Version 2.0

Risk of Openness Index

When do government responses need to be increased or maintained?

Research note

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Since the outbreak of the COVID-19 pandemic, countries have used a wide array of closure and containment policies such as school and workplace closings, travel restrictions, and stay-at-home orders to try to break the chain of infection. They have also rapidly deployed test-trace-isolate procedures to seek to detect and isolate transmission as soon as possible. As the disease has spread around the world, these policies have waxed and waned in many jurisdictions. For example, some have rolled back 'lockdown' measures following a reduction in community transmission. Others are seeing a rise and fall of containment measures as small outbreaks occur. And others still are seeing large surges and responding with aggressive containment policies. As governments seek to calibrate policy to risk, how and when do they know it is safe to open up, and when must they instead close down?

The Oxford COVID-19 Government Response Tracker (OxCGRT) provides a cross-national overview of the risk and response of different countries as they tighten and relax physical distancing measures. The **Risk of Openness Index** is based on the recommendations set out by the World Health Organization (WHO) of the measures that should be put in place before COVID-19 response policies can be safely relaxed. The Risk of Openness Index calculates a measure of risk that a country faces from adopting an 'open' policy stance (that is: one that does not include policy measures to contain the virus through physical distancing measures). The first version of this work was focussed on the WHO framing of when countries could exit lockdown, but considering that many countries have already started to lift measures, the Risk of Openness Index is an entirely revised version of our previous 'Lockdown rollback checklist'.

While the OxCGRT data cannot say precisely the risk faced by each country, it does provide for a rough comparison across nations. Even this "high level" view reveals that many countries are still facing considerable risks as they ease the stringency of policies.

World Health Organization criteria

In April 2020, the WHO outlined six categories of measures governments need to have in place to diminish the risks of easing measures. In brief, these are as follows (quoted in part; for full descriptions see here):

1. COVID-19 transmission is controlled to a level of sporadic cases and clusters of cases, all from known contacts or importations; at a minimum, new cases would be reduced to a level that the health system can manage based on health care capacity.

2. Sufficient public health workforce and health system capacities are in place to enable the major shift from detecting and treating mainly serious cases to detecting and isolating all cases, irrespective of severity and whether there is local transmission or an importation.

3. Outbreak risks in high-vulnerability settings are minimised, which requires all major drivers or amplifiers of COVID-19 transmission to have been identified, with appropriate measures in place to maximise physical distancing and minimise the risk of new outbreaks.

4. Preventive measures are established in workplaces.

5. Manage the risk of exporting and importing cases from communities with high risks of transmission.

6. Communities are fully engaged and understand that the transition away from large-scale movement restrictions and public health and social measures – from detecting and treating serious cases to detecting and isolating all cases – is a 'new normal' in which prevention

measures would be maintained, and that all people have key roles in preventing a resurgence in case numbers.

What does the Oxford data measure?

OxCGRT currently provides information relevant to recommendations 2, 5, and 6. We combine this with:

- epidemiological data from the European Centre for Disease Control and the Johns Hopkins University on cases and deaths, which address recommendation 1
- data collected by Our World in Data on the number of tests conducted in each country, which further addresses WHO recommendation 2
- data from Apple and Google on travel and mobility, which further address WHO recommendation 6

OxCGRT also tracks emergency investments in the healthcare system since 1 January 2020, which can provide useful contextual information. See our codebook on GitHub or our working paper for a complete description of the data.

From this information, we construct a Risk of Openness Index, defined below, which roughly describes the risk of not having closure and containment measures in place, in light of four of the six WHO recommendations. 'Openness' can generally be thought of as the pre-COVID status quo, or in other words: the *absence* of policy measures aimed at reducing physical interaction. This index reports how risky such a policy stance would be. The data is made available in longitudinal format, which makes it possible to see how risk has changed over time, as the pandemic developed.

Because the data only measure four of six recommended actions, we should be cautious about inferring how countries should change their policies from this index. Certainly, a low risk score on this measure does not necessarily mean that countries are safe and can let down their guard. Indeed, the data provides a better indication of which countries are facing greater risk and, thus, are *not* ready to ease restrictions or need to ramp them up.

Moreover, we stress that the WHO recommendations are more specific and extensive than cross-national measures like those OxCGRT can readily provide. The index below should therefore be seen as a starting point for assessing the measures that need to be in place before a country can adopt an 'open' policy stance and remove any restrictions or business closures. **In particular, we note that the OxCGRT data measure countries' stated policies, not how well they implement them**.

We will continue to develop our assessment of the WHO checklist as new indicators become available. Detailed formulae are available at the end of this document in an appendix. For the latest methodology, please refer to the documentation on Github.

Table 1: Summary of sub-indices capturing Risk of Openness Index

WHO recommendation	Data sources	Risk index sub-component

Transmission controlled	*No OxCGRT indicators* Daily cases and deaths data from European Centre for Disease Prevention and Control and John Hopkins University CSSE COVID-19 Data Repository	A metric between 0 and 1 based on new cases confirmed each day. This is captured in two dimensions: 1. A measure to account for a localised outbreak 2. An 'endemic factor' that modulates the index according to the total number of new cases
Test / trace / isolate	OxCGRT: H2 (testing policy) OxCGRT: H3 (contact tracing policy) Testing data from Our World in Data	A metric between 0 and 1; half based on testing and contact tracing policy, and half based on the number of tests-per-case a country has conducted. (does not measure isolation)
High vulnerability settings	*Not currently measured*	*Not currently measured*
Preventative measures established in workplaces	*Not currently measured*	*Not currently measured*
Manage risk of exporting and importing cases	OxCGRT: C8 (international travel restrictions)	A metric between 0 and 1 based on the stringency of the country's restrictions on travel arrivals. (does not measure risk of exporting cases)
Communities understanding and behaviour change	OxCGRT: H1 (public information campaigns) Travel and mobility data from Apple and Google. Daily cases and deaths (from European CDC via Our World in Data)	A metric between 0 and 1 based on whether a country has a public information campaign and the level of mobility reduction, weighted for current transmission risk.

Methodology

The index draws itself from a combination of OxCGRT indicators and data on COVID-19 testing and cases from verified sources. **Error! Reference source not found.** contains a summary of all the sub-indices their sources of data. All sub-indices are scaled between 0 and 1, and the final Risk of Openness Index is a modulated mean of these sub-indices. The Technical Appendix contains further details on the calculation of each sub-index and the full index.

Important: The sub-indices are scaled to an inverse of the risk i.e. a high sub-Index score implies lower risk according to the criterion in question. This inversion is performed in the final step of the risk index calculation.

The first sub-index aims to capture the size of the current outbreak in a country, measured by the total number of daily new cases being recorded in a country (more accurately, we use a weekly rolling average of the daily new cases recorded). The intent of this sub-index is to sensitize the risk index to cases of sporadic outbreaks or localised transmission.

The second sub-index is intended to capture the testing and contact tracing policy of the country. Part of the data required (number of tests conducted) for this is sourced from Our World In Data, and the data regarding the testing and contact tracing policy itself is recorded in the OxCGRT Indicators H2 (testing policy)[1] and H3 (contact-tracing). The sub-index compares a country's daily recorded number of tests-per-case to the globally recorded highest and lowest tests-per-case, thus drawing a comparison metric of the country's position against global standards. This is combined with the H2 and H3 indicators from OxCGRT, appropriately scaled and then averaged to yield a metric that captures a country's ability to test, trace and isolate daily new cases being recorded in the first sub-index.

The third sub-index aims to capture a country's position in terms of importing new cases based on travel restrictions. OxCGRT Indicator C8 captures the international travel restrictions imposed by the country in four scales. The sub-Index is not uniformly scored across the four tiers of policy recorded in C8[2]. A higher gap is maintained between a quarantine policy and selective travel ban/border closure. The non-linearity reflects the considerably higher risk of having open borders and the difficulty of imposing quarantine policies effectively.

The fourth sub-index captures the behaviour changes in the community and the efforts of the government in inducing these behavioural responses. The former is measured by the highest recorded contraction in average mobility[3] as measured by Apple and Google mobility indices. The latter is proxied by the presence of an active government information campaign as measured by the H1 indicator in OxCGRT.

Importantly, the sub-indices alone are not sufficient in capturing the risk faced by a country at current levels of transmission and policy stances. Consider two countries with exactly similar policy stances such that their scores from each sub-index (and therefore an aggregation of them) is identical. Conditional on such similarity, a country with a significantly higher number of newly recorded cases would be at a greater risk at a given level of stringency than the other due to the vastly greater transmission risks involved. To account for this, the endemic factor modulates the initially calculated risk such that all else equal, a country with a relatively higher number of new cases gets a higher risk score than another country with lower number of new cases.[4]

All data, tables, and figures described below are available on the OxCGRT github repository[5], updated automatically in real time. Always check the github repository for the most up-to-date data and figures.

[1] For more details on H2 and other relevant OxCGRT Indicators, refer to Data Appendix
[2] Border closure (4), Travel Ban (3), Quarantine (2), Screening (1), No Policy (0). See Data Appendix for more details
[3] Baseline measure recorded as the median value for the corresponding day of the week, during the period from Jan 3 – Feb 6, 2020
[4] We proportion cases by population in the calculations, rather than using the direct levels of cases
[5] https://github.com/OxCGRT/covid-policy-scratchpad/tree/master/risk_of_openness_index

Visualising the Risk of Openness Index

The objective of the Risk of Openness index is to provide an overview of the current state of risk a country holds with regard to COVID-19 transmission. A secondary objective that we explore through the visualisations is also the evolution of the risk faced by countries and their response to this dynamic risk over time. Multiple dimensions exist to a country's response, our indicator of choice is the Stringency Index (Hale et. al. 2020)[6].

In our analysis, we choose the Stringency Index as the measure of government response and compare the trajectory and positioning of this response with respect to the risk faced in relaxing restrictive policy. The Stringency Index directly correlates with the measures required to slow disease transmission and stall outbreaks - both of which are key contributors to COVID-19 risk. Additionally, the Stringency Index represents policies that can be swiftly implemented. In comparison, fiscal measures, testing policy and contact tracing are slow moving responses and take a significant amount of bureaucratic manoeuvring before being operationalised. From an implementation perspective to the policy maker, a comparison of Stringency Index to the Risk of Openness represents a more actionable analysis, as opposed to other measures that focus on fiscal or health response.

The Stringency Index holds the classic limitations of most composite indices in that by aggregating multiple policy responses, we often lose important sources of variation between countries. Countries differ in the targeting of their policy, and therefore variations emerge between the manner in which stringent policies are implemented by different governments. By aggregating across the intensity and scope of these policies, these variations could possibly get crowded out. However, a key advantage of SI is that an odd measurement error on a certain indicator would also get reduced upon averaging, and this hopefully will reduce the attenuation bias in further analysis.

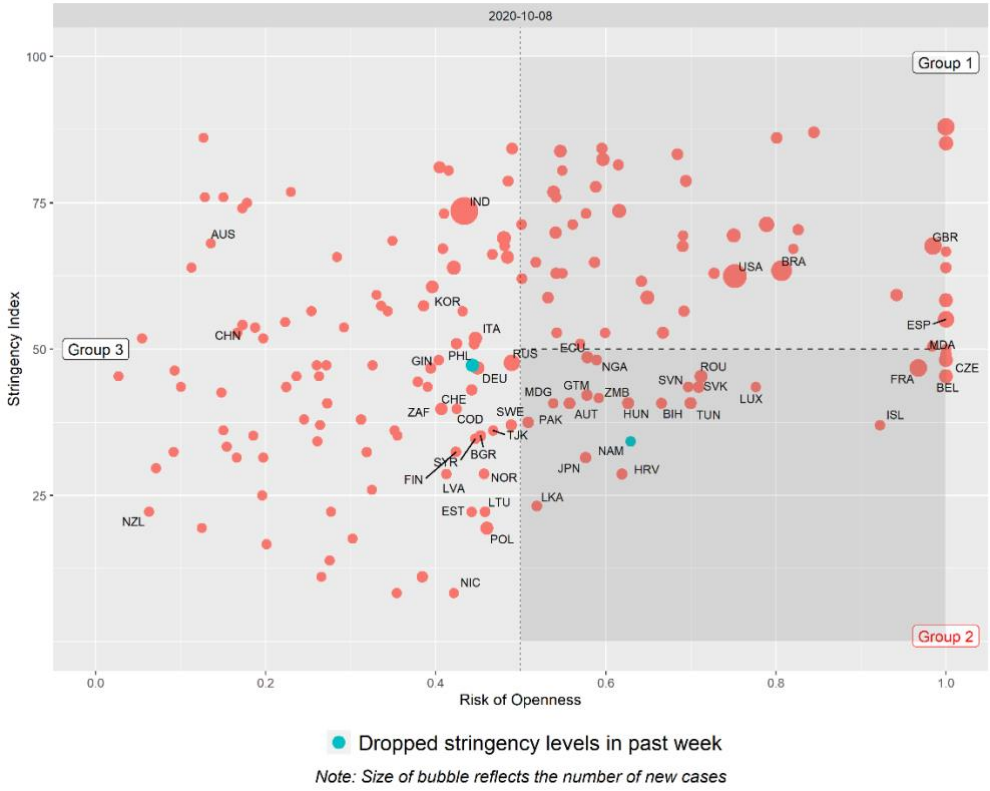
The visualisations are divided into two main outputs:
1. **Point-in-time output** - This is intended to provide a real-time overview of the countries' response to the current risk position it faces
2. **Historical output** - This provides a historical overview of the countries' response to risks faced over time

Point-in-time Output

Error! Reference source not found. depicts the Stringency Index vs. Risk of Openness Index axis, where countries occupy different positions in this space given their values of both indices as on 23rd October, 2020.

[6] The **Stringency Index (SI)** is a composite Index that captures the strength of government restrictions on social and businesses in response to COVID-19. More specifically, it measures restrictions on schools, businesses, travel and stay-at-home requirement, amongst others. For technical details, refer to the documentation.

Figure 1: Scatter plot of Stringency Index vs. Risk of Openness



Group 1 - A position on the **Upper Right-hand Quadrant** indicates that a country is under ***higher risk of openness***, **AND** is currently under a ***high*** stringency regime.

Group 2 - A position on the **Lower Right-hand Quadrant** indicates that a country is under ***higher risk of openness***, **AND** is under a ***low*** stringency regime.

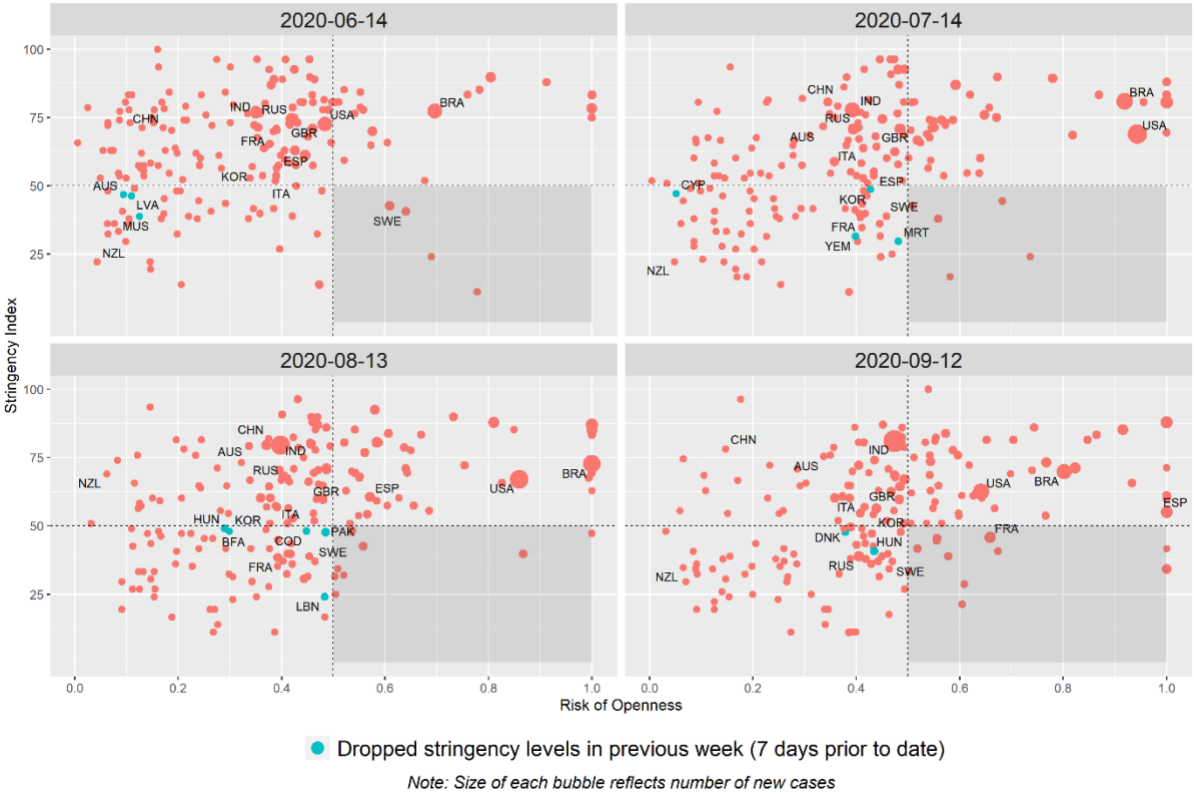
Group 3 - A position on either of the **Left-hand Quadrants** indicates that a country is under **lower risk** of further transmission if the country opens up. Countries maintaining a high stringency in this state are likely in a ***conservative*** policy stance (e.g. NZA, ITA).

In **Error! Reference source not found.** above, **Group-2** countries are the set that are under the highest risk of steering away from a successful COVID-19 response – combining a high risk of openness with a weak policy stance.

Historical output

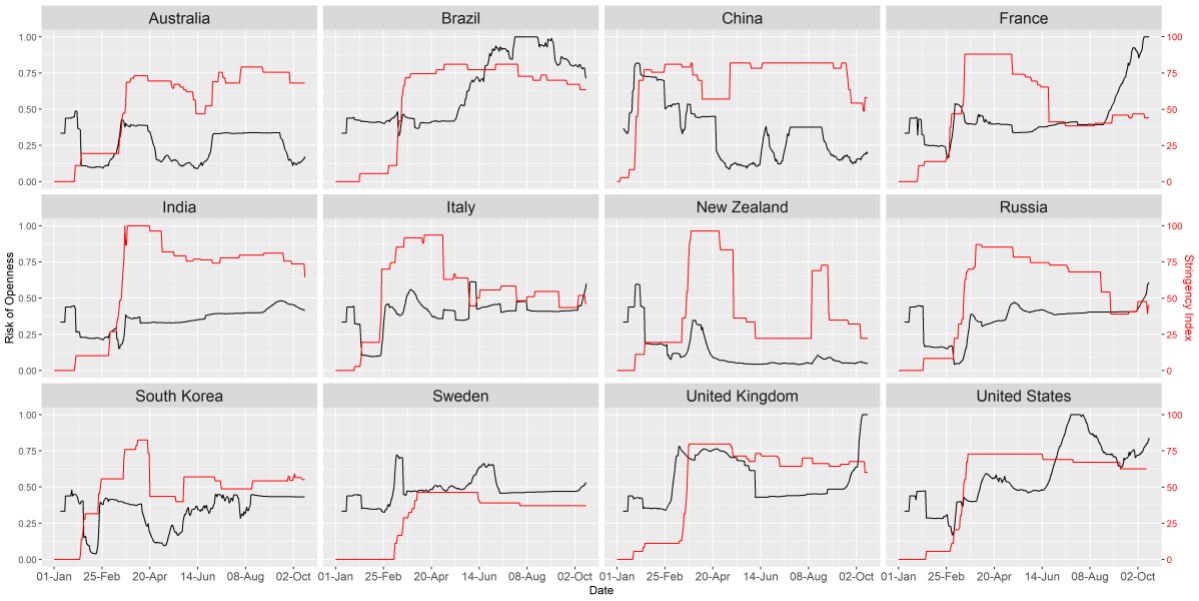
We also use the Risk of Openness index to observing how countries have responded to perceived COVID-19 risk over time. Mapping the movement of countries allows us to observe specific patterns in country responses such as a collective shift to higher stringency conditional on higher risk, or a lack of response from specific countries (as evidenced by a static position on the map, or moving towards **Right-Hand quadrants**).

Figure 2: Scatter plot of Stringency Index vs. Risk of Openness Index over the last quarter



Error! Reference source not found. reflects the positional transition of countries over the last four months. A key feature of this is how very few countries have managed to maintain a position in the Low-risk/Low stringency quadrant, which would have been indicative of a successful COVID-19 response. Instead, we see that early on many countries had a highly stringent response, despite having relatively low risks of openness (probably because the virus was only starting to reach some countries in April and March). Over time, the overall stringency levels lowered (countries become more open) even as the risk of openness increase (countries moved into the lower-right quadrant).

Figure 3: Line plots of Stringency Index and Risk of Openness Index vs. time



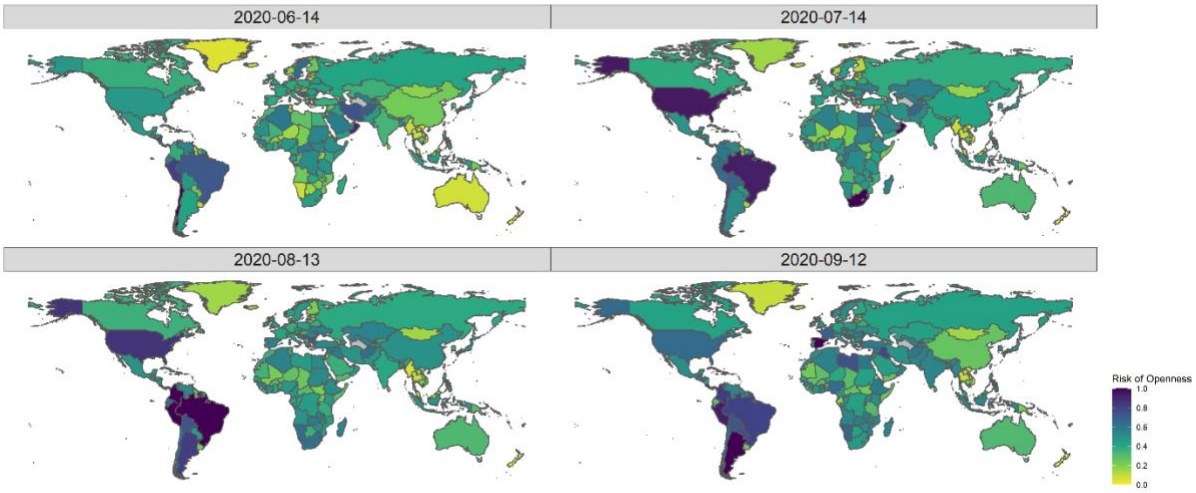
Error! Reference source not found. plots the time series of Stringency Index and Risk of Openness Index for a panel of 12 countries over time. An important note here is that a 'Risk of Openness' is undefined until a country has observed active COVID-19 cases. Therefore, the Risk Index is calculated for a country after the date of its first recorded case of COVID-19, hence the delayed start of the Risk of Openness lines in Figure 3.

During the first months of the year most countries had few measures in place, and so showed a high Risk of Openness despite the low levels of transmission. As the pandemic spread, in most cases the Risk Index fell as stringency first ramped up. In subsequent months we have seen more differentiated responses. Some countries have reduced or maintained levels of stringency even as the Risk Index has gone up, such as Brazil, the United States, France, and South Korea. Other countries have gradually reduced stringency even as Risk Index slowly increases, such as the UK, Russia, and Italy. Australia, in contrast, as ramped stringency up in line with rising risk. Still other countries see relatively little change, such as India or Sweden.

Finally, Figure 4 produces a map of the countries' Risk of Openness over the last quarter at monthly intervals[7]. Here we can see that countries' Risk of Openness changes over time, and can vary significantly between neighbouring countries with different policy regimes.

[7] Further heat-maps are included in our Github repository: https://github.com/OxCGRT/covid-policy-scratchpad/tree/master/risk_of_openness_index

Figure 4: Choropleth map of Risk of Openness Index over the past quarter



Technical Appendix : Formulas for calculating metrics

1. Transmission under control

$$casescontrolled = \frac{\Delta cases_t}{50}$$

Where Δ*cases* is the average new daily cases from the last 7 days.

Cases controlled is automatically set to 1 if $\Delta cases_t \geq 50$

2. Testing and tracing

$$testingandtracing = 0.25(1-\frac{H2}{3})+0.25(1-\frac{H3}{2})+0.5(\frac{ln(tests_{global\_max}) - ln(tests)}{ln(tests_{global\_max}) - ln(tests_{global\_min})})$$

Where:

- H2 is the latest value of the testing policy indicator (H2) in OxCGRT database
- H3 is the latest value of the contact tracing policy indicator (H3) in the OxCGRT database
- *ln(tests)* is the natural logarithm of the number of tests-per-case conducted by that country
- $ln(tests_{global\_max/min})$ is the natural logarithm of the number tests-per-case conducted by the country that has conducted the most/least tests-per-case

If the Our World in Data team has not included a country in their testing database, the portion of the metric based on testing data is set to the global average.
if the Our World in Data team tried to include a country in their testing database but could not find publicly available numbers, the portion of the metric based on testing data is set to 0.

3. Managing vulnerable settings

No data.

4. Putting preventative measures into workplaces

No data.

5. Manage the risk of imported cases

$$manageimportedcases = \begin{cases} 1 & if \quad C8 = 0 \\ 0.5 & if \quad C8 = 1 \\ 0.25 & if \quad C8 = 2 \\ 0 & if \quad C8 = \{3, 4\} \end{cases}$$

Where C8 is the latest value of the international restrictions policy indicator in the OxCGRT.

6. Communities are fully engaged and understand

$$community = (1-0.5(casescontrolled))(\frac{mob - 20}{100})+0.5(casescontrolled)$$

Where

- *cases controlled* is the metric between 0 and 1 calculated in the first item above.
- *mob* is the level of mobility as a percentage of pre-COVID baseline levels reported by Apple (average of all three reported mobility types) or Google (average of “retail and recreation”, “transit stations”, and “workplaces” mobility types).

If a country does not have a national public information campaign (that is, the OxCGRT database reports H1≠2), then the entire metric is set to 0.

If a country has both Apple and Google mobility data, then *mob* is set to whichever reports the greatest reduction in mobility.
If a country has neither Apple nor Google mobility, then this metric is left blank.

If *mob* is less than 20 (that is: a reduction to less than 20% of pre-COVID levels), it is set to 20.
If *mob* is greater than 120 (that is: mobility has increased to 120% of pre-COVID levels), it is set to 120.

Adjusting with an endemic factor

A country's risk of openness isn't completely reflected by the mean of these four sub-components. In particular, if a country has a very high level of transmission over the past week, we deem it to be 'high risk' to reopening, although this isn't effectively captured by the four indices above. Note that *cases controlled* by itself is a measure to alert for transmission outbreaks in a country; it reaches maximum risk at relatively low levels (50 new cases per day) and does not give an indication of countries where the virus is truly endemic. The **endemic factor** acts as a measure of this risk where there are not just a handful of new cases, but rather population-scale transmission. When this is the case, it effectively creates a ‘floor’ on the risk level no matter how good the other sub-components are. The endemic factor is calculated as:

$$EndemicFactor = \begin{cases} 0 & if \quad newcases\_per\_million < 50 \\ 1 & if \quad newcases\_per\_million > 200 \\ \frac{(newcases\_per\_million - 50)}{150} & if \quad 50 < newcases\_per\_million < 200 \end{cases}$$

Here, $newcases - per - million$ is the total number of new cases recorded per 1 million in population. Similar thresholds can be obtained by calibrating the number of new cases observed per hundred thousand of population. The threshold lower and upper limits would then be 5 and 20 respectively.

The Unadjusted Index is then calculated as:

$$RoOI_{unadjusted} = Mean(casescontrolled, testingandtracing, manageimportedcases, community)$$

The Unadjusted Index is then modulated by the Endemic Factor to yield the final Risk of Openness Index as:

$$RoOI_{final} = EndemicFactor + (1 - EndemicFactor)(RoOI_{unadjusted})$$

For the latest methodology, refer to the documentation on Github.

Data Appendix: OxCGRT Indicators

The OxCGRT Indicators in use for Risk of Openness Index calculation are H1, H2, H3 and C8. The range of the indicators is accounted for while averaging each of the sub-indices. For reference, the table below describes the values taken by the relevant indicators and and excerpt from the OxCGRT codebook[8].

C8	C8_International travel controls	Record restrictions on international travel	Ordinal scale	0 - no restrictions 1 - screening arrivals

[8] The indicators are often subject to updates, the latest version of which is always maintained in the linked codebook. The codebook can be accessed at this link

		Note: this records policy for foreign travellers, not citizens		2 - quarantine arrivals from some or all regions 3 - ban arrivals from some regions 4 - ban on all regions or total border closure Blank - no data
H1	H1_Public information campaigns	Record presence of public info campaigns	Ordinal scale	0 - no COVID-19 public information campaign 1 - public officials urging caution about COVID-19 2- coordinated public information campaign (e.g. across traditional and social media) Blank - no data
	H1_Flag		Binary flag for geographic scope (**note**: **not used in Risk Index calculation**)	0 - targeted 1- general Blank - no data
H2	H2_Testing policy	Record government policy on who has access to testing Note: this records policies about testing for current infection (PCR tests) not testing for immunity (antibody test)	Ordinal scale	0 - no testing policy 1 - only those who both (a) have symptoms AND (b) meet specific criteria (e.g. key workers, admitted to hospital, came into contact with a known case, returned from overseas) 2 - testing of anyone showing COVID-19 symptoms 3 - open public testing (e.g. "drive through" testing available to asymptomatic people) Blank - no data
H3	H3_Contact tracing	Record government policy on contact tracing after a positive diagnosis Note: we are looking for policies that would identify all people potentially exposed to COVID-19; voluntary bluetooth apps are unlikely to achieve this	Ordinal scale	0 - no contact tracing 1 - limited contact tracing; not done for all cases 2 - comprehensive contact tracing; done for all identified cases

References

Hale T, Petherick A, Phillips T, Webster S., Variation in government responses to COVID-19. Blavatnik School of Government Working Paper. 2020 May 27;31.