

The global dissemination of COVID-19 through two coexisting international transmission patterns

Supplementary Information

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1 Supplementary figures

The following is the list of figures referred to in the main text.

SI Figure 1: Number of infected cases in all countries. In the main text, only the 20 most populous countries are shown for improved visibility.

SI Figure 2: Log ratio of infected cases in all countries. In the main text, only the 20 most populous countries are shown for improved visibility.

SI Figure 3: The legends for SI Figures 1 and 2.

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SI Figure 5: Scree plots for each year. In the main text, the scree plot for the entire period is shown.

SI Figure 6: The first eigenvectors for the entire period, 2020, 2021, and 2022. The plots are coloured by region.

SI Figure 7: Barycentres for each stringency index quintile group in the first eigenvectors.

SI Figure 8: Barycentres for each containment and health index quintile group in the first eigenvectors.

SI Figure 9: Barycentres for each vaccination rate quintile group in the first eigenvectors.

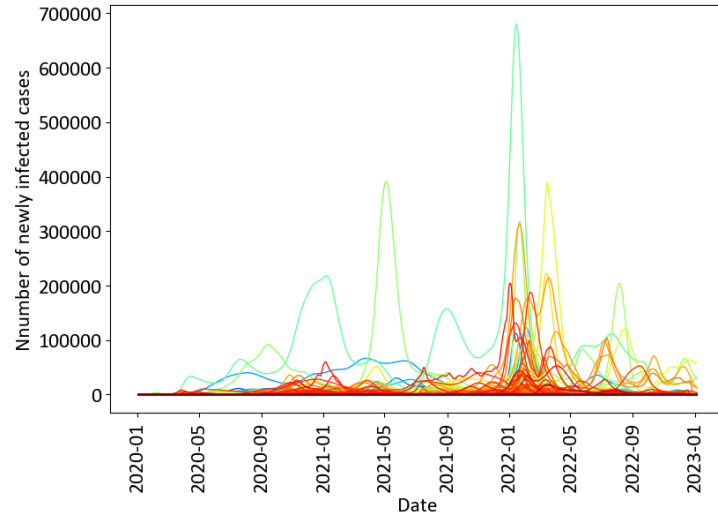
SI Figure 10: Barycentres of the second eigenvectors in the entire period.

SI Figure 12: Barycentres of the second eigenvectors in 2020.

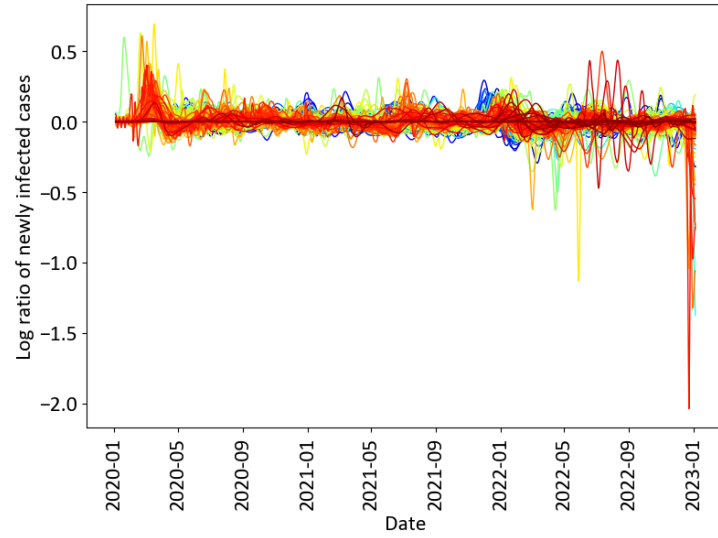
SI Figure 13: Barycentres of the second eigenvectors in 2021.

SI Figure 14: Barycentres of the second eigenvectors in 2022.

SI Figure 11: Barycentres of the third eigenvectors in the entire period.



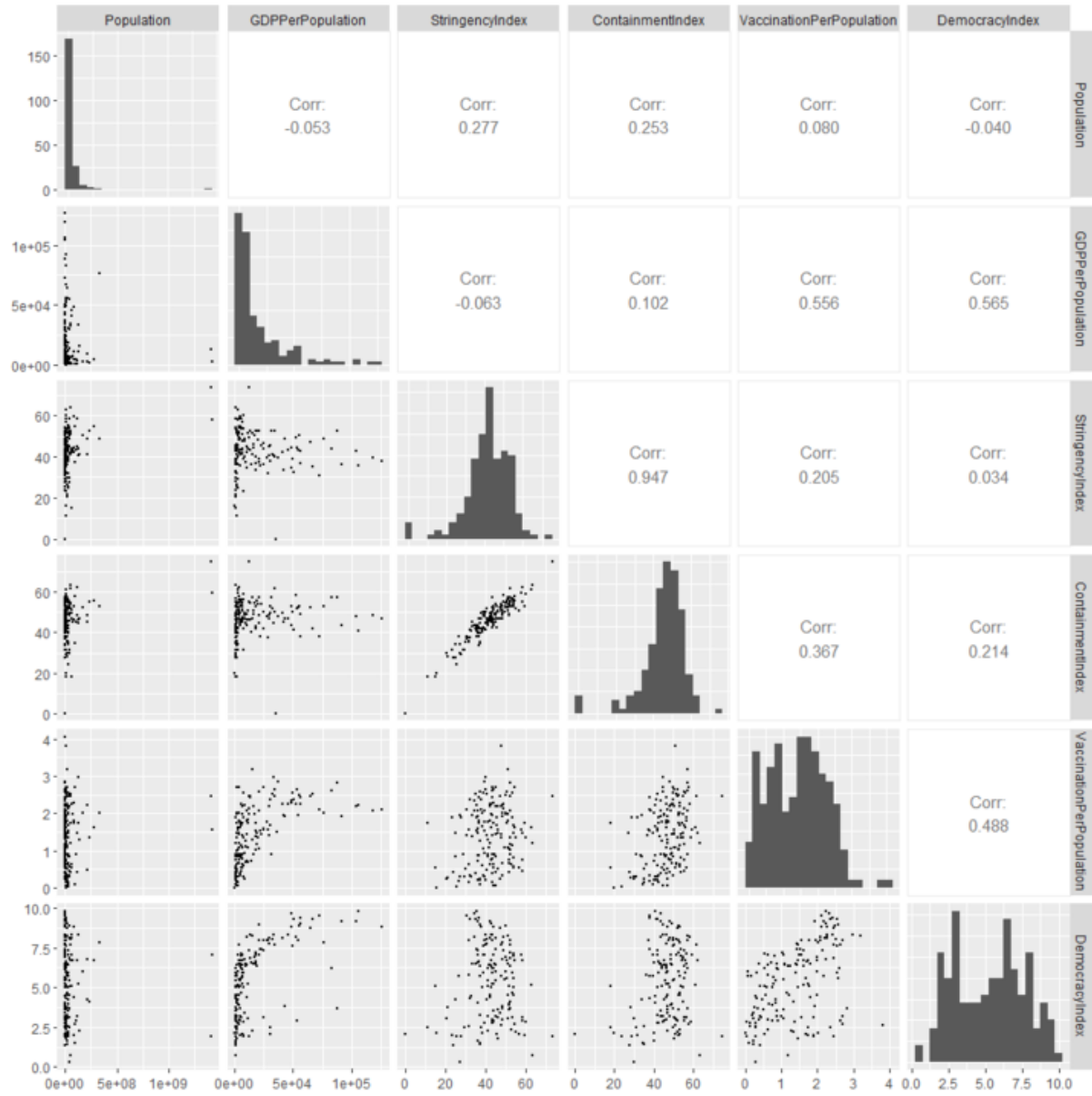
SI Figure 1: Number of infected cases in all countries. Each colour indicates a country. The correspondence of the colours with the countries is shown in SI Figure 3.



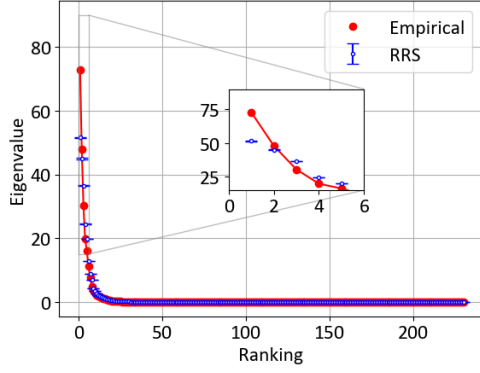
SI Figure 2: Log ratio of infected cases for all countries. Each colour indicates a country. The correspondence of the colours with the countries is shown in SI Figure 3.

Country			
Algeria	Argentina	Bhutan	Greece
Angola	Aruba	Brunei Darussalam	Guernsey
Benin	Bahamas	Cambodia	Holy See
Burkina Faso	Barbados	China	Hungary
Burundi	Belize	Cyprus	Iceland
Cabo Verde	Bermuda	Georgia	Ireland
Cameroon	Bolivia	India	Isle of Man
Central African Republic	Bonaire	Indonesia	Italy
Chad	Brazil	Iran	Jersey
Comoros	British Virgin Islands	Iraq	Latvia
Congo	Canada	Israel	Liechtenstein
Côte d'Ivoire	Cayman Islands	Japan	Lithuania
Democratic Republic of the Congo	Chile	Jordan	Luxembourg
Djibouti	Colombia	Kazakhstan	Malta
Egypt	Costa Rica	Kuwait	Monaco
Equatorial Guinea	Cuba	Kyrgyzstan	Montenegro
Eritrea	Curaçao	Lao People's Democratic Republic	Netherlands
Eswatini	Dominica	Lebanon	North Macedonia
Ethiopia	Dominican Republic	Malaysia	Norway
Gabon	Ecuador	Maldives	Poland
Gambia	El Salvador	Mongolia	Portugal
Ghana	Falkland Islands	Myanmar	Republic of Moldova
Guinea	French Guiana	Nepal	Romania
Guinea Bissau	Greenland	Oman	Russian Federation
Kenya	Grenada	Pakistan	San Marino
Lesotho	Guadeloupe	Palestine	Serbia
Liberia	Guatemala	Philippines	Slovakia
Libya	Guyana	Qatar	Slovenia
Madagascar	Haiti	Republic of Korea	Spain
Malawi	Honduras	Saudi Arabia	Sweden
Mali	Jamaica	Singapore	Switzerland
Mauritania	Martinique	Sri Lanka	The United Kingdom
Mauritius	Mexico	Syrian Arab Republic	Ukraine
Mayotte	Montserrat	Tajikistan	American Samoa
Morocco	Nicaragua	Thailand	Australia
Mozambique	Panama	Timor Leste	Cook Islands
Namibia	Paraguay	Turkey	Fiji
Niger	Peru	United Arab Emirates	French Polynesia
Nigeria	Puerto Rico	Uzbekistan	Guam
Rwanda	Saint Barthélemy	Viet Nam	Kiribati
Réunion	Saint Kitts and Nevis	Yemen	Marshall Islands
Saint Helena	Saint Lucia	Albania	Micronesia
Sao Tome and Principe	Saint Martin	Andorra	Nauru
Senegal	Saint Pierre and Miquelon	Austria	New Caledonia
Seychelles	Saint Vincent and the Grenadines	Belarus	New Zealand
Sierra Leone	Sint Maarten	Belgium	Niue
Somalia	Suriname	Bosnia and Herzegovina	Northern Mariana Islands
South Africa	Trinidad and Tobago	Bulgaria	Palau
South Sudan	Turks and Caicos Islands	Croatia	Papua New Guinea
Sudan	United States Virgin Islands	Czechia	Pitcairn Islands
Togo	United States of America	Denmark	Samoa
Tunisia	Uruguay	Estonia	Solomon Islands
Uganda	Venezuela	Faroe Islands	Tokelau
United Republic of Tanzania	Afghanistan	Finland	Tonga
Zambia	Armenia	France	Tuvalu
Zimbabwe	Azerbaijan	Germany	Vanuatu
Anguilla	Bahrain	Gibraltar	Wallis and Futuna
Antigua and Barbuda	Bangladesh		

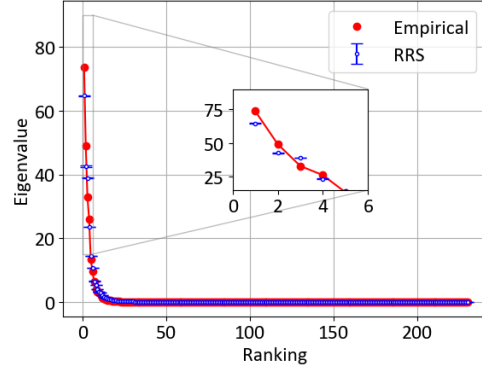
SI Figure 3: Correspondence of colours with countries. These colours are used in SI Figures 1 and 2.



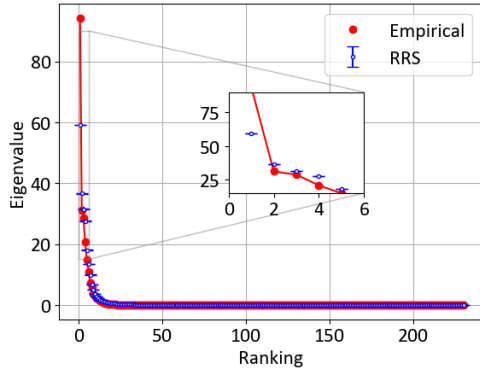
SI Figure 4: Pair plots between auxiliary data points.



(a) 2020

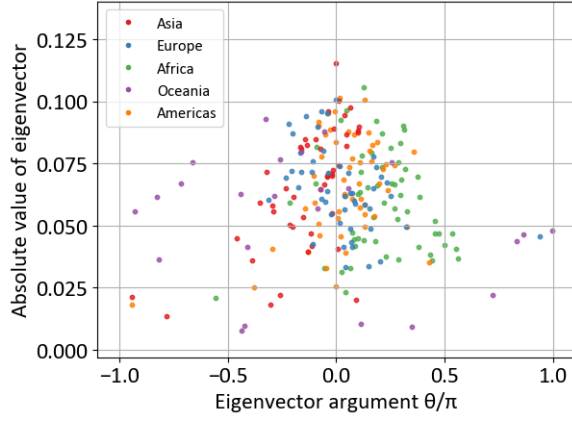


(b) 2021

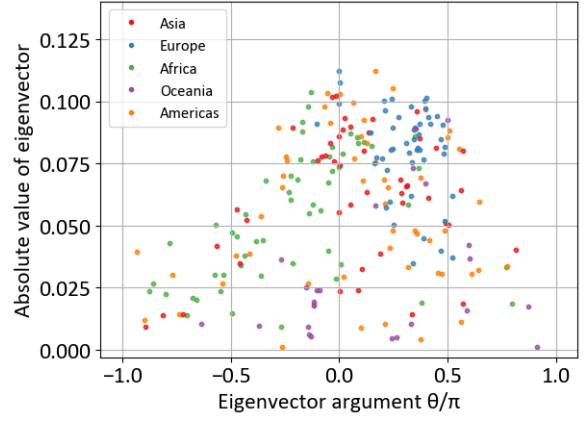


(c) 2022

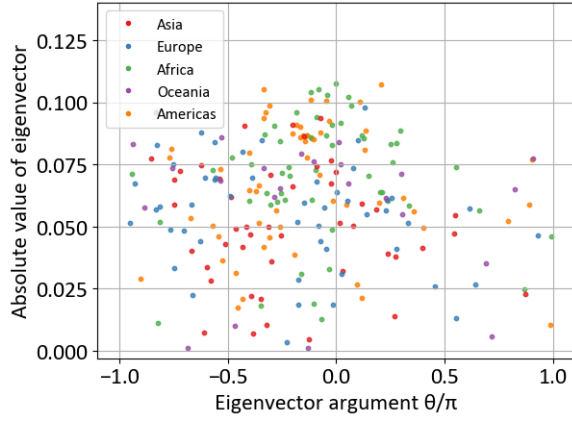
SI Figure 5: Scree plots of CHPCA and the RRS. Each panel covers different years, i.e., 2020, 2021, and 2020. The error bars for the RRS indicate the 1% significance level, which is 2.33 times the standard error.



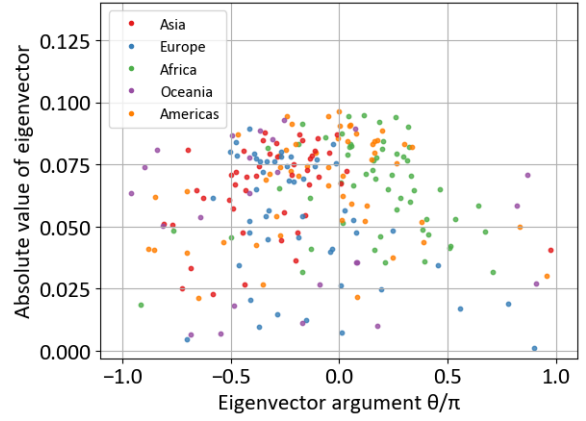
(a) Entire period



(b) 2020

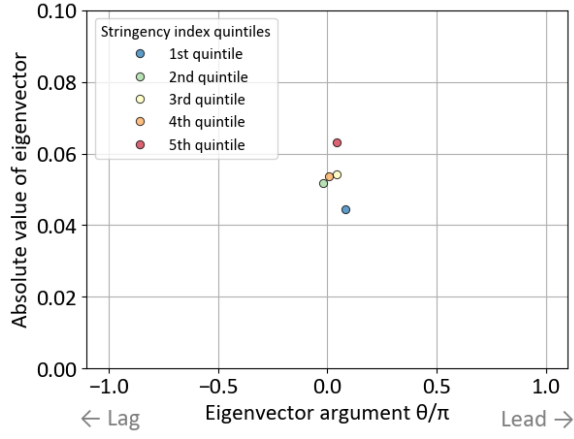


(c) 2021

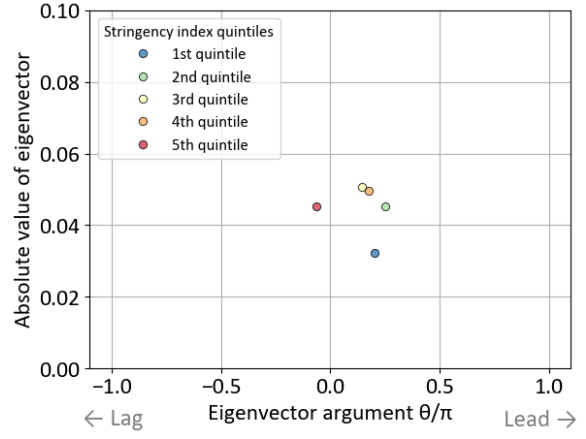


(d) 2022

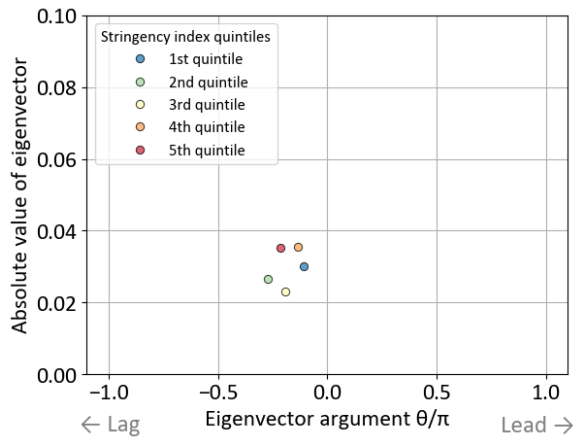
SI Figure 6: Eigenvectors with the first eigenvalue coloured by region. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Note that time progresses from right to left. Panels (a-d) show the entire period, 2020, 2021, and 2022, respectively.



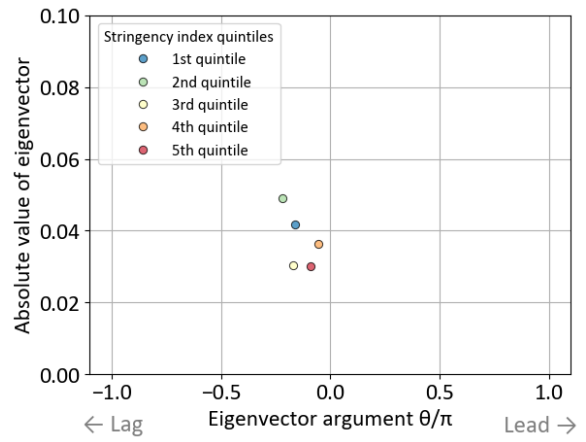
(a) Entire period



(b) 2020

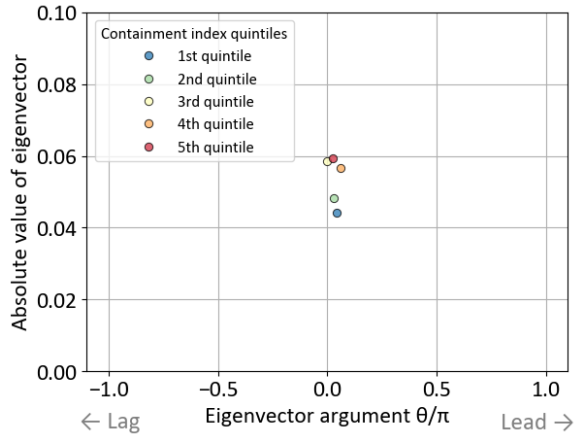


(c) 2021

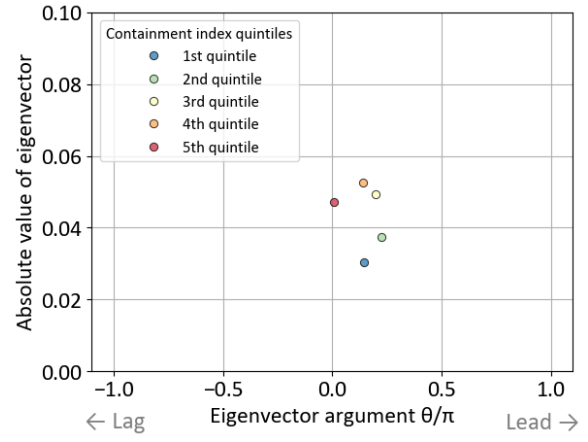


(d) 2022

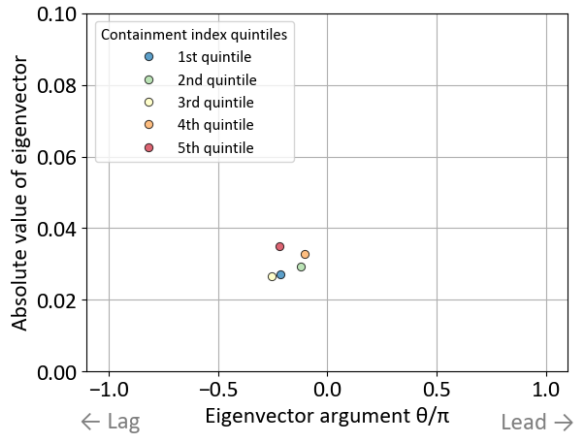
SI Figure 7: Barycentres for five groups of each stringency index based on rank. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Panels (a-d) represent the entire period, 2020, 2021, and 2022, respectively. Note that time progresses from right to left.



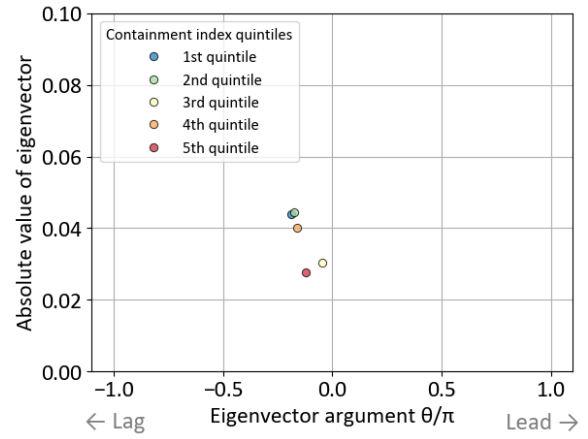
(a) Entire period



(b) 2020

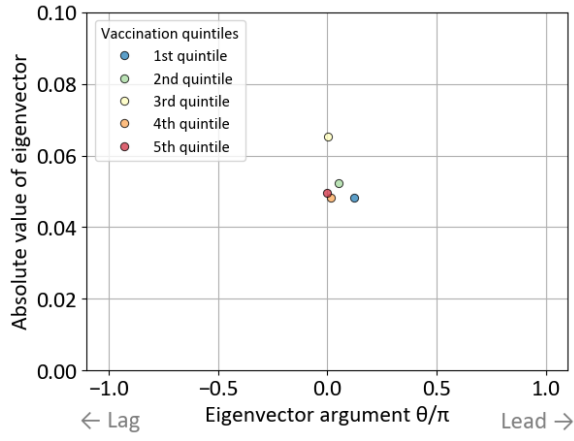


(c) 2021

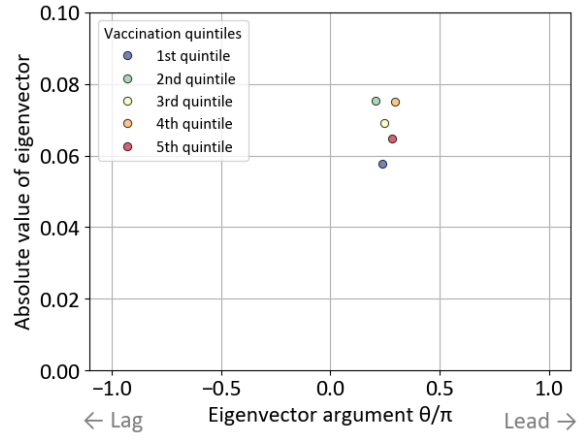


(d) 2022

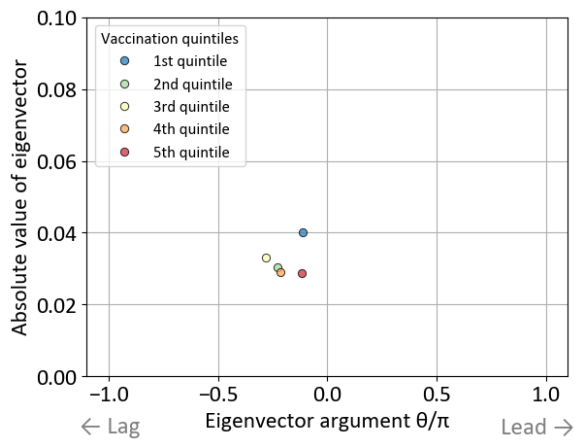
SI Figure 8: Barycentres for five groups of the containment and health index group based on rank. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Panels (a-d) represent the entire period, 2020, 2021, and 2022, respectively. Note that time progresses from right to left.



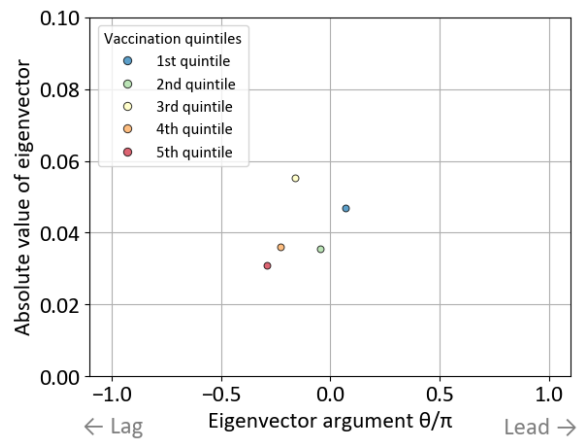
(a) Entire period



(b) 2020

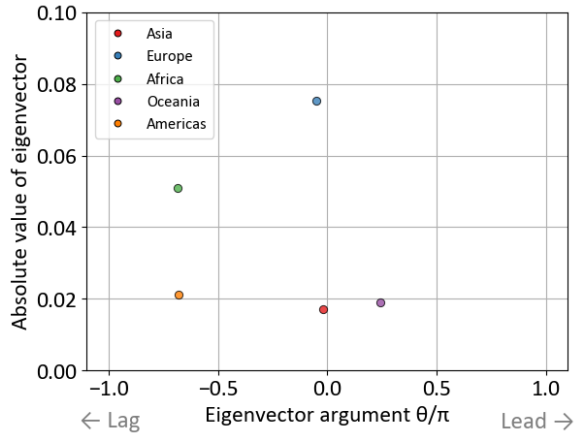


(c) 2021

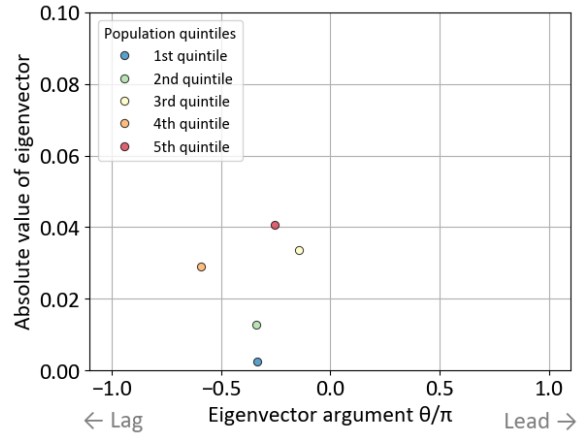


(d) 2022

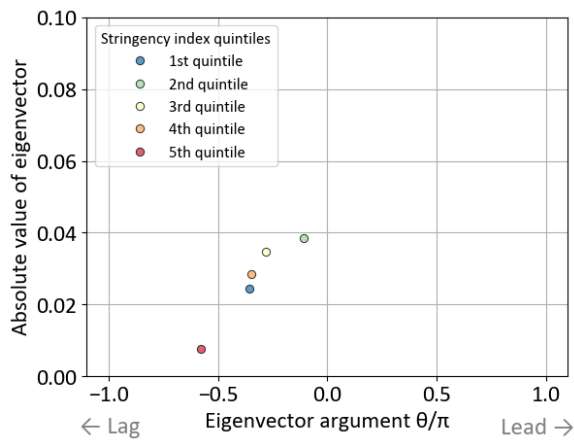
SI Figure 9: Barycentres for five groups of the vaccination rate based on rank. The abscissa corresponds to the real axis, and the ordinate corresponds to the imaginary axis. Panels (a-d) represent the entire period, 2020, 2021, and 2022, respectively. Note that time progresses from right to left.



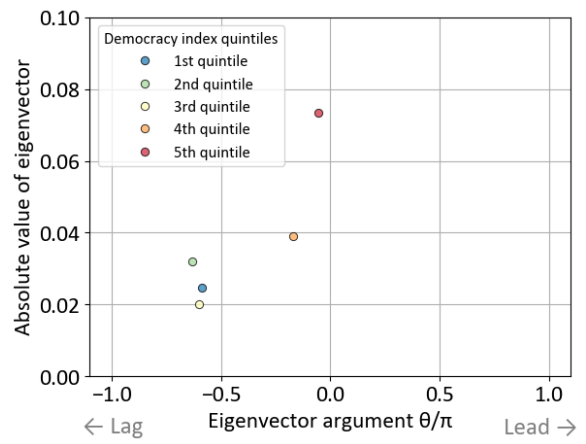
(a) Region



(b) Population

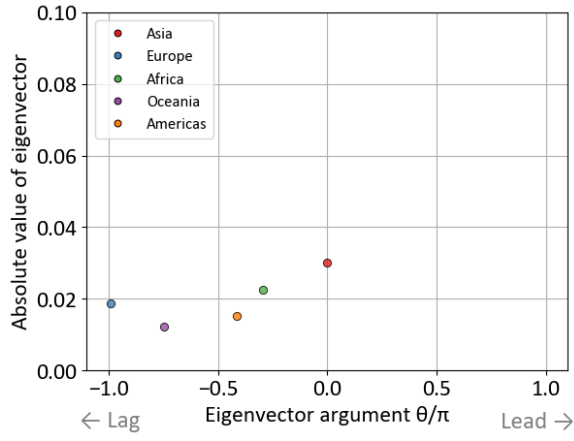


(c) Stringency Index

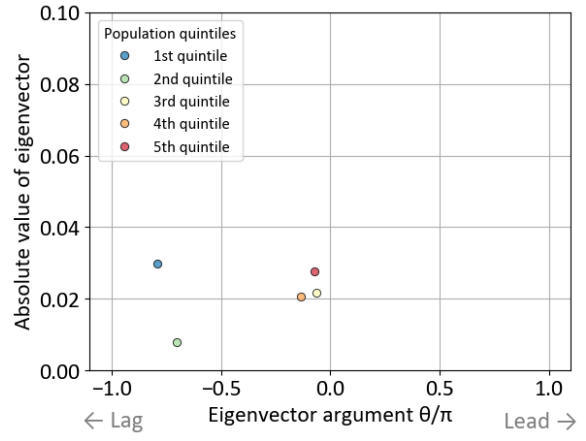


(d) Democracy Index

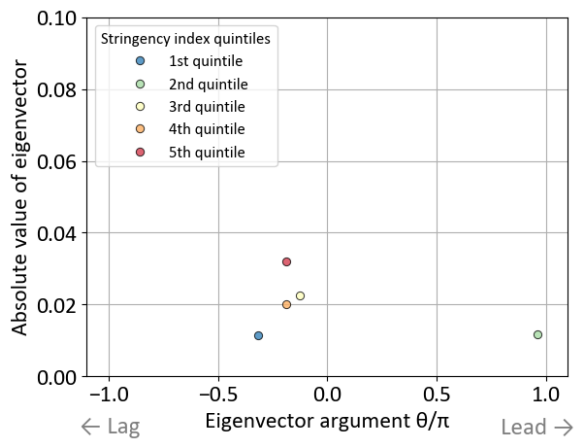
SI Figure 10: Barycentres of the second eigenvectors for data of the entire period. The panels are coloured by (a) region, (b) population, (c) stringency index [1], and (d) democracy index [2]. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Note that time progresses from right to left.



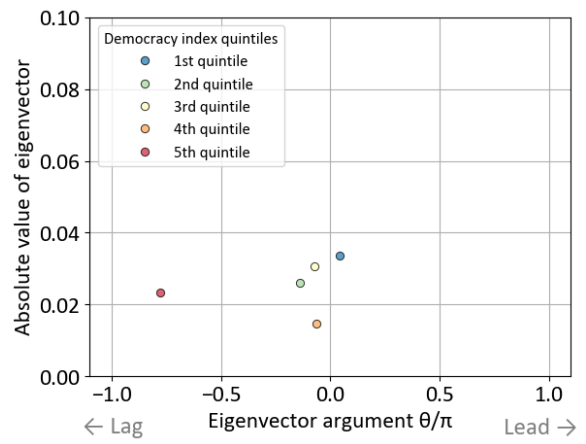
(a) Region



(b) Population

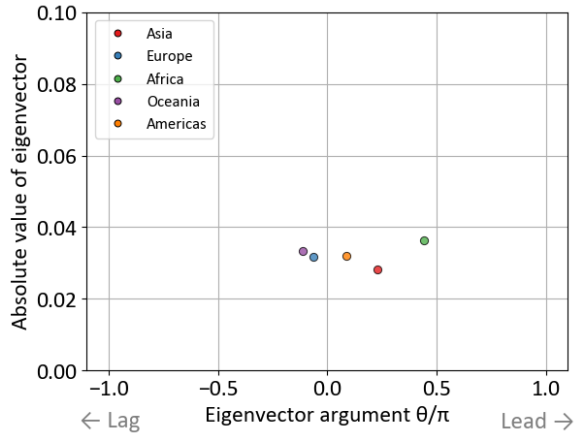


(c) Stringency Index

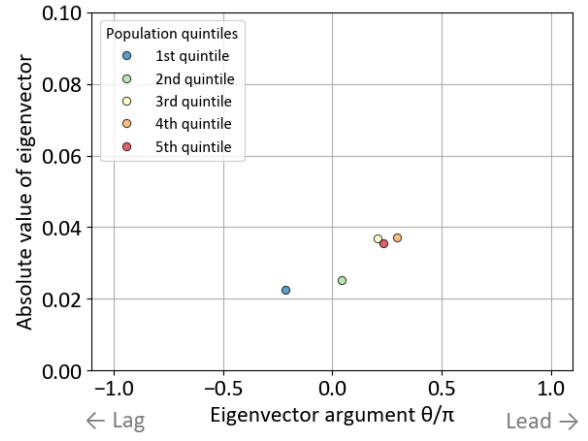


(d) Democracy Index

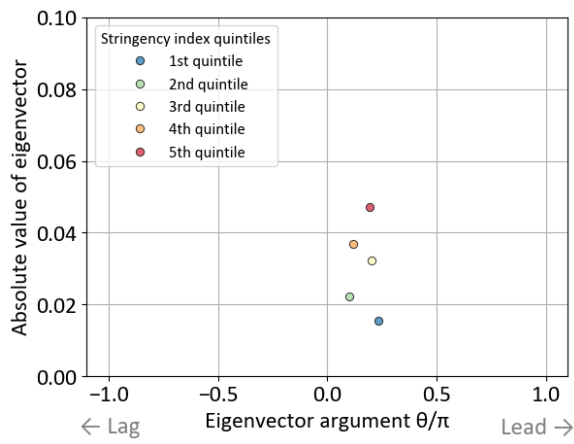
SI Figure 11: Barycentres of the third eigenvectors for the data of the entire period. The panels are coloured by (a) region, (b) population, (c) stringency index [1], and (d) democracy index [2]. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Note that time progresses from right to left.



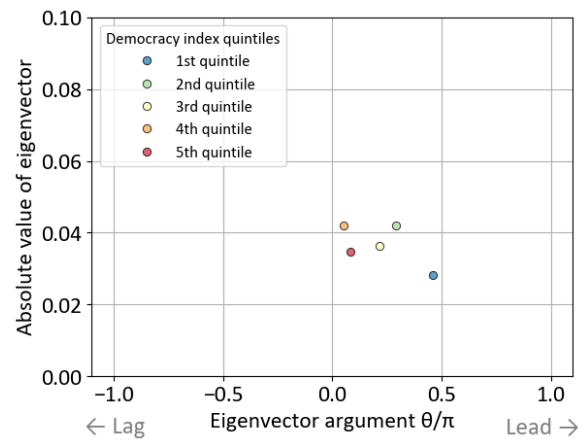
(a) Region



(b) Population

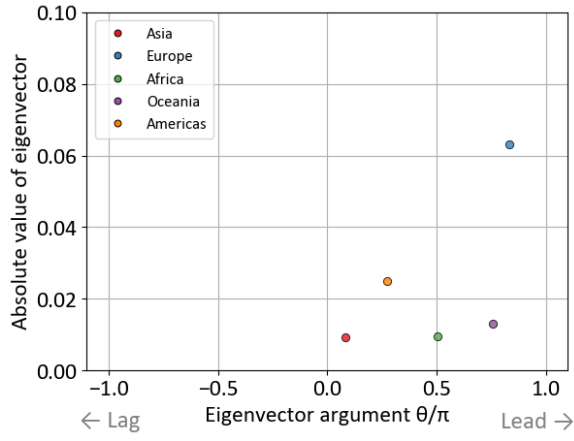


(c) Stringency Index

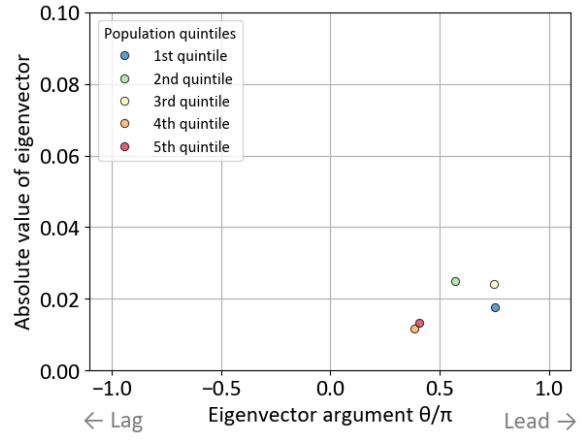


(d) Democracy Index

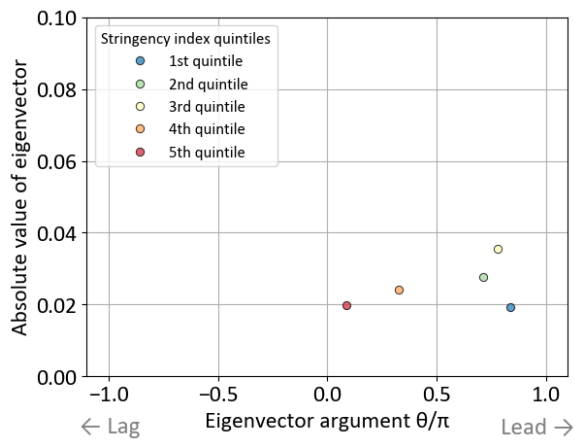
SI Figure 12: Barycentres of the second eigenvectors for the 2020 data. The panels are coloured by (a) region, (b) population, (c) stringency index [1], and (d) democracy index [2]. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Note that time progresses from right to left.



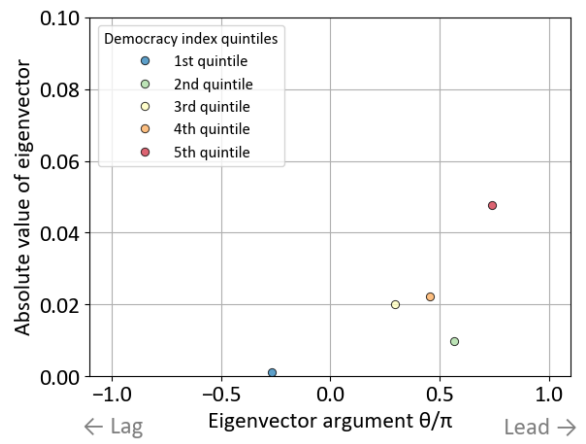
(a) Region



(b) Population

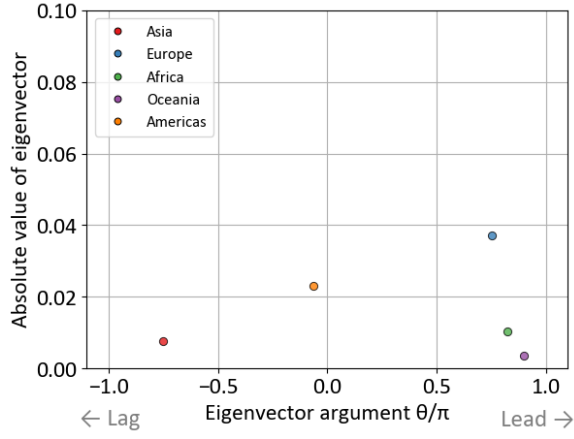


(c) Stringency Index

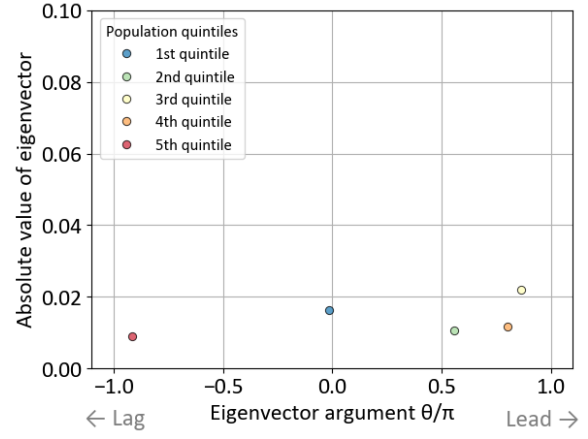


(d) Democracy Index

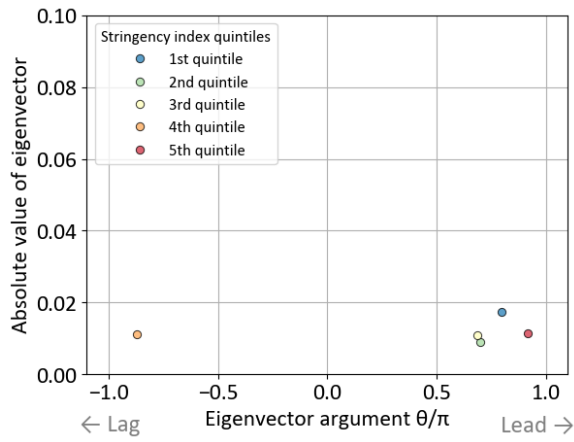
SI Figure 13: Barycentres of the second eigenvectors for the 2021 data. The panels are coloured by (a) region, (b) population, (c) stringency index [1], and (d) democracy index [2]. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Note that time progresses from right to left.



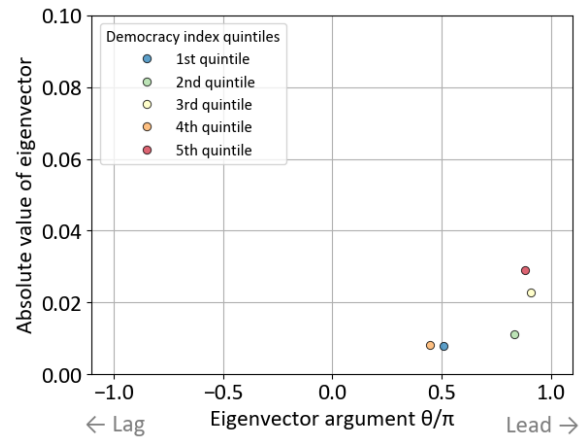
(a) Region



(b) Population



(c) Stringency Index



(d) Democracy Index

SI Figure 14: Barycentres of the second eigenvectors for the 2022 data. The panels are coloured by (a) region, (b) population, (c) stringency index [1], and (d) democracy index [2]. The abscissa corresponds to the argument, and the ordinate corresponds to the absolute value (amplitude) of the eigenvector. Note that time progresses from right to left.

2 Supplementary tables

The following list contains the tables referred to in the main text.

SI Table 1: Sample size of the auxiliary data.

SI Table 2: Mean distance from the barycentre. The mean distance is calculated for each group.

SI Table 1: Sample sizes of auxiliary data. The numbers indicates the number of observed countries in each dataset.

	2020	2021	2022
Population	265	265	265
GDP	257	251	233
Stringency Index	183	180	180
Containment Index	184	180	180
Vaccinations Rate	39	217	213
Democracy Index	167	167	167

SI Table 2: Mean distance from the barycentre. The mean distance is calculated for each group. The columns indicate the position within the five groups, which are divided by rank.

	Group	Entire Period	2020	2021	2022
Regions	Asia	0.030	0.044	0.046	0.041
	Europe	0.027	0.030	0.053	0.038
	Africa	0.027	0.040	0.055	0.044
	Oceania	0.046	0.031	0.057	0.053
	Americas	0.026	0.041	0.053	0.055
Population	First	0.036	0.034	0.054	0.058
	Second	0.032	0.042	0.053	0.049
	Third	0.029	0.043	0.054	0.047
	Fourth	0.028	0.044	0.055	0.047
	Fifth	0.032	0.044	0.053	0.050
GDP/Population	First	0.025	0.035	0.056	0.040
	Second	0.041	0.043	0.054	0.058
	Third	0.032	0.042	0.048	0.046
	Fourth	0.027	0.037	0.058	0.048
	Fifth	0.022	0.030	0.046	0.043
Stringency Index	First	0.028	0.046	0.063	0.038
	Second	0.032	0.038	0.050	0.046
	Third	0.032	0.048	0.053	0.048
	Fourth	0.031	0.044	0.054	0.055
	Fifth	0.030	0.039	0.047	0.059
Containment & Health Index	First	0.033	0.044	0.062	0.044
	Second	0.030	0.045	0.057	0.044
	Third	0.031	0.044	0.043	0.051
	Fourth	0.031	0.044	0.055	0.047
	Fifth	0.030	0.041	0.050	0.061
Vaccination Rate	First	0.028	0.038	0.062	0.045
	Second	0.034	0.032	0.056	0.050
	Third	0.029	0.028	0.056	0.051
	Fourth	0.031	0.022	0.050	0.054
	Fifth	0.032	0.035	0.045	0.047
Democracy Index	First	0.032	0.041	0.059	0.050
	Second	0.029	0.040	0.049	0.047
	Third	0.035	0.041	0.059	0.048
	Fourth	0.026	0.038	0.055	0.049
	Fifth	0.023	0.025	0.045	0.040

References

- [1] Our World in Data. Covid-19: Stringency index. <https://ourworldindata.org/covid-stringency-index> (accessed September 1, 2023), 2023.
- [2] Economist Intelligence. Democracy Index. <https://www.eiu.com/n/campaigns/democracy-index-2022/> (accessed: September 1, 2023), 2023.