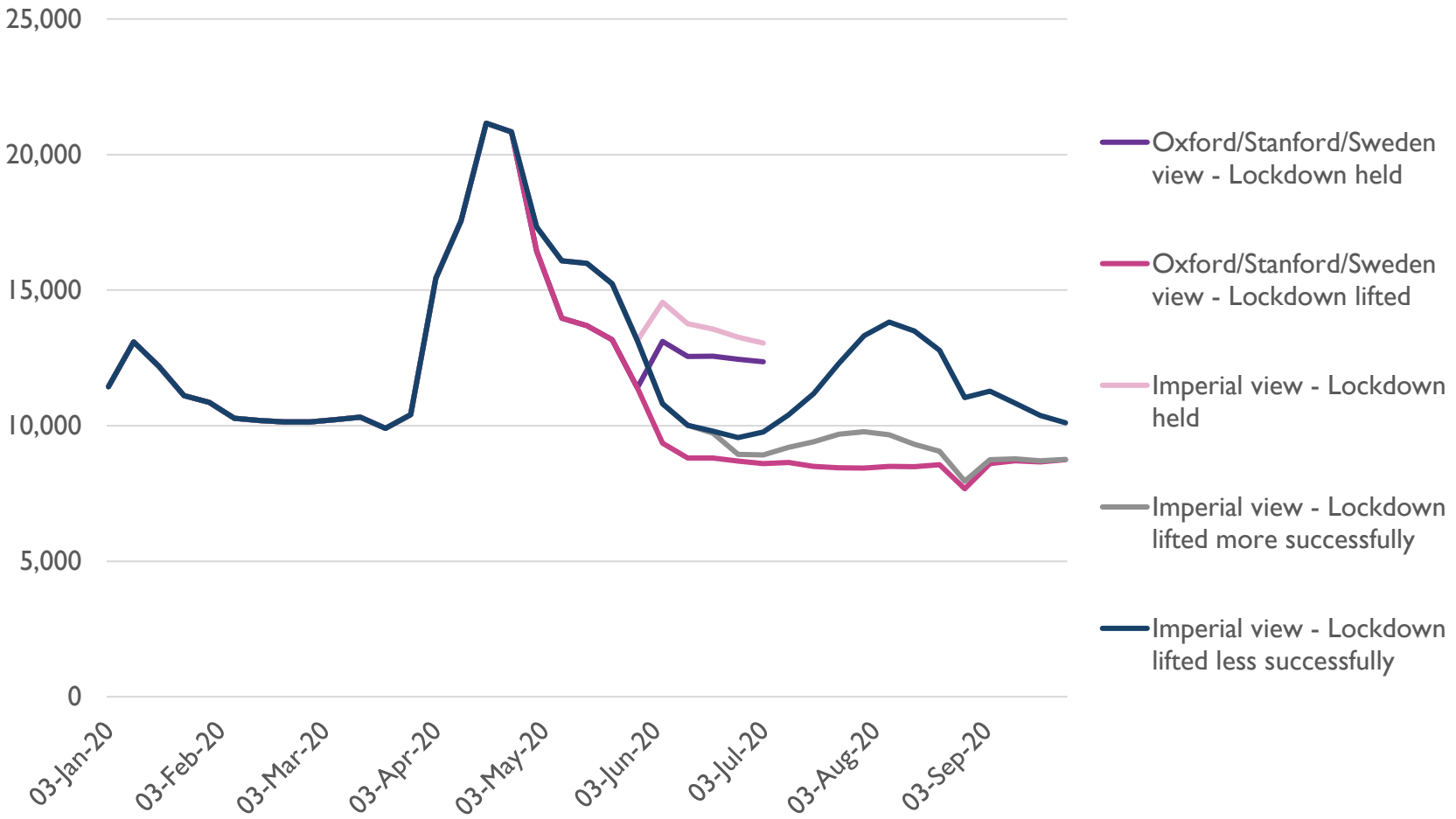
South East total deaths, all causes



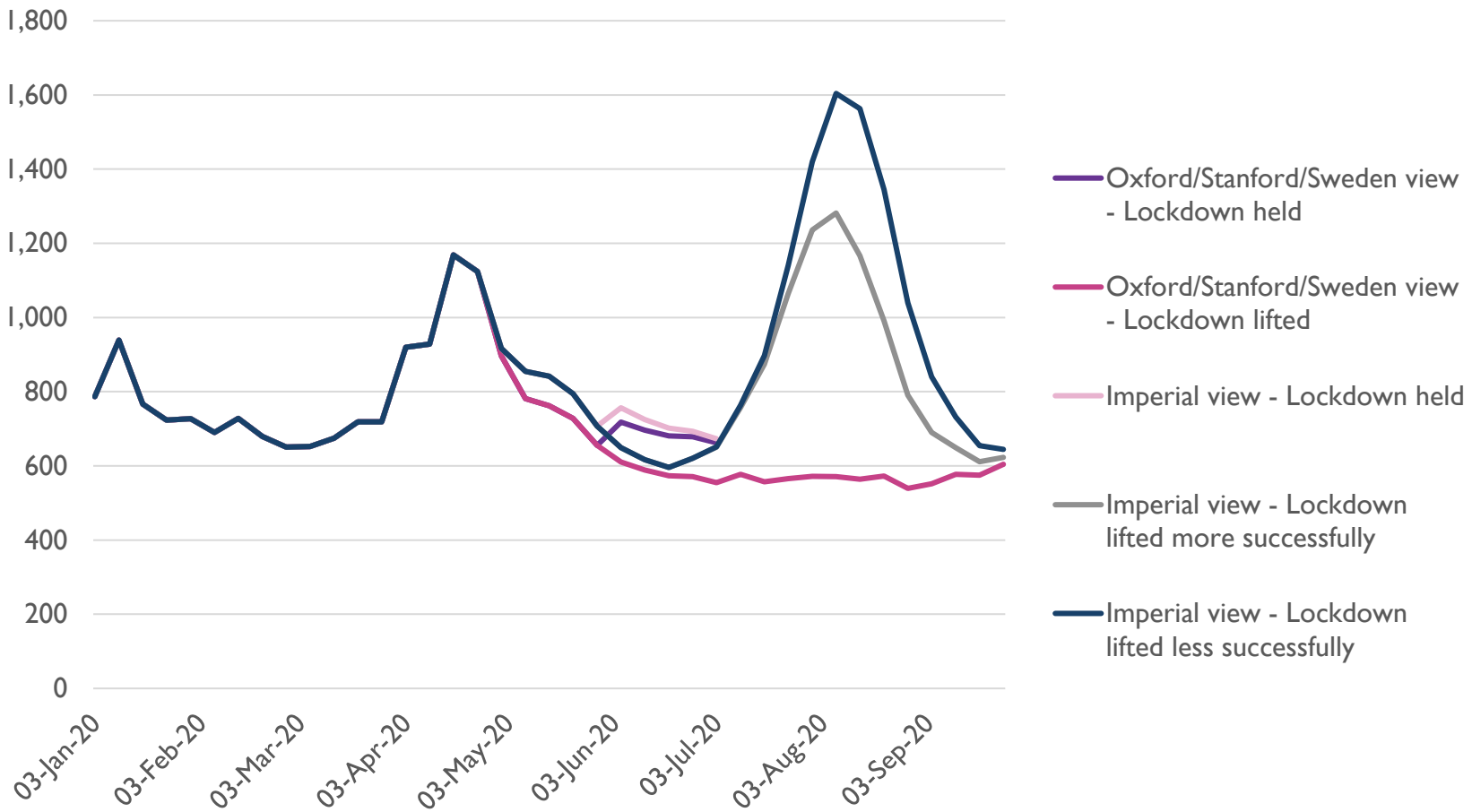
South West total deaths, all causes



England total deaths, all causes



Wales total deaths, all causes



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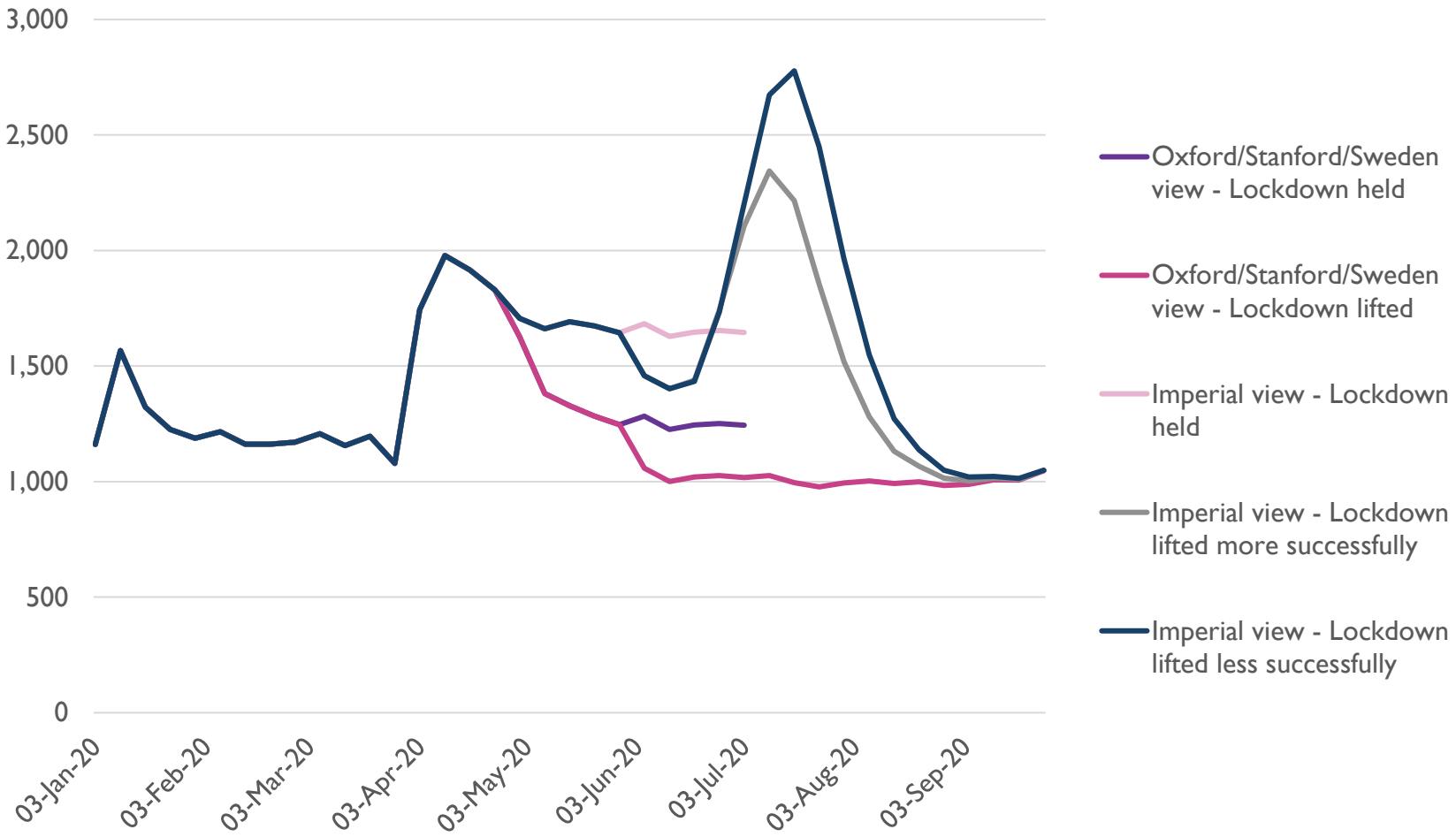
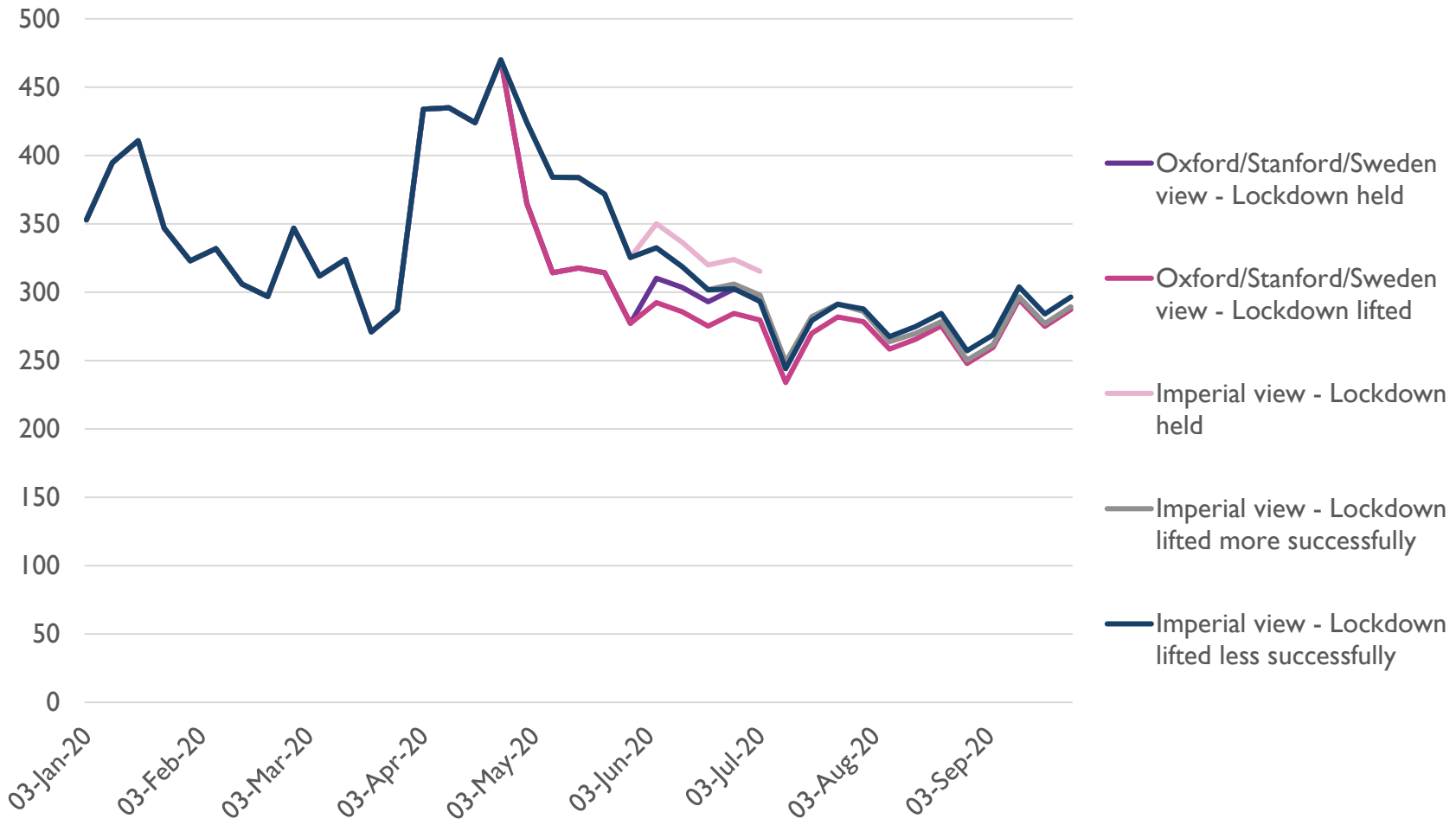
Scotland total deaths, all causes



Northern Ireland total deaths, all causes



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UK total deaths, all causes