A study of the effectiveness of travel restrictions in the EEA

Edge Health

oxera

Executive summary

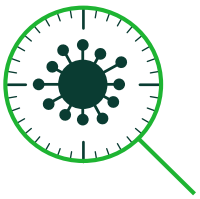
There have been extensive travel restrictions in place across Europe over the last two years, ranging from mandatory quarantines to pre-departure testing and on-arrival testing. Despite these travel restrictions, Europe has experienced significant waves of COVID-19.

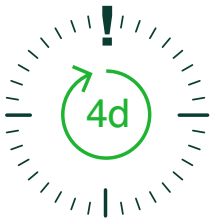
While the current wave of infections associated with the Omicron variant is subsiding in most European countries, new Variants of Concern (VOCs) are likely to continue to emerge. However, nearly two years on from the start of the pandemic, there is a question about whether implementing travel restrictions to protect domestic populations against COVID-19 is a useful and proportionate approach.

Indeed, analysis shows that travel restrictions have failed to prevent the spread of COVID-19.[1] The International Health Regulation Emergency Committee of the World Health Organisation (WHO) also recently highlighted the failure of travel restrictions to limit the importation of VOCs.[2]

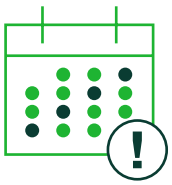
As we look to a world where COVID-19 is endemic, it is relevant to consider the role of air passenger travel restrictions in limiting the importation of COVID-19, particularly as a result of new VOCs.

There is unlikely to be a demonstrable benefit associated with introducing travel restrictions in response to new variants.
This is consistent with experience since the beginning of the pandemic that indicates that it is difficult to identify a variant as a VOC sufficiently quickly to be able to introduce travel restrictions that have an impact.





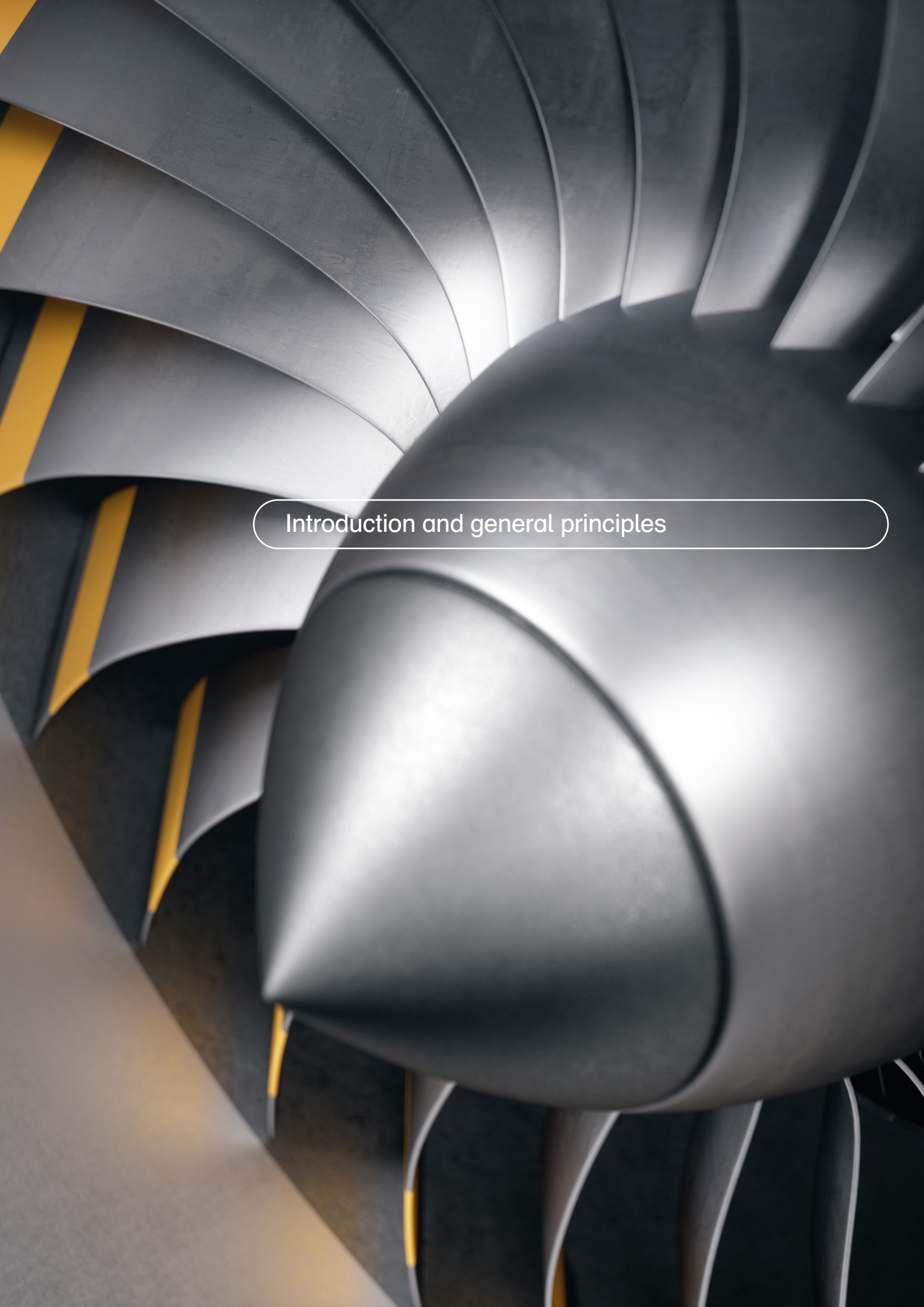
Even if travel restrictions were pre-emptively introduced, or could be put in place on the day the variant is first imported, they would not have an impact on limiting the peak of cases, and would only delay the peak by a maximum of four days. If we consider this timing in the context of Omicron, most European countries did not introduce travel restrictions until a number of weeks after Omicron was identified as a VOC by the WHO on 24 November.



The effectiveness of travel restrictions is further reduced when a variant is more infectious.
If the introduction of travel restrictions is delayed by even one week, the benefit of travel restrictions in terms of delaying the peak of COVID-19 cases declines by half, to a maximum of two days from the day the variant is first imported.

[1] For example, see Oxera and Edge Health (2022), 'Impact of travel restrictions on Omicron in Italy and Finland', Prepared for ACI Europe and IATA, 26 January; Oxera and Edge Health (2022), 'A framework for considering the impact of air travel restrictions on the UK', Prepared for Manchester Airports Group and Airlines UK, January.
[2] In a recent meeting, the WHO noted that: 'The failure of travel restrictions introduced after the detection and reporting of Omicron variant to limit international spread of Omicron demonstrates the ineffectiveness of such measures over time. Travel measures (e.g. masking, testing, isolation/quarantine, and vaccination) should be based on risk assessments and avoid placing the financial burden on international travellers'. World Health Organisation (2022), 'Statement on the tenth meeting of the International Health Regulations (2005) Emergency Committee regarding the coronavirus disease (COVID-19) pandemic', 19 January, https://www.who.int/news/item/19-01-2022-statement-on-the-tenth-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-coronavirus-disease-(covid-19)-pandemic.

Overview



Introduction and general principles

Introduction

There has been a range of international travel restrictions in place across Europe since the start of the pandemic. Countries in the European Economic Area (EEA) have implemented different restrictions from one another in response to the same set of circumstances. These restrictions have also changed over time within a given country—e.g. from mandatory quarantine, to pre-departure PCR tests, to antigen tests upon arrival.

Successful vaccination campaigns, natural immunity, and improved treatments such as antivirals mean that many European countries have removed or are significantly reducing local restrictions even as Omicron is still spreading. At the same time, as of 26 January, 12 EU member states still required vaccinated passengers to take pre-departure tests (in some cases in addition to on-arrival tests) for intra-European travel.

More recently, some countries have started to remove travel restrictions, and as of February 2022, only one country has travel restrictions in place. The European Council has also adopted revised recommendations for a common approach to travel measures for intra-EU travel as of 1 February based on an individual risk-based approach rather than the epidemiological situation of a country or region.[1] It states that there should be no testing or quarantine/self-isolation for fully vaccinated or recovered travellers holding a valid EU Digital COVID Certificate (DCC).[2] On 22 February, the Council also adopted a proposal to facilitate extra-EU travel.[3]

However, the experience with Omicron shows that countries are quick to introduce travel restrictions once a variant is identified as a VOC,[4] and are then slow to remove them. Indeed, there is an Emergency Break procedure in the Council's recommendation allowing states to reimpose travel restrictions in case new Variants of Concern or Interest are detected. This is despite evidence showing that travel restrictions have not been effective at slowing the spread of Omicron, and the significant costs of such restrictions for passengers, the aviation sector, and the economy.

[1] See European Council (2022), 'Infographic - A common approach to COVID-19 travel measures in the EU', https://www.consilium.europa.eu/en/infographics/covid19-travel-measures-eu-january-2022/.
[2] Unvaccinated passengers should be subject to a NAAT or rapid antigen test before arrival or within 24 hours of arriving.
[3] See European Union (2021), 'Proposal for a COUNCIL RECOMMENDATION amending Council Recommendation (EU) 2020/912 on the temporary restriction on non-essential travel into the EU and the possible lifting of such restriction', 26 January, https://op.europa.eu/en/publication-detail/-/publication/4dc62746-4df9-11ec-91ac-01aa75ed71a1/language-en, and European Council (2022), 'Infographic - COVID-19: travel from third countries into the EU ', 22 February, https://www.consilium.europa.eu/en/infographics/covid19-travel-restrictions-third-countries-february2022/. For example, member states should not only accept COVID-19 vaccines that have been granted a marketing authorisation pursuant to Regulation (EC) No 726/2004 of the European Parliament and of the Council, but also those having completed the emergency listing procedure of the World Health Organization (WHO).
[4] There is generally a delay between variants first being sequenced and then identified as a VOC. This means that even if travel restrictions are put in place soon after a variant is identified as a concern, cases are already likely to have been seeded at that stage.

Looking forward, there are likely to be new VOCs. The key question therefore concerns the role that travel restrictions can play in reducing the spread of COVID-19, based on the data and lessons of the last two years.

It is in this context that ACI EUROPE and IATA have asked Oxera and Edge Health to analyse the impact that travel restrictions could have going forward. In particular, we have analysed a number of different scenarios around the importation of VOCs and future waves of COVID-19 to help consider:[5]

- the extent to which travel restrictions affect the speed and peak of the spread of COVID-19 as a result of a new variant;
- the trigger points for bringing in, as well as removing, testing requirements to deal with new VOCs—i.e. the critical point at which introducing travel restrictions could have an impact and the point at which there would be a critical mass of a VOC domestically such that travel restrictions are no longer relevant.

This analysis helps provide information about the benefits of travel restrictions from a public health perspective that can then be compared with the costs that such restrictions impose on the economy.

General principles for imposing travel restrictions

In order to determine appropriate travel restrictions going forward, it is important to consider the objective of such restrictions. Any restrictions imposed should aim to minimise economic disruption. This includes all potential issues that could arise as a result of seeding new VOCs, such as the impact of widespread infection on health services, as well as the disruption caused to the economy. In line with this objective, it is relevant to consider the following key principles.

- Travel restrictions should only be imposed if they can have a meaningful impact on the peak and/or timing of cases; otherwise they should not be imposed at all.
- Travel restrictions should be removed once seeded cases exceed the level beyond which such restrictions would make a material difference to the trajectory of infections.
- The costs of imposing any restrictions should be balanced against the benefits.
- Given the incremental cost of restrictions, they should be targeted as much as possible.

[5] This analysis builds on previous analysis undertaken by Oxera and Edge Health over the last year. For example, see Oxera and Edge Health (2022), 'Impact of travel restrictions on Omicron in Italy and Finland', prepared for ACI EUROPE and IATA, 26 January.

Analysis: scenarios and results

Analysis

We have modelled a number of scenarios to consider the impact of future air travel restrictions. The modelling includes three scenarios that reflect the most likely outcomes over the next several months (i.e. short- and medium-term scenarios) where variants are more infectious than Omicron or are able to evade vaccines.

The modelling also considers a potential scenario for the longer term (i.e. longer-term scenario). In this scenario, less infectious variants could become dominant. However, it is difficult to predict what will happen in the longer term (e.g. natural immunity could be greater, meaning even less infectious variants could become dominant; or natural immunity could wane such that Omicron becomes dominant again). Therefore, it is important to consider the longer-term picture again as more data becomes available.

Each scenario has been modelled for the case where traffic is back to 80% of 2019 levels, and for a sensitivity with traffic at approximately 50% of 2019 levels. We also include a sensitivity analysis in the Appendix that considers the impact of travel restrictions if natural immunity wanes going forward and booster programmes are being rolled out.

We compare having pre-emptive travel restrictions, or restrictions imposed on the day the variant is imported, to having no testing regime in place. In particular, we consider pre-departure testing (an antigen test 48 hours before travelling or PCR test 72 hours before travelling), which has been the most common testing regime in European countries.

Scenarios considered

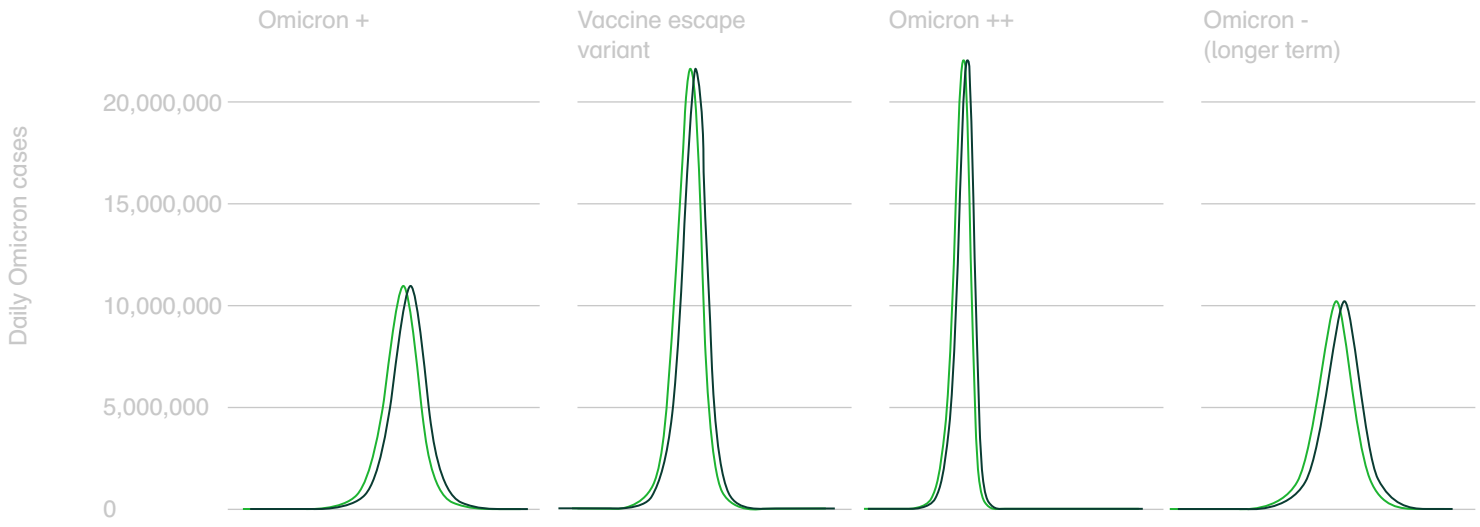
Scenario	Rt of scenario*	Description of scenario	Travel restrictions modelled
		Medium term	
Scenario 1	3.75	**Omicron +**: variant slightly (1.25 times) more infectious than Omicron once 20% of the population has some natural immunity to Omicron	(i) no passenger testing or quarantine (ii) pre-departure antigen (48hrs) and pre-depature PCR (72hrs)
Scenario 2	4.86	**Vaccine escape variant**: same infectiousness as Omicron but twice the immune escape, and therefore an Rt 1.6 times more infectious than Omicron once 20% of the population has some natural immunity to Omicron	
Scenario 3	7.51	**Omicron ++**: variant significantly (2.5 times) more infectious than Omicron once 30% of the population has some natural immunity to Omicron	
		Longer term	
Scenario 4	3.56	**Omicron -**: variant slightly (1.25 times) more infectious than Omicron once 25% of the population has some natural immunity to Omicron	

Note: * Rt is when the variant is first seeded. We have assumed that masks and COVID-19 testing continue in the EEA.

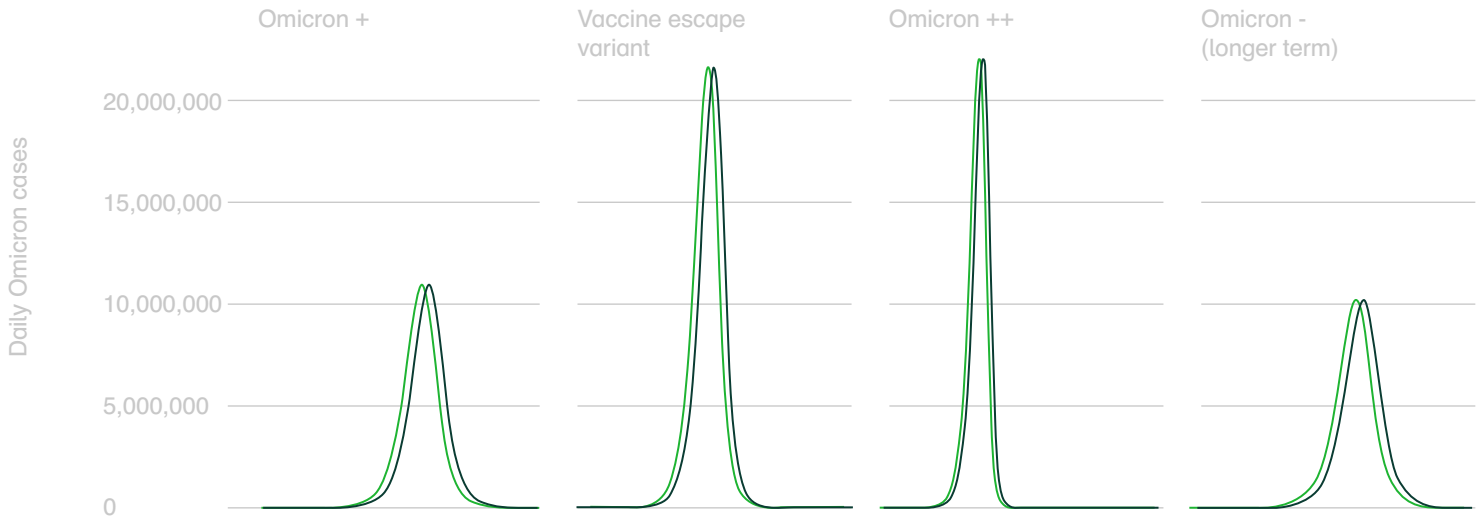
Air travel restrictions do not affect the size of the peak

Introducing air passenger testing does not affect the height of the peak of cases, relative to not having any restrictions in place. This holds even when travel volumes are high.

High volume



Low volume



No testing or quarantine
Pre-departure antigen 48hrs or PCR 72hrs

There is a small impact of air passenger testing on the timing of the peak; however, as the variant gets more infectious, the impact of travel restrictions on the delay in the peak decreases

The table below shows the impact of variant infectiousness on the delay of the peak when travel volumes are high (i.e. 80% of 2019 levels). Variants are ordered from least to most infectious. The imposition of air passenger testing leads to between a two- and four-day delay in the peak of cases. This delay is measured from the day the variant is first imported, which is likely to precede a variant being identified as a concern.

Travel restriction	Scenario	Delay in peak relative to no testing and quarantine (days)
Pre-departure antigen 48hrs or PCR 72hrs	Omicron -	4
	Omicron +	4
	Vaccine escape variant	2
	Omicron ++	2

Impact of delaying travel restrictions on the timing of the peak

As variants become more infectious according to the scenarios we have modelled, it becomes more difficult to impose travel restrictions that can have an impact on the timing of the peak of cases. The table below shows how the delay of the peak depends on the number of days it takes to put restrictions in place. For example, for Omicron +, if restrictions are put in place one week after the variant is first imported, the peak would be delayed by a maximum of two days. It took Italy over six weeks and Finland eight weeks from the time that Omicron was first sequenced to introduce travel restrictions.

The table below shows the impact of variant infectiousness on the delay of the peak when travel volumes are high (i.e. 80% of 2019 levels). Variants are ordered from least to most infectious. The scenario where Day 0 travel restrictions are introduced can be considered akin to having pre-emptive travel restrictions in place.

Day restrictions are implemented								
	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Omicron -	4	4	3	3	3	3	3	2
Omicron +	4	3	3	3	3	3	2	2
Vaccine escape variant	2	2	1	1	1	1	1	0
Omicron ++	2	1	1	1	1	1	0	0

Conclusion

Conclusion

Air travel restrictions do not affect the size of the peak but could delay the peak by a few days if they are introduced pre-emptively, or on the day that the variant is first imported

Our analysis indicates that any travel restrictions imposed over the next several months will have no impact on the size of the peak, but could delay the peak of cases by a maximum of four days, regardless of the level of passenger traffic. This is the case only if restrictions are imposed pre-emptively, or could be introduced on the same day that a variant is imported and therefore likely before it is actually identified as a VOC.

Any benefits of air travel restrictions diminish quickly over time

Each additional day of delay leads to a reduction in the effectiveness of travel restrictions, such that if restrictions are not imposed until one week after the variant is imported, there is at most two days' benefit to introducing such restrictions in terms of the trajectory of COVID-19 infections. In two of the scenarios considered, by Day 7 there will no longer be any benefit to the restrictions and they should therefore be removed. It is notable that it took countries such as Italy and Finland between six and eight weeks from the time that Omicron was first sequenced to introduce travel restrictions.

Ongoing restrictions will have a significant impact on the economy

Experience since the start of the pandemic indicates that it takes time to become aware of a variant, and then to identify it as a concern, such that putting policies in place sufficiently quickly is likely to be extremely difficult. A potential alternative, therefore, would be to impose ongoing travel restrictions in case a new variant emerges, potentially alongside local restrictions. However, even in these cases restrictions will have minimal benefits, and the significant direct and indirect costs to the economy would need to be taken into account.

Monitoring the situation for the long term is important

In the longer term, if a less infectious variant is able to become dominant, travel restrictions may have limited benefits. However, it is difficult to determine potential scenarios beyond the short/medium term, and it would therefore be important to reconsider the restrictions for the period beyond the next several months at a later stage.

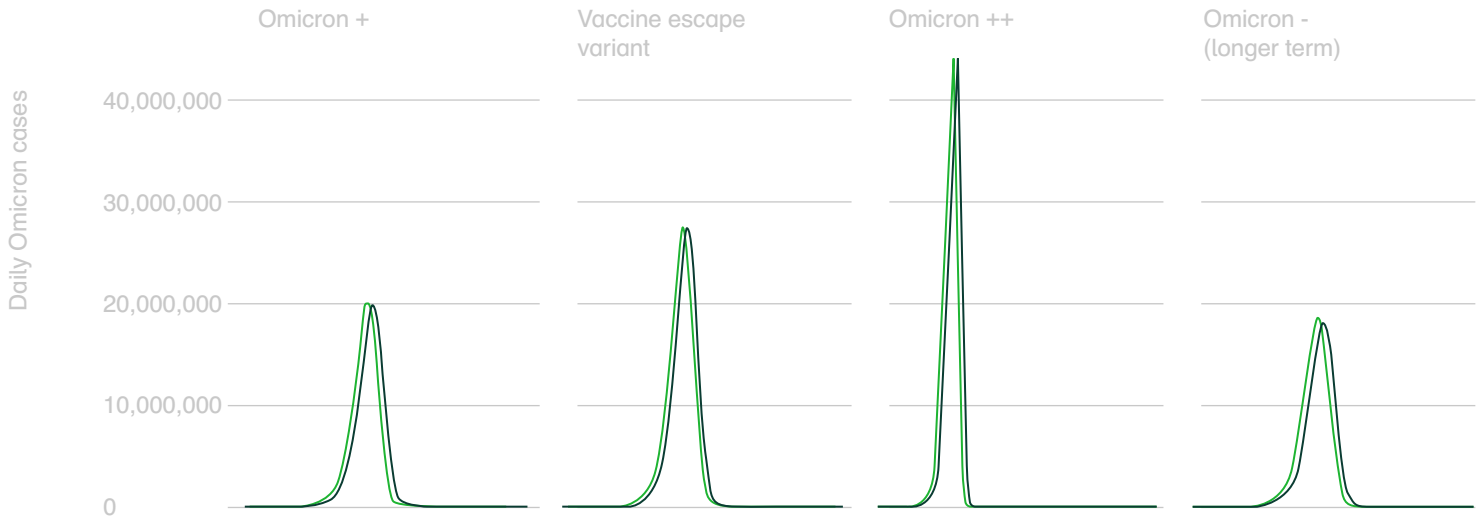
Appendix

A1.1 Sensitivity: when there is an ongoing vaccination roll-out

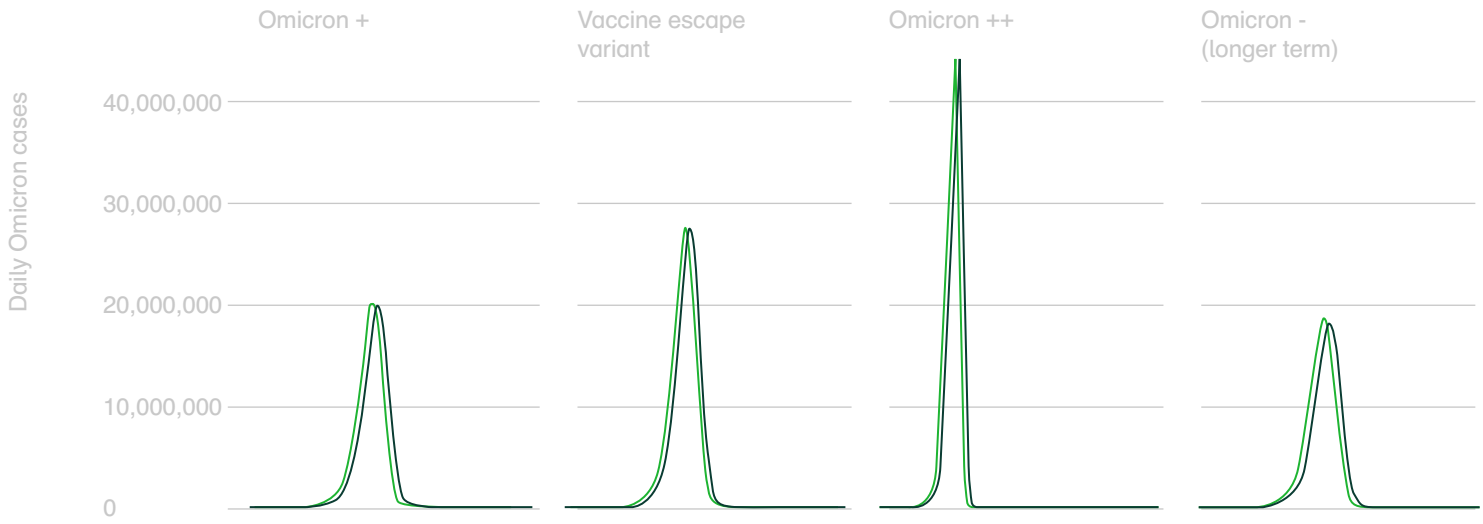
If there is an ongoing vaccine roll-out (e.g. due to waning immunity), travel restrictions can have a small impact on the peak of cases and can delay the peak by a few days, particularly when travel volumes are high.

Booster vaccine still being rolled out

High volume



Low volume



No testing or quarantine
Pre-departure antigen 48hrs or PCR 72hrs

However, as the variant gets more infectious, the impact of travel restrictions on the delay in the peak decreases, even when boosters are still being rolled out.

The table below shows the impact of variant infectiousness on the size and delay of the peak when boosters are still being rolled out and travel volumes are high (i.e. 80% of 2019 volumes). Variants are ordered from least to most infectious.

Travel restriction	Scenario	Delay in peak relative to no testing and quarantine	Reduction in peak relative to no testing and quarantine
Pre-departure antigen 48hrs or PCR 72hrs	Omicron -	3	2.3%
	Omicron +	3	1.6%
	Vaccine escape variant	3	0.3%
	Omicron ++	1	0%

A1.2 Traffic sensitivity: traffic at 50% of 2019 levels

The table below displays the impact of variant infectiousness on the delay of the peak when there are lower travel volumes (i.e. 50% of 2019 levels). The variants are ordered from least to most infectious.

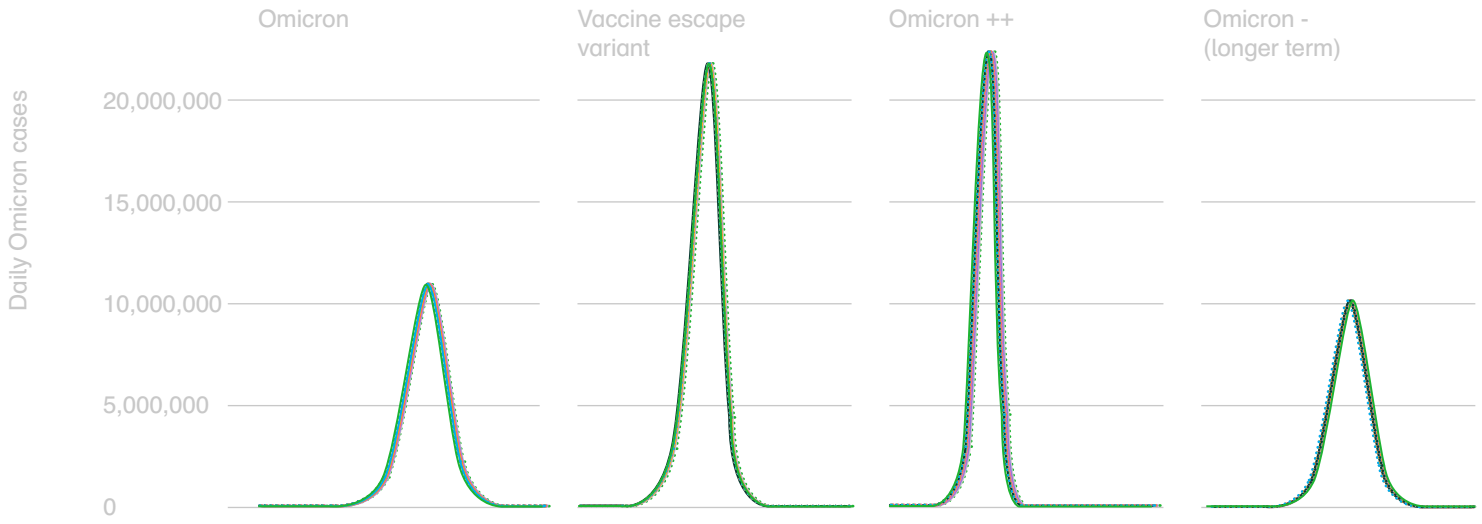
	Travel restriction	Scenario	Time difference in peak from no testing and quarantine
Boosters already rolled out	Pre-departure antigen 48hrs or PCR 72hrs	Omicron -	4
		Omicron +	4
		Vaccine escape variant	3
		Omicron ++	2
Booster doses being rolled out	Pre-departure antigen 48hrs or PCR 72hrs	Omicron -	4
		Omicron +	4
		Vaccine escape variant	3
		Omicron ++	2

A1.3 Additional plots: impact of delayed implementation of testing on timing of peak

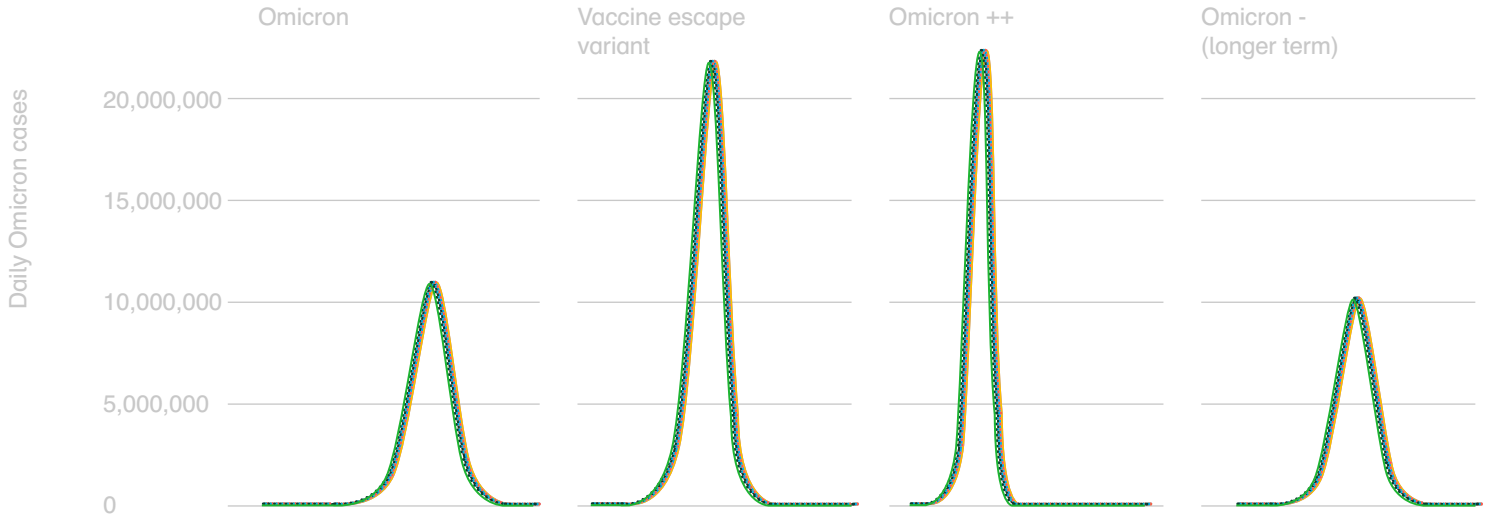
A1.3.1 When there is no ongoing vaccination roll-out

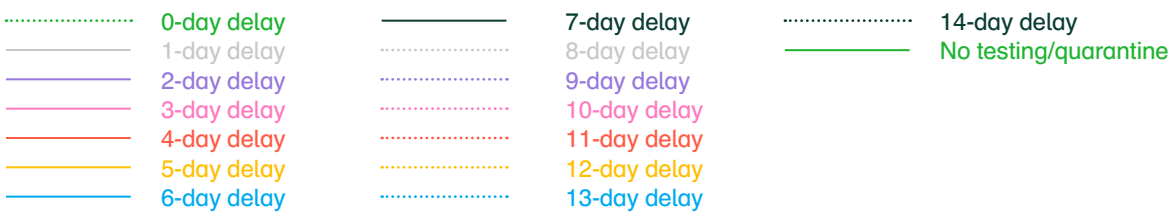
Impact of introducing travel restrictions, by the delay from the day of the first seeded case (pre-departure antigen 48hrs or PCR 72hrs)

High volume



Low volume

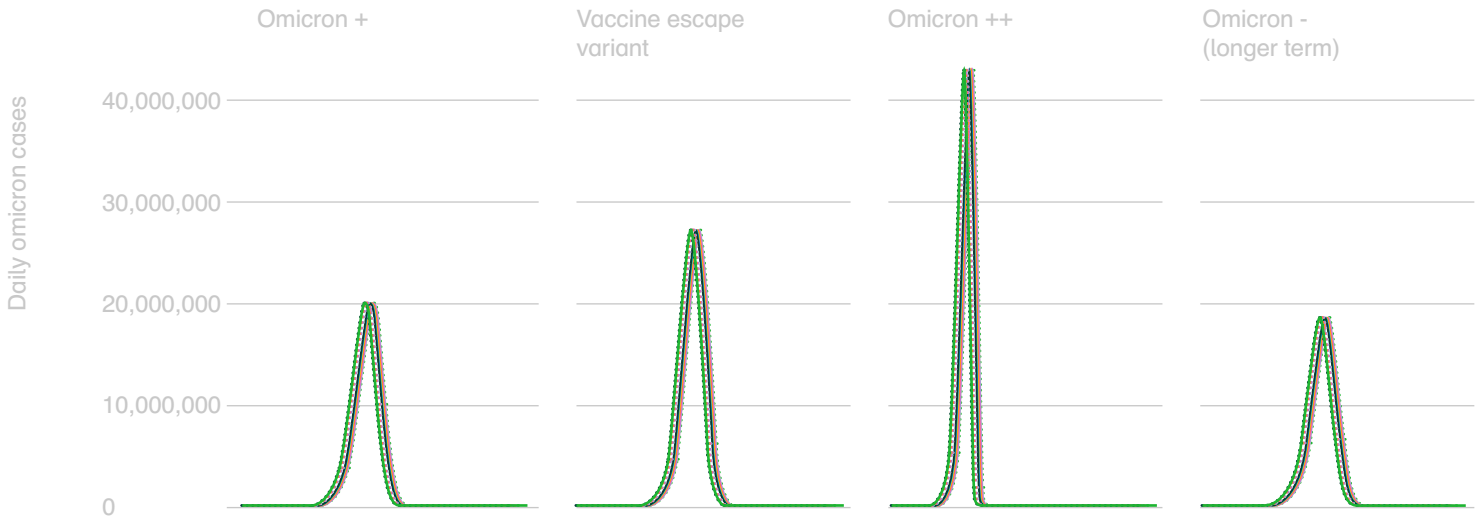




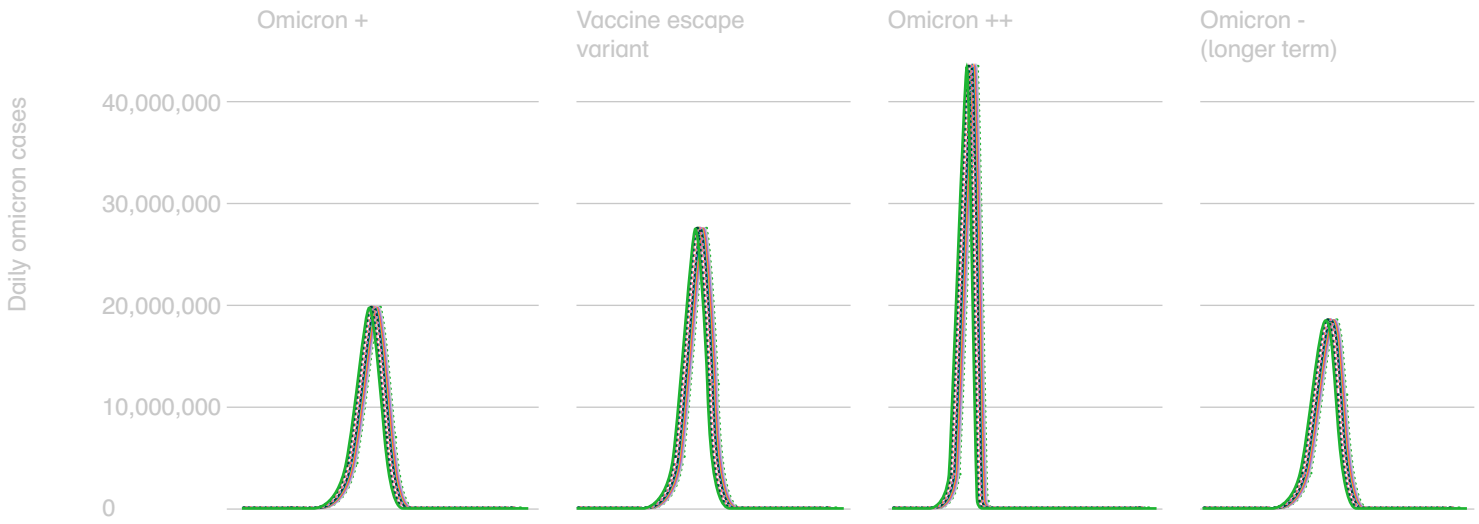
A1.3.2 When there is an ongoing vaccination roll-out

Impact of introducing travel restrictions, by the delay from the day of the first seeded case (pre-departure antigen 48hrs or PCR 72hrs)

High volume



Low volume



0-day delay
1-day delay
2-day delay
3-day delay
4-day delay
5-day delay
6-day delay
7-day delay
8-day delay
9-day delay
10-day delay
11-day delay
12-day delay
13-day delay
14-day delay
No testing/quarantine

A1.4 Assumptions

A1.4.1 Assumptions on travel volumes and air passenger prevalence

Model input	Description	Value	Source
Median infectious days an air passenger spends in their destination	Without quarantine and testing schemes, when a passenger is infected in another country, they will spend some of their infectious days in their country of departure and some in their country of arrival. Using a simulation model based on a paper from the London School of Hygiene & Tropical Medicine (LSHTM), we estimate the median number of infectious days a passenger will spend in their country of arrival to be 3.	3 days	Oxera and Edge Health (2021), 'Effectiveness of dual-testing schemes for air passengers'. For LSHTM's work see: Clifford et al. (2020), 'Strategies to reduce the risk of SARS-CoV-2 re-introduction from international travellers', 25 July.
Air passenger volumes	We use IATA data on passenger volumes from outside to inside the EEA for February–June to approximate future air traffic volumes. We model two scenarios: 50% of 2019/20 volumes and 80% of 2019/20 volumes. We assume that most passengers are completing round trips, so passenger volumes are divided by two to get inbound passengers.	We model two scenarios: 50% of 2019/20 volumes and 80% of 2019/20 volumes.	IATA
Air passenger COVID-19 prevalence	To recreate future fictional scenarios that are comparable to Omicron, we model future VOCs (Omicron -, Omicron +, Omicron ++, and the vaccine escape variant) assuming that the prevalence is the same as Omicron was towards the beginning of the wave. Omicron assumptions: we use UK government Test and Trace data available up to 13 December to approximate potential future air passenger prevalence, scaling for historical tourism numbers across several European countries. We conservatively use Germany, with the highest estimated incoming air passenger prevalence.	Prevalence: 1.1–1.2%	https://www.gov.uk/government/publications/weekly-statistics-for-nhs-test-and-trace-england-2-to-8-december-2021 https://www.bancaditalia.it/pubblicazioni/indagine-turismo-internazionale/2021-indagine-turismo-internazionale/statistiche_ITI_18062021.pdf https://www.finavia.fi/en/about-finavia/about-air-traffic/traffic-statistics/traffic-statistics-year
Percentage of positive cases attributed to other variants	Omicron -, Omicron +, Omicron ++ and the vaccine escape variant are assumed to be the same as Omicron in proportion of total positive cases in air passengers towards the beginning of the wave. Omicron assumptions: the percentage shares of Omicron cases are based on the European average from the 'SARS-CoV-2 variants dashboard' disclosed by the European Centre for Disease Prevention and Control (ECDC).	–	https://www.ecdc.europa.eu/en/covid-19/situation-updates/variants-dashboard

A1.4.2 Assumptions on travel testing efficacy

Model input	Description	Value	Source
Antigen 48hrs pre-departure or PCR 72hrs before departure	We use the efficacy of pre-departure testing at screening incoming air passenger infectious days as a model input. We use the estimated efficacy of antigen and PCR tests taken at the respective times pre-departure, taking the weighted average assuming that two-thirds of passengers will opt for the cheaper antigen test option. Assuming that no testing or quarantine schemes are used to screen incoming air passenger infectious days.	46%	Oxera and Edge Health (2021), 'Assessment of the effectiveness of rapid testing for SARS-CoV-2'.
No testing or quarantine	Assuming that no testing or quarantine schemes are used to screen incoming air passenger infectious days.	–	Oxera and Edge Health (2021), 'Effectiveness of dual-testing schemes for air passengers'.

A1.4.3 Assumptions on EEA booster vaccine roll-out

Model input	Description	Value	Source
Historical vaccination rates	We use weekly vaccination data for the EEA as published by the ECDC, and estimate daily vaccination uptake by aggregating reported numbers of administered first, second and third doses by countries, target groups and vaccine manufacturers.	–	https://www.ecdc.europa.eu/en/publications-data/data-covid-19-vaccination-eu-eea
Projected vaccination rates	We calculate the average daily vaccinations delivered in the last week of available data to estimate the speed of the vaccination roll-out in projected scenarios. We assume that the number of individuals receiving a second dose cannot exceed the number of individuals who had received a first dose three months prior. This is based on medical recommendations to get second doses within three months of the previous dose. Equally, we assume that the number of individuals receiving a third dose (booster) cannot exceed the number of individuals who have received a second dose. As the speed of vaccination roll-out is dose-specific, to prevent a violation of the assumption above in the later stages of the projection, the speed of roll-out for a dose is set to the speed of the dose of the lower tier where required.	–	https://www.ecdc.europa.eu/en/publications-data/data-covid-19-vaccination-eu-eea

A1.4.4 SARS-Cov-2 and variant-specific parameters (I)

Model input	Description	Value	Source
Ro	We assume that Omicron + and Omicron ++ are 1.25 and 2.5 times, respectively, more infectious than Omicron, once 20% of the population has been infected with Omicron and therefore has some form of natural immunity. The Vaccine escape variant is equally as infectious as Omicron. The Omicron - variant is 1.25 times as infectious as Omicron once 25% of the population has been infected. These factors combine in our model to result in a calculated Rt. Initial Omicron assumptions: initial data suggests that the Rt and secondary attack rates of the Omicron variant are 2 to 3 times higher than those of the Delta variant. While some of this difference is likely to be due to differing immunity for the variants in the population, we conservatively assume that Omicron is 2.5 times more infectious than Delta.	Omicron +: 9.14 Omicron ++: 18.28 Vaccine escape variant: 8 Omicron -: 8.68 Omicron: 8, assuming that Delta has an Ro of ~3.2 (this assumes pre-pandemic mixing patterns)	https://www.medrxiv.org/content/10.1101/2021.12.19.21268038v1.full.pdf https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1043466/20211222_OS_Daily_Omicron_Overview.pdf https://github.com/blab/rt-from-frequency-dynamics/tree/master/estimates/omicron-countries Ro of Delta: https://academic.oup.com/jtm/article/28/7/taab124/6346388
Days infectious	As reports of the duration of the infectious period for the Omicron variant are not available at the time of writing, we use the median time an individual is infectious calculated from previous variants.	7.35 days	Oxera and Edge Health (2021) 'Effectiveness of dual-testing schemes for air passengers'. For LSHTM's work see: Clifford et al. (2020), 'Strategies to reduce the risk of SARS-CoV-2 re-introduction from international travellers', 25 July.
Incubation period	Preliminary evidence suggests that the time from exposure to symptoms is shorter for the Omicron variant compared to other variants.	3 days	https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2021.26.50.2101147
Impact of natural immunity (for people previously infected with the Omicron variant)	Studies conducted in England suggest that a previous history of infection reduces the risk of re-infection by 84%. Infections with previous variants were protective against infection with the Alpha variant. Immunity was observed for a minimum of seven months after initial infection. We assume that the immunity for the Omicron variant is similar, and apply scaling based on estimates of the relative efficacy of vaccines to the Omicron and Delta variants.	84% decrease in risk of infection, immune escape of 16%	https://www.sciencedirect.com/science/article/pii/S0140673621006759?casa_token=d-Aupl8roEYAAAAA:E_YnW1p75HlEH7DgPN_N_7aCANo7QcSrk93TlvcAS2khOBLt6rCwhCpwh8eYPh-bMGIscQ6k
Natural immunity for new variants compared to Omicron	Natural immunity for the Omicron -, Omicron +, Omicron ++ and the Vaccine escape variants is assumed to be the same as for Omicron. We estimate this using the relative efficacy (for vaccinated individuals with two or three doses) against the Omicron variant compared to the Delta variant, using a weighted average of the Pfizer +Pfizer and AZ + Pfizer combination.	50%	https://www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2021-12-16-COVID19-Report-48.pdf

A1.4.4 SARS-Cov-2 and variant-specific parameters (II)

Model input	Description	Value	Source
Unvaccinated population who have previously been infected	We use data on EEA cases beginning in the month of November (mainly Omicron) to project how many of the unvaccinated population will have natural immunity to Omicron by May/July.	20% (short/medium term) or 25% (longer term)	https://www.ecdc.europa.eu/en/publications-data/data-daily-new-cases-covid-19-eueea-country
Delay between vaccination and vaccine efficacy	While immunity builds up over time after individuals are vaccinated, there is still substantial protection from vaccinations (~60%) on the first day after vaccination. Using a step function, we are able to approximate this effect.	Step function, 1 week	http://www.bccdc.ca/Health-Info-Site/Documents/COVID-19_vaccine/Public_health_statement_deferred_second_dose.pdf
Estimated relative efficacy of vaccinations against new variants, based on data from Omicron	Vaccine efficacy for Omicron -, Omicron +, Omicron ++ are assumed to be the same as for Omicron. The vaccine efficacy against the Vaccine escape variant is assumed to be half of Omicron. Modelling from Imperial has estimated the relative efficacy of vaccinations against the Omicron variant, extrapolating laboratory studies to real-world efficacy. We supplement this with data on real-world efficacy, which is now starting to become available. These estimates are conservative compared to the range of scenarios estimated by other modelling groups (LSHTM). We also assume, given recent data on Omicron hospitalisation rates, that vaccines remain similarly protective against hospitalisation or death to Delta.	See Table 1, p. 14	https://www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2021-12-16-COVID19-Report-48.pdf and https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1043807/technical-briefing-33.pdf for real-world supplementary data. https://cmmid.github.io/topics/covid19/reports/omicron_england/report_11_dec_2021.pdf

A1.4.5 Impact of local social distancing measures on infection spread in the EEA, assuming that some mask/testing requirements continue

Model input	Description	Value	Source
Impact of mandatory masks, symptomatic testing	The reduction in Rt resulting from non-pharmaceutical interventions.	-17.9%	https://www.medrxiv.org/content/10.1101/2020.05.28.20116129v4.full.pdf http://epidemicforecasting.org/containment-calculator https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-020-01872-8/figures/5

Contact:
Michele Granatstein
Partner, Oxera
michele.granatstein@oxera.com
+44 (0) 20 7776 6606

Jennifer Connolly
Data Scientist, Edge Health
jennifer@edgehealth.co.uk
+ 44 (0) 20 8133 4504

George Batchelor
Co-Founder and Director,
Edge Health
george@edgehealth.co.uk
+ 44 (0) 20 8133 4504

www.oxera.com