A framework for considering the impact of air travel restrictions on the UK

—

Prepared for Manchester Airports Group and Airlines UK
Oxera and Edge Health

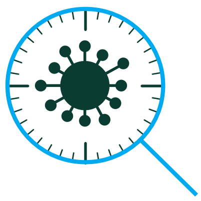
January 2022

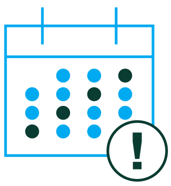
Executive summary

Despite the travel restrictions in place over the last 20 months, the UK was one of the first countries to experience waves of COVID-19 associated with new Variants of Concern (i.e. Alpha, Delta and Omicron). SAGE has previously noted that any new Variants of Concern that have a selective advantage will enter the UK at an early stage of their spread, unless travel to the UK is completely closed off. Therefore, there is a question about the role of air travel restrictions in limiting the importation of new Variants of Concern and minimising the disruption caused to individuals, the NHS, and the UK economy.

There is unlikely to be a demonstrable benefit associated with introducing travel restrictions in response to new variants

Experience since the beginning of the pandemic indicates that it is difficult to identify a variant as a concern sufficiently quickly to be able to introduce travel restrictions that have an impact on the peak of cases.





The peak will be delayed but not reduced

If travel restrictions are put in place on the same day that a variant is imported, they would not have an impact on limiting the peak of cases if booster doses have already been rolled out, and would only delay the peak by two to eight days.

The peak can be delayed by two to eight days, however the effectiveness of travel restrictions is further reduced when a variant is more infectious

If the introduction of travel restrictions is delayed by even five days—i.e. they are put in place on Day 6 rather than Day 0—there is at most a one-day benefit to introducing such restrictions in terms of the trajectory of COVID infections.[1]

In addition, the more infectious the variant, the less benefit there is to introducing travel restrictions.

There is a significant cost of travel restrictions to passengers and the UK economy of between

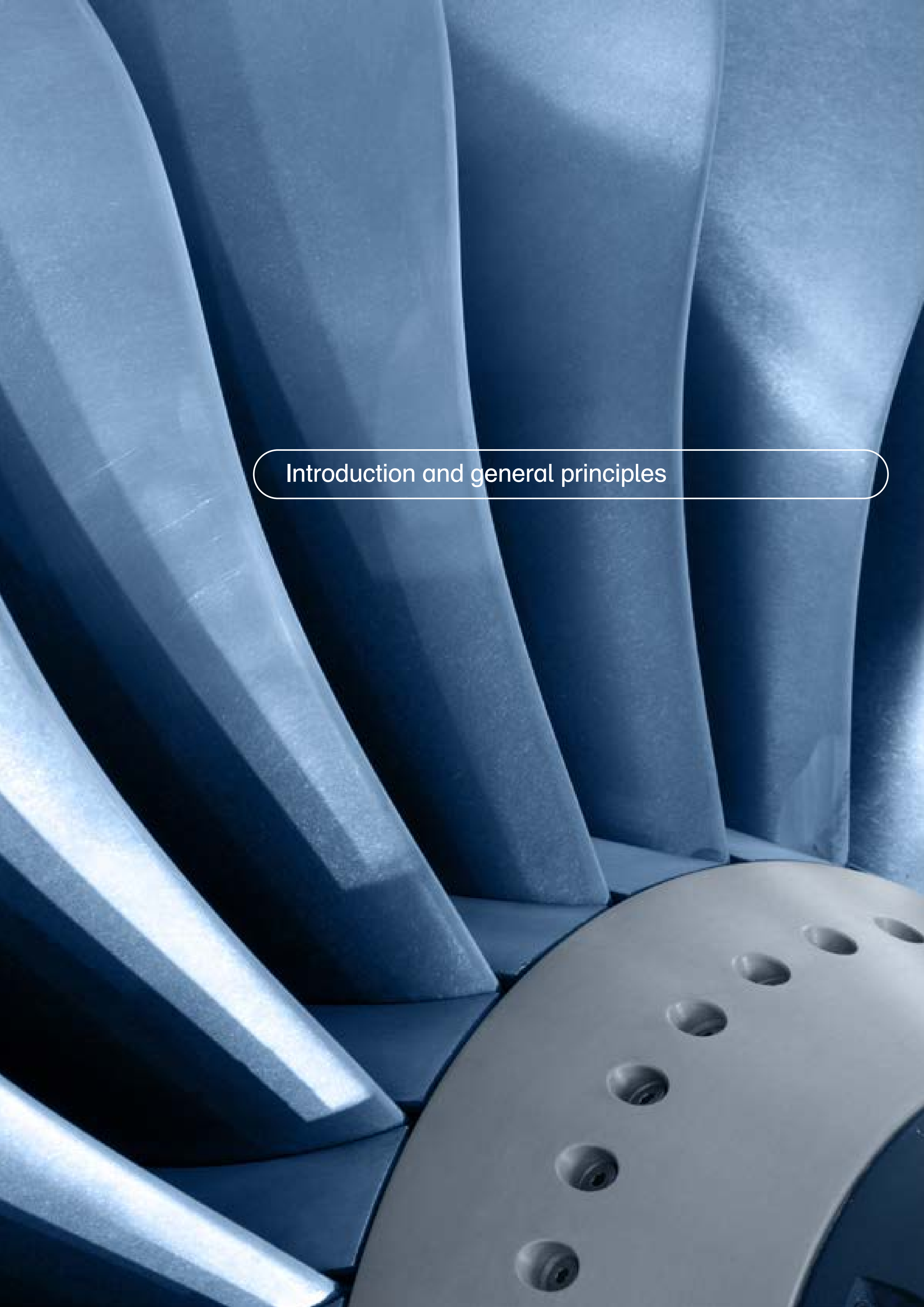
£8bn and £11bn

for each additional year that travel restrictions are in place.[2]

[1] Assuming passenger volumes are 80% of 2019 levels, using a Day 2 antigen test (relative to a five-day delay on Day 0).
[2] Oxera (2021), 'Assessing the impact of recent international travel restrictions on the UK aviation sector and the wider economy', prepared for MAG, 15 December.

Overview

Introduction and general principles



The UK has had extensive international travel restrictions in place since the start of the pandemic. These restrictions have changed over time—from mandatory quarantine, to single antigen tests, to regimes requiring up to three tests for passengers arriving in the UK in order to prevent the spread of Variants of Concern (VOC). Despite the restrictions in place in late 2021, the UK had one of the earliest waves of Omicron.

In the UK, successive waves of COVID infections are being met with fewer domestic restrictions as a result of successful vaccination campaigns, natural immunity, and improved treatments such as antivirals. However, there is a reluctance to remove travel restrictions due to a concern about future VOC that may emerge.

To date, the travel restrictions that have been in place have created significant costs for passengers, the aviation sector, and the UK economy. Frequent changes in restrictions have also created uncertainty, contributing to a reduction in demand for air travel. The cost of the recent restrictions has been estimated at between £8bn and £11bn per year.[1]

It is in this context that Manchester Airports Group and Airlines UK have asked Oxera and Edge Health to consider the impact that travel restrictions could have on the importation of VOC and future waves of COVID-19.

This analysis builds on previous analysis undertaken by Oxera and Edge Health over the last year.[2] In particular, we have analysed a number of different scenarios to help consider:

- how travel restrictions affect the speed and peak of a new variant's spread in the UK;
- the trigger points for bringing in, as well as removing, testing requirements to deal with new VOC—i.e. what is the critical point at which introducing travel restrictions could have an impact and at what point is there a critical mass of a VOC domestically such that travel restrictions are no longer relevant?
- the benefits of travel restrictions from a public health perspective compared with the costs they impose on the UK economy.

[1] Oxera (2021), 'Assessing the impact of recent international travel restrictions on the UK aviation sector and the wider economy', prepared for MAG, 15 December.
[2] For example, Edge Health and Oxera (2022), 'Impact of travel restrictions on Omicron in the UK', prepared for MAG, 5 January.

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 VOC, such as the impact of widespread infection on the NHS, the impact on managing Test and Trace, as well as the disruption caused to the UK economy.

In line with this objective, it is relevant to consider the following key principles.

- Travel restrictions should be introduced rapidly in response to the identification of a new VOC such that the restrictions actually have an impact on the peak and/or timing of cases.
- If the VOC is identified only after imposing travel restrictions would make a difference, restrictions 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.

Analysis: scenarios and results

A number of scenarios have been modelled to consider the impact of future air travel restrictions

The modelling reflects the most likely outcomes over the next several months (i.e. short/medium-term scenarios) and represents 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 relatively competitive. 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 more competitive; or natural immunity could wane such that Omicron becomes competitive again). Therefore, it is important to consider the longer-term picture again as more data becomes available.

Each scenario has been modelled for:

- where booster doses have already been rolled out, and a sensitivity where booster programmes are being rolled out due to reductions in natural immunity;
- where traffic is back to 80% of 2019 levels, and a sensitivity with traffic at approximately 50% of 2019 levels.

Scenarios considered

Scenario	Rt of scenario*	Description of scenario	Travel restrictions modelled
		Short/medium term	(i) no passenger testing or quarantine (ii) Day 2 antigen (iii) Day 2 PCR (iv) Day 2 PCR and pre-departure antigen
Scenario 1	4.90	**Omicron +:** variant slightly (1.25 times) more infectious than Omicron once 30% of the population has some natural immunity to Omicron	
Scenario 2	5.79	**Vaccine escape variant:** same infectiousness as Omicron but twice the immune escape, and therefore an Rt 1.5 times more infectious than Omicron once 30% of the population has some natural immunity to Omicron	
Scenario 3	9.80	**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	4.15	Omicron -: variant slightly (1.25 times) more infectious than Omicron once 43% of the population has some natural immunity to Omicron	

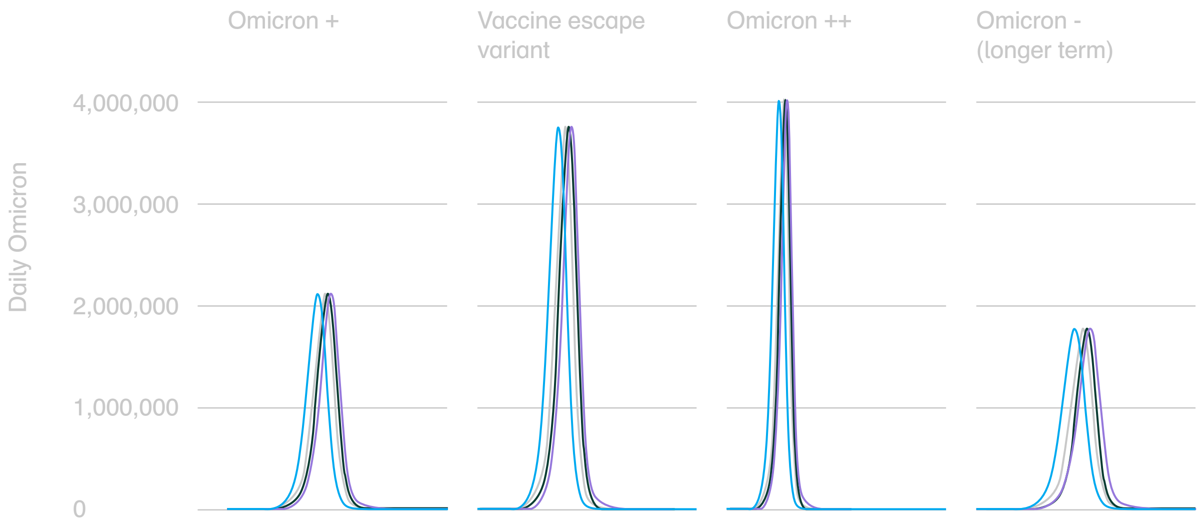
Note: * Rt when the variant is first seeded.
Source: Oxera and Edge Health.

Where booster doses have already been rolled out.

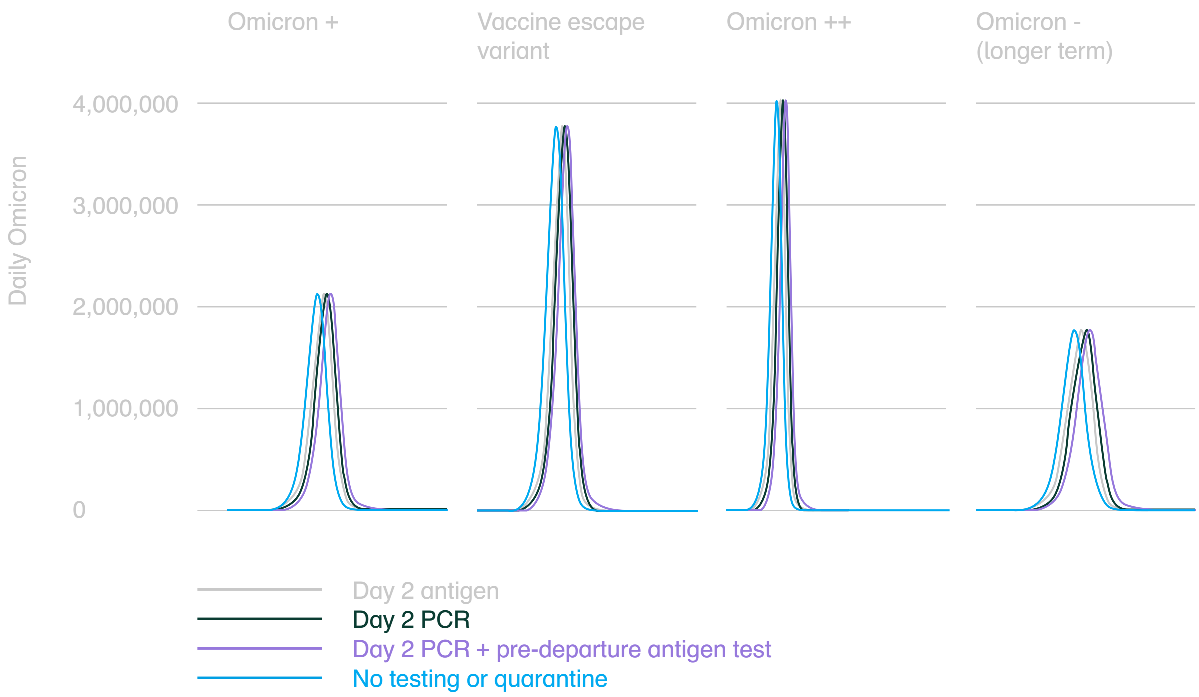
Do air travel restrictions affect the size of the peak?

Once the booster vaccine is rolled out, introducing travel restrictions does not affect the size of the peak, relative to not having any restrictions. This is the case even when travel volumes are high.

High volume



Low volume



Where booster doses have already been rolled out.

Do air travel restrictions affect the timing of the peak?

There is a small impact of travel restrictions 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 boosters have already been rolled out and travel volumes are high (i.e. 80% of 2019 levels). Variants are ordered from least to most infectious.

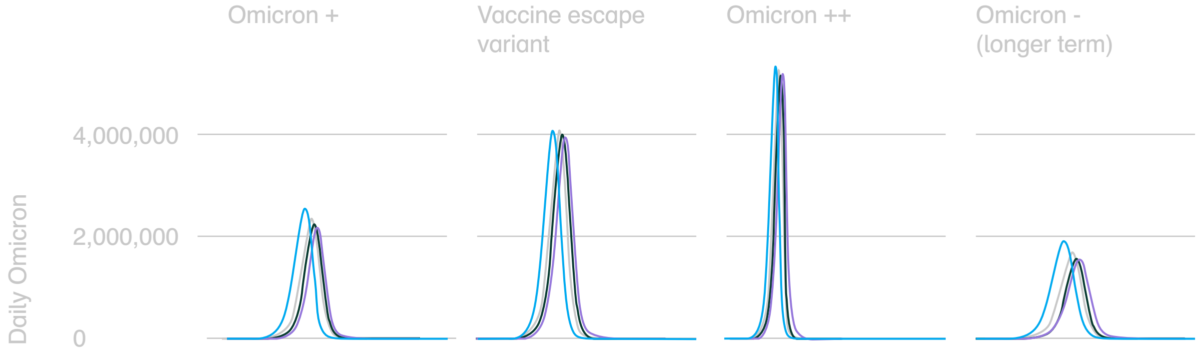
Travel restriction	Scenario	Delay in peak relative to no testing and quarantine (days)
Day 2 antigen	Omicron -	6
	Omicron +	5
	Vaccine escape variant	4
	Omicron ++	3
Day 2 PCR	Omicron -	8
	Omicron +	7
	Vaccine escape variant	6
	Omicron ++	4
Day 2 PCR and pre-departure test	Omicron -	10
	Omicron +	8
	Vaccine escape variant	7
	Omicron ++	5

The sensitivity where the booster doses are being rolled out.

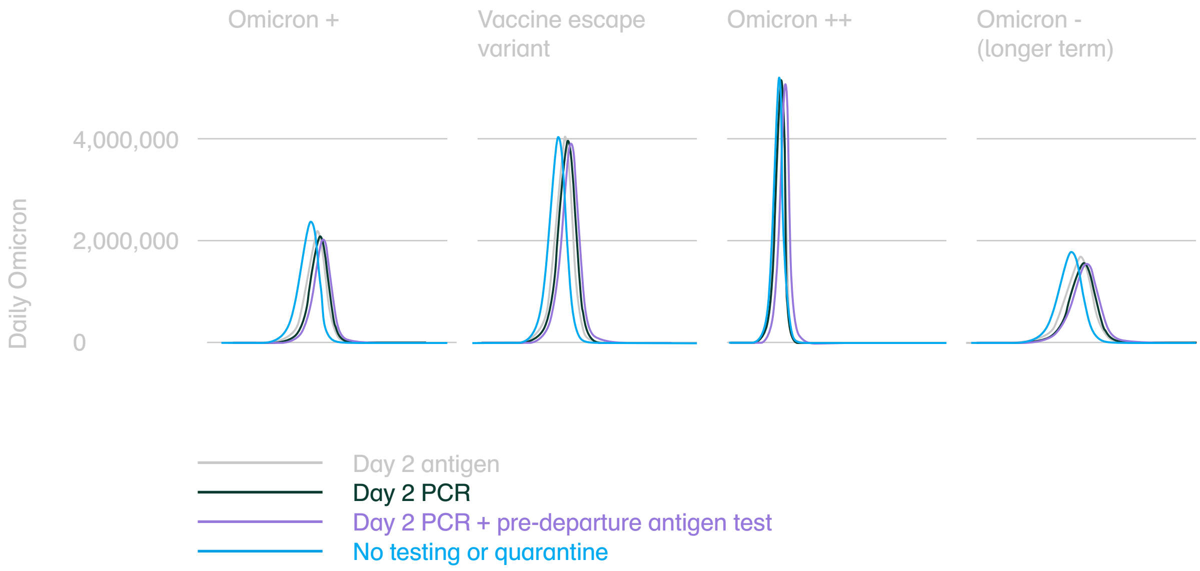
How do traffic levels impact the effectiveness of air travel restrictions?

If there is an ongoing vaccine roll-out (e.g. due to waning immunity), travel restrictions can help reduce the peak of cases and can delay the peak, particularly when travel volumes are high.

High volume



Low volume



The sensitivity where the booster doses are being rolled out.

How do air travel restrictions affect the peak?

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 (days)	Reduction in peak relative to no testing and quarantine
Day 2 antigen	Omicron -	6	10%
	Omicron +	5	7%
	Vaccine escape variant	4	2%
	Omicron ++	3	2%
Day 2 PCR	Omicron -	8	14%
	Omicron +	7	11%
	Vaccine escape variant	6	3%
	Omicron ++	4	3%
Day 2 PCR and pre-departure test	Omicron -	10	16%
	Omicron +	8	13%
	Vaccine escape variant	7	4%
	Omicron ++	5	4%

Impact of delaying travel restrictions on the timing of the peak

As variants become more infectious, it becomes more difficult to impose travel restrictions that can have an impact on 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 on Day 5 rather than Day 0, the peak would be delayed by one day rather than five days.

This shows the scenario where boosters have already been rolled out, travel volumes are high (i.e. 80% of 2019 levels), and there is Day 2 antigen testing in place. Variants are ordered from least to most infectious. Similar trends are observed for other types of travel testing.

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

Conclusion

Conclusion

The travel restrictions imposed over the last 20 months show that it has not been possible to stop entirely a VOC from being seeded in the UK. Therefore, the objective of any travel restriction imposed should be to limit the disruption caused by a new VOC.

Air travel restrictions do not affect the size of the peak but could delay it

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 between two and eight days if boosters have already been rolled out, regardless of the level of passenger traffic. This is the case only if restrictions are imposed on the same day that a VOC is imported.

Any benefits of air travel restrictions reduce 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 Day 6, there is at most one day's benefit to introducing such restrictions in terms of the trajectory of COVID infections. Even if travel restrictions are imposed on Day 0, by Day 11 there will no longer be any benefit to the restrictions and they should therefore be removed.

Ongoing restrictions will have a significant impact on the UK economy

Experience since the start of the pandemic indicates that it takes time to become aware of a variant, then 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. However, even in these cases restrictions will have minimal benefits, and the significant direct and indirect costs to the UK economy would need to be taken into account.

Air travel restrictions have limited benefits when immunity wanes

If natural immunity wanes over time, and booster doses are being rolled out, travel restrictions have some limited benefit in terms of reducing the peak of cases, particularly when travel volumes are high. However, unless ongoing travel restrictions are in place or travel restrictions are imposed, by Day 11 there will be no benefits. Also, given the cost of restrictions, any restrictions imposed should be targeted as much as possible.

Monitoring the situation for the long term is important

In the longer term, if a less infectious variant is able to become relatively competitive with Omicron, travel restrictions may have limited benefits. For example, if through domestic surveillance it becomes clear that Omicron is under control due to significant natural immunity in the population, we might be at risk from less infectious variants, and travel restrictions could have more of a benefit if a VOC is identified. However, it is difficult to determine potential scenarios beyond the short/medium term, and it would therefore be important to re-consider the restrictions for the period beyond the next several months at a later stage.

Appendix

Traffic sensitivity: traffic at 50% of 2019 levels (I)

The table below shows the impact of variant infectiousness on the delay of the peak when boosters have already been rolled out and travel volumes are low. Variants are ordered from least to most infectious.

Travel restriction	Scenario	Delay in peak relative to no testing and quarantine
Day 2 antigen	Omicron -	6
	Omicron +	5
	Vaccine escape variant	4
	Omicron ++	3
Day 2 PCR	Omicron -	8
	Omicron +	7
	Vaccine escape variant	6
	Omicron ++	4
Day 2 PCR and pre-departure test	Omicron -	10
	Omicron +	8
	Vaccine escape variant	7
	Omicron ++	5

Traffic sensitivity: traffic at 50% of 2019 levels (II)

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 low. 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
Day 2 antigen	Omicron -	6	8%
	Omicron +	4	8%
	Vaccine escape variant	4	2%
	Omicron ++	2	1%
Day 2 PCR	Omicron -	8	11%
	Omicron +	6	11%
	Vaccine escape variant	6	4%
	Omicron ++	3	2%
Day 2 PCR and pre-departure test	Omicron -	10	12%
	Omicron +	7	14%
	Vaccine escape variant	7	4%
	Omicron ++	4	3%

Impact of delay in implementing travel restrictions on peak cases, when boosters are being rolled out

The figure below shows the impact of introducing travel restrictions (a Day 2 antigen test) according to the delay from the first seeded case.

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 LSHTM, we estimated that the median number of infectious days that a passenger will spend in their country of arrival is 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 publicly available data on passenger volumes from the CAA for November–March to approximate future air traffic volumes. We model two scenarios: 48% 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.	48% of 2019/20 volumes 80% of 2019/20 volumes	https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2021-10/
Air passenger COVID-19 prevalence	To recreate future fictional scenarios that are comparable to Omicron, we model future VOC (Omicron -, Omicron +, Omicron ++, 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. We conservatively use prevalence in mid-October, before the government moved to Day 2 antigen testing.	Prevalence: 0.95%	https://www.gov.uk/government/publications/weekly-statistics-for-nhs-test-and-trace-england-2-to-8-december-2021
Percent 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: No Omicron variants were detected via travel testing and sequencing between the 4th-24th of November, based on a sample of 2208 positive test results. We therefore conservatively assume that the proportion of omicron cases of total positive cases is on the upper end of the Wilson score 99% confidence interval. (We also conservatively assume that Test-and-Trace only begun sequencing for Omicron when it was designated a variant under investigation on the 21st of November 2021).	November: 2.5% December: 34%	https://www.gov.uk/government/publications/weekly-statistics-for-nhs-test-and-trace-england-2-to-8-december-2021

Assumptions: travel testing efficacy

Model input	Description	Value	Source
Day 2 antigen testing policy	This policy required passengers to get tested on or before Day 2. Given the ease of use of antigen tests, we assume that most passengers will take their test on arrival, using the efficacy of on-arrival antigen testing at screening incoming air passenger infectious days as a model input. (UK travel policy from 24 October–26 November.)	63% (40–85%)	Oxera and Edge Health (2021), 'Assessment of the effectiveness of rapid testing for SARS-CoV-2'.
Day 2 PCR testing policy	This policy required passengers to get tested on or before Day 2. We assume that most passengers will take their test on Day 1, using the efficacy of Day 2 PCR testing at screening incoming air passenger infectious days as a model input. (UK travel policy from 27 November–6 December.)	76% (59–89%)	Oxera and Edge Health (2021), 'Assessment of the effectiveness of rapid testing for SARS-CoV-2'.
Day 2 PCR testing + pre-departure antigen test policy	This policy requires passengers to get tested on or before Day 2. We assume that most passengers will take their test on Day 1, using the efficacy of Day 1 PCR testing combined with a pre-departure antigen test at screening incoming air passenger infectious days as a model input. (UK travel policy 7 December–present.)	83% (65–95%)	Oxera and Edge Health (2021), 'Effectiveness of dual-testing schemes for air passengers'.
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'.

Assumptions: UK booster vaccine roll-out

Model input	Description	Value	Source
Percent of total population vaccinated, booster doses rolled out	For future modelled scenarios where booster vaccinations have already been rolled out before a VOC enters a population, we assume that the dosage levels are the same as the last day of the projection (22/03/2022) and remain constant throughout the whole new modelled time period.	70%	See previous work: Oxera and Edge Health (2021), 'Impact of travel and domestic restrictions on omicron in the UK'.
Percent of total population vaccinated, booster doses still being rolled out scenario	We use estimates of the speed of a future vaccination roll-out based on previous experience rolling out the booster vaccine for Omicron to date and projections for the speed of rolling out the booster campaign over the course of Jan/Feb/March 2022.	Varies linearly, see source	See previous work: Oxera and Edge Health (2021), 'Impact of travel and domestic restrictions on omicron in the UK'.

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 30% 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 43% of the population has been infected. These factors combine in our model to get a resulting calculated Rt (see slide outlining modelled scenarios). Initial Omicron assumptions: Initial data suggests that the Rt and secondary attack rates of the Omicron variant are 2–3 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 +: 10 Omicron ++: 20 Vaccine escape variant: 8 Omicron -: 8.47 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 with other variants.	3 days	https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2021.26.50.2101147
Risk of hospitalisation for Omicron compared with Delta	Omicron -, Omicron +, Omicron ++ and the Vaccine escape variant are assumed to have the same risk of hospitalisation as Omicron. Several studies are now indicating that Omicron variant infections are milder than Delta infections. Real-world data from England suggests that patients had a decrease in hospital admission risk of 62%. We focus on modelling cases, rather than hospitalisations, in this work. In the future, more tailored vaccines or antiviral medications may be approved.	-62%	https://www.medrxiv.org/content/10.1101/2021.12.21.21268116v1, https://www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2021-12-22-COVID19-Report-50.pdf, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1043807/technical-briefing-33.pdf

SARS-Cov-2 and variant-specific parameters (II)

Model input	Description	Value	Source
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 7 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 with Omicron	We estimate this using the relative efficacy (for vaccinated individuals with 2 or 3 doses) against the Omicron variant compared with 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
Unvaccinated population who have previously been infected	We use data on UK cases beginning in November months (mainly Omicron) to project how many of the unvaccinated population will have natural immunity to Omicron by March/May. Using modelling comparing reported cases with the actual burden of disease, we estimate that only roughly a third of cases are reported.	30% (short/medium term) or 42% (longer term)	https://coronavirus.data.gov.uk/; https://www.medrxiv.org/content/10.1101/2021.02.09.21251411v2.full (as in Imperial report 55).

SARS-Cov-2 and variant-specific parameters (III)

Model input	Description	Value	Source
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 ++ is 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 with 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

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