

## Appendix IV Global Innovation Index science and technology cluster methodology

Since 2016, the Global Innovation Index (GII) has sought to identify science and technology (S&T) clusters using a bottom-up approach. This approach disregards administrative or political borders and instead pinpoints those geographical areas that show a high density of inventors and scientific authors. The resulting clusters often encompass several municipal districts, sub-federal states and sometimes even two or more countries. Two innovation metrics are employed in the compilation of the top 100 GII S&T clusters worldwide: location of inventors listed on published patent applications and authors listed on published scientific articles.

For patents, this method relies on applications under WIPO's Patent Cooperation Treaty (PCT). PCT patents offer a useful basis for analyzing patents globally. The PCT system applies a single set of procedural rules and collects information based on uniform filing standards. This reduces potential biases that could arise from using data collected from multiple national sources. The patents selected were published over the most recent five-year period available, between 2018 and 2022, to minimize the effects of volatility that can occur between years.<sup>1</sup>

To widen the range of innovation included, scientific publications from the Web of Science's Science Citation Index Expanded (SCIE) are incorporated. The SCIE provides detailed coverage of the world's most impactful academic journals. For the analysis presented here, science and technology fields are the focus, while articles from the fields of social sciences and humanities are disregarded. In addition, scientific publications are limited solely to articles of original research. This excludes other published items, such as meeting abstracts, conference summaries or paper briefs. As with PCT filings, the most recent five-year period according to data availability was also used for the SCIE – publication years 2017 to 2021.

The WIPO PCT patent data set consists of approximately 1.3 million patent applications published between 2018 and 2022, containing 3.9 million inventor addresses. For the SCIE, the data set comprises 7.6 million articles published between 2017 and 2021, containing 25.1 million listed author addresses.

The process for geocoding of addresses for this report is as follows. PCT inventor addresses were geocoded using the Environmental Systems Research Institute (ESRI) ArcGIS World Geocoder service.<sup>2</sup> In cases where the ESRI address matches proved either ambiguous or insufficiently accurate, the city name in the address string was extracted and matched using records in the city-level data set from the GeoNames Gazetteer database.<sup>3</sup> This latter database gives the geolocation of cities around the globe and contains 48,000 geocoded cities. This same city-matching approach was applied to all SCIE author addresses.

Overall, 97.6 percent of inventor addresses were geocoded at either the city level or a more accurate level, while 95.7 percent of scientific author addresses were geocoded at the city level. Appendix Table 5 provides a summary of the geocoding results for the top 20 countries, which together account for the majority of inventor and scientific author addresses. As shown in the table, the coverage of geocoded PCT inventor addresses across all 20 countries is typically above 98 percent, only falling below 98 percent in one instance. Coverage of scientific author addresses is also high, above 90% in all but one instance. All of the 20 countries had at least 95 percent of their PCT applications and Scientific articles contain at least one inventor or author with a geocoded address, only falling below 95 percent in one instance.

Addresses were clustered by applying the density-based spatial clustering of applications with noise (DBSCAN) algorithm. This algorithm requires predefined radius and density parameters. As in previous years, a radius of 15 km and a density of 4,500 listed inventors/authors was applied. Equal weight was given to inventors and authors by expressing data points as a share of total inventor and author addresses, respectively. Given that the number of scientific articles far exceeds the number of patents, cluster identification based on the raw data points would have resulted in clusters shaped predominantly by the scientific author landscape.

The result was an initial list of 248 clusters. After review, neighboring clusters were merged if the edge of one cluster was within 3–5 km of another and where the co-author/co-inventor

relationships were higher than for any other relationship with any other cluster or non-cluster points. A total of 22 clusters met these criteria, with mergers reducing the overall number of clusters identified to 237.<sup>4</sup>

The remaining 237 clusters were then ranked by counting the number of patents and scientific articles in a given cluster. Numbers were aggregated using fractional counting, in which counts reflect the share of a patent's inventors and an article's authors present in a particular cluster. In addition, mirroring the equal weighting approach described above, fractional counts are relative to the total numbers of patents and scientific articles.

To produce an intensity ranking, the European Commission's Global Human Settlement Layer (GHSL) population distribution data were matched geographically to the top 100 clusters identified in the overall ranking.<sup>5</sup> Just as with inventor/author geocoded locations, these population data allowed us to define the total population of a cluster using a bottom-up approach. We chose to define a cluster's area as all the space within 0.05 degrees of each inventor/author location. Overlaying the resultant cluster polygons on top of the population data and aggregating all points which lay within each polygon gave a total population estimate for each cluster.<sup>6</sup> The clusters were then ranked by dividing the total S&T share by population.

**Appendix Table 3 Top 100 S&T clusters, 2023**

| Rank | Cluster name                 | Economy | PCT applications | Scientific publications | Share total PCT filings (%) | Share of total pubs (%) | Total | Previous rank <sup>a</sup> | Rank change <sup>a</sup> |
|------|------------------------------|---------|------------------|-------------------------|-----------------------------|-------------------------|-------|----------------------------|--------------------------|
| 1    | Tokyo–Yokohama               | JP      | 127,418          | 115,020                 | 10.1                        | 1.5                     | 11.7  | 1                          | 0                        |
| 2    | Shenzhen–Hong Kong–Guangzhou | CN/HK   | 113,482          | 153,180                 | 9.0                         | 2.1                     | 11.1  | 2                          | 0                        |
| 3    | Seoul                        | KR      | 63,447           | 133,604                 | 5.1                         | 1.8                     | 6.8   | 4                          | 1                        |
| 4    | Beijing                      | CN      | 38,067           | 279,485                 | 3.0                         | 3.7                     | 6.8   | 3                          | -1                       |
| 5    | Shanghai–Suzhou              | CN      | 32,924           | 162,635                 | 2.6                         | 2.2                     | 4.8   | 6                          | 1                        |
| 6    | San Jose–San Francisco, CA   | US      | 47,269           | 58,575                  | 3.8                         | 0.8                     | 4.6   | 5                          | -1                       |
| 7    | Osaka–Kobe–Kyoto             | JP      | 38,413           | 51,948                  | 3.1                         | 0.7                     | 3.8   | 7                          | 0                        |
| 8    | Boston–Cambridge, MA         | US      | 18,184           | 76,378                  | 1.4                         | 1.0                     | 2.5   | 8                          | 0                        |
| 9    | San Diego, CA                | US      | 23,261           | 20,928                  | 1.9                         | 0.3                     | 2.1   | 11                         | 2                        |
| 10   | New York City, NY            | US      | 13,838           | 74,849                  | 1.1                         | 1.0                     | 2.1   | 9                          | -1                       |
| 11   | Nanjing                      | CN      | 7,143            | 113,488                 | 0.6                         | 1.5                     | 2.1   | 12                         | 1                        |
| 12   | Paris                        | FR      | 15,176           | 61,692                  | 1.2                         | 0.8                     | 2.0   | 10                         | -2                       |
| 13   | Wuhan                        | CN      | 6,250            | 89,756                  | 0.5                         | 1.2                     | 1.7   | 15                         | 2                        |
| 14   | Hangzhou                     | CN      | 10,755           | 62,924                  | 0.9                         | 0.8                     | 1.7   | 14                         | 0                        |
| 15   | Nagoya                       | JP      | 17,736           | 16,091                  | 1.4                         | 0.2                     | 1.6   | 13                         | -2                       |
| 16   | Los Angeles, CA              | US      | 11,556           | 44,058                  | 0.9                         | 0.6                     | 1.5   | 16                         | 0                        |
| 17   | Washington, DC–Baltimore, MD | US      | 5,525            | 76,039                  | 0.4                         | 1.0                     | 1.5   | 17                         | 0                        |
| 18   | Daejeon                      | KR      | 12,275           | 25,552                  | 1.0                         | 0.3                     | 1.3   | 20                         | 2                        |
| 19   | Xi'an                        | CN      | 1,786            | 86,937                  | 0.1                         | 1.2                     | 1.3   | 21                         | 2                        |
| 20   | London                       | GB      | 5,981            | 59,068                  | 0.5                         | 0.8                     | 1.3   | 18                         | -2                       |
| 21   | Seattle, WA                  | US      | 11,472           | 20,322                  | 0.9                         | 0.3                     | 1.2   | 19                         | -2                       |
| 22   | Munich                       | DE      | 10,248           | 24,239                  | 0.8                         | 0.3                     | 1.1   | 22                         | 0                        |
| 23   | Qingdao                      | CN      | 7,286            | 39,745                  | 0.6                         | 0.5                     | 1.1   | 29                         | 6                        |
| 24   | Chengdu                      | CN      | 2,046            | 67,334                  | 0.2                         | 0.9                     | 1.1   | 27                         | 3                        |
| 25   | Cologne                      | DE      | 7,466            | 34,286                  | 0.6                         | 0.5                     | 1.1   | 23                         | -2                       |
| 26   | Amsterdam–Rotterdam          | NL      | 4,230            | 52,864                  | 0.3                         | 0.7                     | 1.0   | 25                         | -1                       |
| 27   | Taipei–Hsinchu               | TW*     | 3,907            | 52,752                  | 0.3                         | 0.7                     | 1.0   | 26                         | -1                       |
| 28   | Houston, TX                  | US      | 8,475            | 24,636                  | 0.7                         | 0.3                     | 1.0   | 24                         | -4                       |
| 29   | Stuttgart                    | DE      | 9,342            | 14,874                  | 0.7                         | 0.2                     | 0.9   | 28                         | -1                       |
| 30   | Tel Aviv–Jerusalem           | IL      | 7,268            | 24,219                  | 0.6                         | 0.3                     | 0.9   | 31                         | 1                        |
| 31   | Moscow                       | RU      | 2,036            | 55,086                  | 0.2                         | 0.7                     | 0.9   | 32                         | 1                        |
| 32   | Chicago, IL                  | US      | 5,763            | 32,343                  | 0.5                         | 0.4                     | 0.9   | 30                         | -2                       |
| 33   | Singapore                    | SG/MY   | 4,861            | 36,803                  | 0.4                         | 0.5                     | 0.9   | 35                         | 2                        |
| 34   | Tehran                       | IR      | 249              | 63,113                  | 0.0                         | 0.8                     | 0.9   | 33                         | -1                       |
| 35   | Philadelphia, PA             | US      | 5,390            | 32,309                  | 0.4                         | 0.4                     | 0.9   | 34                         | -1                       |
| 36   | Tianjin                      | CN      | 1,267            | 53,680                  | 0.1                         | 0.7                     | 0.8   | 36                         | 0                        |
| 37   | Changsha                     | CN      | 1,149            | 52,768                  | 0.1                         | 0.7                     | 0.8   | 39                         | 2                        |
| 38   | Stockholm                    | SE      | 6,069            | 19,984                  | 0.5                         | 0.3                     | 0.8   | 37                         | -1                       |
| 39   | Minneapolis, MN              | US      | 6,625            | 15,375                  | 0.5                         | 0.2                     | 0.7   | 38                         | -1                       |
| 40   | Hefei                        | CN      | 2,549            | 38,974                  | 0.2                         | 0.5                     | 0.7   | 53                         | 13                       |
| 41   | Eindhoven                    | NL      | 7,982            | 5,339                   | 0.6                         | 0.1                     | 0.7   | 40                         | -1                       |
| 42   | Melbourne                    | AU      | 2,126            | 40,056                  | 0.2                         | 0.5                     | 0.7   | 41                         | -1                       |
| 43   | Berlin                       | DE      | 3,624            | 30,464                  | 0.3                         | 0.4                     | 0.7   | 42                         | -1                       |
| 44   | Chongqing                    | CN      | 1,651            | 41,412                  | 0.1                         | 0.6                     | 0.7   | 49                         | 5                        |
| 45   | Frankfurt am Main            | DE      | 5,410            | 18,590                  | 0.4                         | 0.2                     | 0.7   | 43                         | -2                       |
| 46   | Sydney                       | AU      | 2,539            | 33,695                  | 0.2                         | 0.5                     | 0.7   | 44                         | -2                       |
| 47   | Raleigh, NC                  | US      | 3,057            | 30,206                  | 0.2                         | 0.4                     | 0.6   | 45                         | -2                       |
| 48   | Madrid                       | ES      | 1,580            | 38,849                  | 0.1                         | 0.5                     | 0.6   | 46                         | -2                       |
| 49   | Zürich                       | CH      | 3,759            | 24,437                  | 0.3                         | 0.3                     | 0.6   | 50                         | 1                        |
| 50   | Milan                        | IT      | 2,578            | 31,077                  | 0.2                         | 0.4                     | 0.6   | 51                         | 1                        |
| 51   | Brussels–Antwerp             | BE      | 3,079            | 27,659                  | 0.2                         | 0.4                     | 0.6   | 48                         | -3                       |

Appendix Table 3 Continued

| Rank | Cluster name        | Economy  | PCT applications | Scientific publications | Share total PCT filings (%) | Share of total pubs (%) | Total | Previous rank <sup>a</sup> | Rank change <sup>a</sup> |
|------|---------------------|----------|------------------|-------------------------|-----------------------------|-------------------------|-------|----------------------------|--------------------------|
| 52   | Toronto, ON         | CA       | 2,756            | 28,967                  | 0.2                         | 0.4                     | 0.6   | 54                         | 2                        |
| 53   | Harbin              | CN       | 251              | 42,974                  | 0.0                         | 0.6                     | 0.6   | 55                         | 2                        |
| 54   | Barcelona           | ES       | 2,431            | 29,851                  | 0.2                         | 0.4                     | 0.6   | 52                         | -2                       |
| 55   | Jinan               | CN       | 1,638            | 34,308                  | 0.1                         | 0.5                     | 0.6   | 57                         | 2                        |
| 56   | Bengaluru           | IN       | 4,342            | 15,579                  | 0.3                         | 0.2                     | 0.6   | 60                         | 4                        |
| 57   | Denver, CO          | US       | 3,084            | 21,910                  | 0.2                         | 0.3                     | 0.5   | 59                         | 2                        |
| 58   | Changchun           | CN       | 376              | 37,310                  | 0.0                         | 0.5                     | 0.5   | 63                         | 5                        |
| 59   | Istanbul            | TR       | 2,144            | 26,230                  | 0.2                         | 0.4                     | 0.5   | 47                         | -12                      |
| 60   | Montréal, QC        | CA       | 2,235            | 25,406                  | 0.2                         | 0.3                     | 0.5   | 58                         | -2                       |
| 61   | Copenhagen          | DK       | 3,123            | 18,911                  | 0.2                         | 0.3                     | 0.5   | 62                         | 1                        |
| 62   | Heidelberg–Mannheim | DE       | 3,941            | 13,849                  | 0.3                         | 0.2                     | 0.5   | 61                         | -1                       |
| 63   | Shenyang            | CN       | 716              | 32,840                  | 0.1                         | 0.4                     | 0.5   | 68                         | 5                        |
| 64   | Delhi               | IN       | 1,111            | 30,443                  | 0.1                         | 0.4                     | 0.5   | 65                         | 1                        |
| 65   | Cambridge           | GB       | 3,146            | 17,751                  | 0.3                         | 0.2                     | 0.5   | 64                         | -1                       |
| 66   | Rome                | IT       | 960              | 29,642                  | 0.1                         | 0.4                     | 0.5   | 67                         | 1                        |
| 67   | Portland, OR        | US       | 4,769            | 6,705                   | 0.4                         | 0.1                     | 0.5   | 56                         | -11                      |
| 68   | Atlanta, GA         | US       | 1,844            | 23,550                  | 0.1                         | 0.3                     | 0.5   | 66                         | -2                       |
| 69   | Dalian              | CN       | 1,089            | 27,534                  | 0.1                         | 0.4                     | 0.5   | 69                         | 0                        |
| 70   | Nuremberg–Erlangen  | DE       | 3,619            | 9,491                   | 0.3                         | 0.1                     | 0.4   | 71                         | 1                        |
| 71   | Dallas, TX          | US       | 3,458            | 10,093                  | 0.3                         | 0.1                     | 0.4   | 73                         | 2                        |
| 72   | São Paulo           | BR       | 763              | 25,815                  | 0.1                         | 0.3                     | 0.4   | 70                         | -2                       |
| 73   | Helsinki            | FI       | 2,841            | 13,367                  | 0.2                         | 0.2                     | 0.4   | 74                         | 1                        |
| 74   | Busan               | KR       | 2,314            | 16,194                  | 0.2                         | 0.2                     | 0.4   | 75                         | 1                        |
| 75   | Zhengzhou           | CN       | 740              | 25,472                  | 0.1                         | 0.3                     | 0.4   | 82                         | 7                        |
| 76   | Vienna              | AT       | 1,589            | 20,160                  | 0.1                         | 0.3                     | 0.4   | 76                         | 0                        |
| 77   | Cincinnati, OH      | US       | 3,460            | 7,753                   | 0.3                         | 0.1                     | 0.4   | 72                         | -5                       |
| 78   | Pittsburgh, PA      | US       | 1,869            | 17,051                  | 0.1                         | 0.2                     | 0.4   | 79                         | 1                        |
| 79   | Oxford              | GB       | 1,583            | 18,437                  | 0.1                         | 0.2                     | 0.4   | 77                         | -2                       |
| 80   | Xiamen              | CN       | 1,947            | 16,127                  | 0.2                         | 0.2                     | 0.4   | 85                         | 5                        |
| 81   | Ann Arbor, MI       | US       | 1,266            | 19,984                  | 0.1                         | 0.3                     | 0.4   | 78                         | -3                       |
| 82   | Lanzhou             | CN       | 464              | 23,368                  | 0.0                         | 0.3                     | 0.4   | 93                         | 11                       |
| 83   | Chennai             | IN       | 1,133            | 19,367                  | 0.1                         | 0.3                     | 0.4   | 88                         | 5                        |
| 84   | Mumbai              | IN       | 1,606            | 16,203                  | 0.1                         | 0.2                     | 0.3   | 84                         | 0                        |
| 85   | Vancouver, BC       | CA       | 1,586            | 16,167                  | 0.1                         | 0.2                     | 0.3   | 83                         | -2                       |
| 86   | Kanazawa            | JP       | 3,687            | 3,441                   | 0.3                         | 0.0                     | 0.3   | 80                         | -6                       |
| 87   | Ankara              | TR       | 739              | 20,308                  | 0.1                         | 0.3                     | 0.3   | 86                         | -1                       |
| 88   | Lyon                | FR       | 2,123            | 12,050                  | 0.2                         | 0.2                     | 0.3   | 81                         | -7                       |
| 89   | Zhenjiang           | CN       | 928              | 18,948                  | 0.1                         | 0.3                     | 0.3   | 104                        | 15                       |
| 90   | Warsaw              | PL       | 446              | 21,602                  | 0.0                         | 0.3                     | 0.3   | 89                         | -1                       |
| 91   | Daegu               | KR       | 1,837            | 13,061                  | 0.1                         | 0.2                     | 0.3   | 91                         | 0                        |
| 92   | Austin, TX          | US       | 2,320            | 9,917                   | 0.2                         | 0.1                     | 0.3   | 90                         | -2                       |
| 93   | Wuxi                | CN       | 2,110            | 10,906                  | 0.2                         | 0.1                     | 0.3   | 106                        | 13                       |
| 94   | Fuzhou              | CN       | 678              | 19,405                  | 0.1                         | 0.3                     | 0.3   | 102                        | 8                        |
| 95   | Ottawa, ON          | CA       | 1,898            | 11,986                  | 0.2                         | 0.2                     | 0.3   | 92                         | -3                       |
| 96   | Phoenix, AZ         | US       | 2,364            | 9,051                   | 0.2                         | 0.1                     | 0.3   | 87                         | -9                       |
| 97   | Basel               | CH/DE/FR | 2,556            | 7,774                   | 0.2                         | 0.1                     | 0.3   | 96                         | -1                       |
| 98   | Göteborg            | SE       | 2,078            | 10,329                  | 0.2                         | 0.1                     | 0.3   | 95                         | -3                       |
| 99   | Hamburg             | DE       | 1,765            | 11,479                  | 0.1                         | 0.2                     | 0.3   | 99                         | 0                        |
| 100  | Brisbane            | AU       | 1,129            | 15,233                  | 0.1                         | 0.2                     | 0.3   | 97                         | -3                       |

Source: WIPO Statistics Database, May 2023.

Notes: <sup>a</sup> This column represents the previous year's rankings, which have been adjusted to align with the updated methodology. The codes given in the tables in this appendix are the ISO alpha-2 country codes, with the following addition: TW\* = Taiwan, Province of China.

Appendix Table 4 Ranking of S&amp;T intensity

| Rank per capita | Cluster name                 | Economy  | Estimated cluster population | PCT applications per capita <sup>a</sup> | Scientific publications per capita <sup>a</sup> | Total S&T share per capita <sup>a</sup> | Rank change <sup>b</sup> |
|-----------------|------------------------------|----------|------------------------------|--|---|---|--------------------------|
| 1               | Cambridge                    | GB       | 477,995                      | 6,582                                    | 37,136  | 1.02                                    | 0                        |
| 2               | San Jose–San Francisco, CA   | US       | 6,262,908                    | 7,547                                    | 9,353   | 0.73                                    | 0                        |
| 3               | Oxford                       | GB       | 539,483                      | 2,934                                    | 34,176  | 0.69                                    | 0                        |
| 4               | Eindhoven                    | NL       | 1,031,903                    | 7,735                                    | 5,174   | 0.69                                    | 0                        |
| 5               | Boston–Cambridge, MA         | US       | 4,232,444                    | 4,296                                    | 18,046  | 0.58                                    | 1                        |
| 6               | Daejeon                      | KR       | 2,348,673                    | 5,226                                    | 10,879  | 0.56                                    | -1                       |
| 7               | Ann Arbor, MI                | US       | 659,586                      | 1,920                                    | 30,297  | 0.56                                    | 0                        |
| 8               | San Diego, CA                | US       | 3,835,826                    | 6,064                                    | 5,456   | 0.56                                    | 0                        |
| 9               | Seattle, WA                  | US       | 2,526,151                    | 4,541                                    | 8,045   | 0.47                                    | 0                        |
| 10              | Munich                       | DE       | 2,767,781                    | 3,702                                    | 8,757   | 0.41                                    | 4                        |
| 11              | Kanazawa                     | JP       | 881,092                      | 4,184                                    | 3,905   | 0.39                                    | 1                        |
| 12              | Raleigh, NC                  | US       | 1,772,830                    | 1,724                                    | 17,038  | 0.37                                    | 3                        |
| 13              | Göteborg                     | SE       | 841,183                      | 2,470                                    | 12,279  | 0.36                                    | 3                        |
| 14              | Beijing                      | CN       | 19,292,327                   | 1,973                                    | 14,487  | 0.35                                    | 4                        |
| 15              | Stockholm                    | SE       | 2,159,150                    | 2,811                                    | 9,255   | 0.35                                    | 2                        |
| 16              | Helsinki                     | FI       | 1,232,664                    | 2,305                                    | 10,844  | 0.33                                    | 3                        |
| 17              | Zürich                       | CH       | 1,933,135                    | 1,945                                    | 12,641  | 0.32                                    | 3                        |
| 18              | Tokyo–Yokohama               | JP       | 36,197,318                   | 3,520                                    | 3,178   | 0.32                                    | 3                        |
| 19              | Basel                        | CH/DE/FR | 1,020,380                    | 2,505                                    | 7,619   | 0.30                                    | 6                        |
| 20              | Copenhagen                   | DK       | 1,670,776                    | 1,869                                    | 11,319  | 0.30                                    | 2                        |
| 21              | Nuremberg–Erlangen           | DE       | 1,384,238                    | 2,615                                    | 6,857   | 0.30                                    | 2                        |
| 22              | Stuttgart                    | DE       | 3,195,495                    | 2,923                                    | 4,655   | 0.30                                    | 2                        |
| 23              | Minneapolis, MN              | US       | 2,699,170                    | 2,454                                    | 5,696   | 0.27                                    | 3                        |
| 24              | Pittsburgh, PA               | US       | 1,395,595                    | 1,339                                    | 12,218  | 0.27                                    | 3                        |
| 25              | Seoul                        | KR       | 26,436,274                   | 2,400                                    | 5,054   | 0.26                                    | 4                        |
| 26              | Heidelberg–Mannheim          | DE       | 2,003,186                    | 1,968                                    | 6,914   | 0.25                                    | 2                        |
| 27              | Ottawa, ON                   | CA       | 1,255,368                    | 1,512                                    | 9,548   | 0.25                                    | 3                        |
| 28              | Nanjing                      | CN       | 8,632,198                    | 827                                      | 13,147  | 0.24                                    | 7                        |
| 29              | Hangzhou                     | CN       | 7,021,090                    | 1,532                                    | 8,962   | 0.24                                    | 4                        |
| 30              | Osaka–Kobe–Kyoto             | JP       | 15,704,848                   | 2,446                                    | 3,308   | 0.24                                    | 2                        |
| 31              | Qingdao                      | CN       | 4,883,232                    | 1,492                                    | 8,139   | 0.23                                    | 7                        |
| 32              | Shenzhen–Hong Kong–Guangzhou | CN/HK    | 49,538,901                   | 2,291                                    | 3,092   | 0.22                                    | 5                        |
| 33              | Washington, DC–Baltimore, MD | US       | 6,958,796                    | 794                                      | 10,927  | 0.21                                    | 3                        |
| 34              | Portland, OR                 | US       | 2,258,229                    | 2,112                                    | 2,969   | 0.21                                    | -3                       |
| 35              | Xi'an                        | CN       | 6,290,985                    | 284                                      | 13,819  | 0.21                                    | 6                        |
| 36              | Cincinnati, OH               | US       | 1,857,103                    | 1,863                                    | 4,175   | 0.20                                    | -2                       |
| 37              | Changsha                     | CN       | 3,997,004                    | 288                                      | 13,202  | 0.20                                    | 6                        |
| 38              | Wuhan                        | CN       | 8,839,629                    | 707                                      | 10,154  | 0.19                                    | 8                        |
| 39              | Nagoya                       | JP       | 8,964,894                    | 1,978                                    | 1,795   | 0.18                                    | 0                        |
| 40              | Paris                        | FR       | 11,217,166                   | 1,353                                    | 5,500   | 0.18                                    | 2                        |
| 41              | Vancouver, BC                | CA       | 1,920,504                    | 826                                      | 8,418   | 0.18                                    | 3                        |
| 42              | Frankfurt am Main            | DE       | 3,813,326                    | 1,419                                    | 4,875   | 0.18                                    | 3                        |
| 43              | Lyon                         | FR       | 1,874,163                    | 1,133                                    | 6,429   | 0.18                                    | -3                       |
| 44              | Denver, CO                   | US       | 3,072,747                    | 1,004                                    | 7,130   | 0.18                                    | 5                        |
| 45              | Sydney                       | AU       | 3,839,713                    | 661                                      | 8,775   | 0.17                                    | 3                        |
| 46              | Philadelphia, PA             | US       | 5,076,519                    | 1,062                                    | 6,364   | 0.17                                    | 4                        |
| 47              | Vienna                       | AT       | 2,406,439                    | 660                                      | 8,377   | 0.16                                    | 5                        |
| 48              | Houston, TX                  | US       | 6,128,063                    | 1,383                                    | 4,020   | 0.16                                    | -1                       |
| 49              | Berlin                       | DE       | 4,275,066                    | 848                                      | 7,126   | 0.16                                    | 2                        |
| 50              | Atlanta, GA                  | US       | 2,841,151                    | 649                                      | 8,289   | 0.16                                    | 3                        |

Appendix Table 4 Continued

| Rank per capita | Cluster name        | Economy | Estimated cluster population | PCT applications per capita <sup>a</sup> | Scientific publications per capita <sup>a</sup> | Total S&T share per capita <sup>a</sup> | Rank change <sup>b</sup> |
|-----------------|---------------------|---------|------------------------------|--|---|---|--------------------------|
| 51              | Austin, TX          | US      | 1,967,860                    | 1,179                                    | 5,039   | 0.16                                    | 3                        |
| 52              | Melbourne           | AU      | 4,529,662                    | 469                                      | 8,843   | 0.16                                    | 3                        |
| 53              | Amsterdam–Rotterdam | NL      | 6,953,571                    | 608                                      | 7,602   | 0.15                                    | 3                        |
| 54              | Montréal, QC        | CA      | 3,507,450                    | 637                                      | 7,244   | 0.15                                    | 3                        |
| 55              | Changchun           | CN      | 3,624,328                    | 104                                      | 10,294  | 0.15                                    | 5                        |
| 56              | Brussels–Antwerp    | BE      | 4,254,045                    | 724                                      | 6,502   | 0.14                                    | 2                        |
| 57              | Brisbane            | AU      | 2,049,367                    | 551                                      | 7,433   | 0.14                                    | 2                        |
| 58              | Milan               | IT      | 4,470,896                    | 577                                      | 6,951   | 0.14                                    | 4                        |
| 59              | Jinan               | CN      | 4,262,386                    | 384                                      | 8,049   | 0.14                                    | 8                        |
| 60              | Chengdu             | CN      | 7,789,484                    | 263                                      | 8,644   | 0.14                                    | 13                       |
| 61              | Rome                | IT      | 3,501,527                    | 274                                      | 8,465   | 0.14                                    | 3                        |
| 62              | Toronto, ON         | CA      | 4,493,449                    | 613                                      | 6,446   | 0.14                                    | 1                        |
| 63              | Hefei               | CN      | 5,429,701                    | 469                                      | 7,178   | 0.13                                    | 18                       |
| 64              | New York City, NY   | US      | 16,134,372                   | 858                                      | 4,639   | 0.13                                    | 1                        |
| 65              | Chicago, IL         | US      | 6,900,333                    | 835                                      | 4,687   | 0.13                                    | -4                       |
| 66              | Harbin              | CN      | 4,649,090                    | 54                                       | 9,244   | 0.13                                    | 6                        |
| 67              | Dalian              | CN      | 3,559,819                    | 306                                      | 7,735   | 0.13                                    | 8                        |
| 68              | Tehran              | IR      | 6,771,866                    | 37                                       | 9,320   | 0.13                                    | -2                       |
| 69              | Warsaw              | PL      | 2,547,547                    | 175                                      | 8,480   | 0.13                                    | 0                        |
| 70              | Lanzhou             | CN      | 2,761,553                    | 168                                      | 8,462   | 0.13                                    | 7                        |
| 71              | Tel Aviv–Jerusalem  | IL      | 7,215,450                    | 1,007                                    | 3,357   | 0.13                                    | -3                       |
| 72              | London              | GB      | 10,204,869                   | 586                                      | 5,788   | 0.12                                    | -2                       |
| 73              | Los Angeles, CA     | US      | 12,262,007                   | 942                                      | 3,593   | 0.12                                    | 1                        |
| 74              | Shanghai–Suzhou     | CN      | 39,290,672                   | 838                                      | 4,139   | 0.12                                    | 8                        |
| 75              | Hamburg             | DE      | 2,435,222                    | 725                                      | 4,714   | 0.12                                    | -4                       |
| 76              | Barcelona           | ES      | 5,060,158                    | 480                                      | 5,899   | 0.12                                    | 0                        |
| 77              | Singapore           | SG/MY   | 7,629,733                    | 637                                      | 4,824   | 0.12                                    | 1                        |
| 78              | Daegu               | KR      | 2,828,895                    | 650                                      | 4,617   | 0.11                                    | 2                        |
| 79              | Cologne             | DE      | 9,636,503                    | 775                                      | 3,558   | 0.11                                    | 0                        |
| 80              | Zhenjiang           | CN      | 3,107,637                    | 299                                      | 6,097   | 0.11                                    | n.a.                     |
| 81              | Xiamen              | CN      | 3,575,564                    | 545                                      | 4,510   | 0.10                                    | 6                        |
| 82              | Madrid              | ES      | 6,430,213                    | 246                                      | 6,042   | 0.10                                    | 2                        |
| 83              | Phoenix, AZ         | US      | 3,160,779                    | 748                                      | 2,864   | 0.10                                    | 0                        |
| 84              | Busan               | KR      | 4,108,717                    | 563                                      | 3,941   | 0.10                                    | 1                        |
| 85              | Tianjin             | CN      | 8,503,650                    | 149                                      | 6,313   | 0.10                                    | 3                        |
| 86              | Dallas, TX          | US      | 4,264,360                    | 811                                      | 2,367   | 0.10                                    | 0                        |
| 87              | Taipei–Hsinchu      | TW*     | 11,351,789                   | 344                                      | 4,647   | 0.09                                    | 2                        |
| 88              | Shenyang            | CN      | 5,926,243                    | 121                                      | 5,541   | 0.08                                    | 2                        |
| 89              | Fuzhou              | CN      | 3,788,203                    | 179                                      | 5,123   | 0.08                                    | n.a.                     |
| 90              | Chongqing           | CN      | 8,587,433                    | 192                                      | 4,822   | 0.08                                    | 1                        |
| 91              | Zhengzhou           | CN      | 5,355,743                    | 138                                      | 4,756   | 0.07                                    | 2                        |
| 92              | Wuxi                | CN      | 4,557,289                    | 463                                      | 2,393   | 0.07                                    | n.a.                     |
| 93              | Ankara              | TR      | 4,858,391                    | 152                                      | 4,180   | 0.07                                    | -1                       |
| 94              | Moscow              | RU      | 14,055,141                   | 145                                      | 3,919   | 0.06                                    | 0                        |
| 95              | Istanbul            | TR      | 12,694,255                   | 169                                      | 2,066   | 0.04                                    | 0                        |
| 96              | Bengaluru           | IN      | 14,805,929                   | 293                                      | 1,052   | 0.04                                    | 0                        |
| 97              | Chennai             | IN      | 10,687,599                   | 106                                      | 1,812   | 0.03                                    | 0                        |
| 98              | São Paulo           | BR      | 18,356,410                   | 42                                       | 1,406   | 0.02                                    | 0                        |
| 99              | Delhi               | IN      | 28,458,701                   | 39                                       | 1,070   | 0.02                                    | 0                        |
| 100             | Mumbai              | IN      | 21,112,341                   | 76                                       | 767   | 0.02                                    | 0                        |

Source: WIPO Statistics Database, May 2023.

Notes: <sup>a</sup> Per capita figures refer to 1,000,000 of population. <sup>b</sup> This column represents the previous year's rankings, which have been adjusted to align with the updated methodology. n.a. indicates not applicable. The codes given in the tables in this appendix are the ISO alpha-2 country codes, with the following addition: TW\* = Taiwan, Province of China.

## Appendix Table 5 Summary of geocoding results

| Country                      | Scientific publications |                                 |                          | PCT applications    |                                  |                                     |                                 |                          |
|------------------------------|-------------------------|---------------------------------|--------------------------|---------------------|----------------------------------|-------------------------------------|---------------------------------|--------------------------|
|                              | Number of addresses     | City-level address accuracy (%) | Publications covered (%) | Number of addresses | Block-level address accuracy (%) | Sub-city-level address accuracy (%) | City-level address accuracy (%) | Applications covered (%) |
| China                        | 5,709,166               | 99.0                            | 99.5                     | 899,931             | 83.0                             | 0.0                                 | 16.9                            | 99.8                     |
| United States                | 6,926,084               | 97.0                            | 98.3                     | 945,562             | 96.0                             | 3.7                                 | 0.2                             | 99.9                     |
| Japan                        | 1,292,914               | 92.2                            | 95.5                     | 621,999             | 32.9                             | 23.6                                | 41.4                            | 98.4                     |
| Germany                      | 1,512,886               | 97.6                            | 98.4                     | 272,949             | 97.3                             | 0.7                                 | 1.9                             | 99.9                     |
| Republic of Korea            | 858,760                 | 96.5                            | 98.1                     | 293,886             | 30.3                             | 0.6                                 | 69.0                            | 99.9                     |
| United Kingdom               | 1,541,130               | 96.9                            | 97.9                     | 87,833              | 54.8                             | 39.5                                | 5.4                             | 99.7                     |
| France                       | 1,137,986               | 93.3                            | 95.5                     | 107,561             | 92.6                             | 3.9                                 | 2.4                             | 99.1                     |
| Italy                        | 1,282,423               | 95.9                            | 97.3                     | 46,693              | 93.3                             | 4.8                                 | 1.6                             | 99.7                     |
| India                        | 899,463                 | 92.4                            | 95.0                     | 48,458              | 34.7                             | 53.3                                | 11.1                            | 99.4                     |
| Canada                       | 973,115                 | 98.3                            | 99.0                     | 47,255              | 96.9                             | 2.8                                 | 0.3                             | 99.8                     |
| Spain                        | 972,255                 | 97.5                            | 98.6                     | 27,806              | 85.2                             | 11.3                                | 2.8                             | 99.7                     |
| Netherlands (Kingdom of the) | 549,403                 | 97.5                            | 98.6                     | 50,507              | 85.1                             | 0.3                                 | 14.0                            | 99.4                     |
| Brazil                       | 742,852                 | 98.5                            | 99.6                     | 10,818              | 89.3                             | 9.3                                 | 1.1                             | 99.7                     |
| Australia                    | 941,612                 | 86.2                            | 90.4                     | 21,683              | 91.1                             | 5.2                                 | 3.4                             | 99.8                     |
| Switzerland                  | 368,966                 | 90.8                            | 92.5                     | 43,048              | 92.2                             | 1.3                                 | 6.2                             | 99.7                     |
| Russian Federation           | 430,319                 | 99.0                            | 99.2                     | 16,506              | 94.3                             | 3.9                                 | 1.4                             | 99.7                     |
| Sweden                       | 324,003                 | 98.0                            | 98.4                     | 46,067              | 94.9                             | 0.7                                 | 4.0                             | 99.6                     |
| Türkiye                      | 423,747                 | 96.5                            | 96.6                     | 17,814              | 59.6                             | 27.8                                | 10.9                            | 98.8                     |
| Israel                       | 176,686                 | 92.5                            | 96.8                     | 32,813              | 70.7                             | 4.1                                 | 18.6                            | 96.2                     |
| Belgium                      | 270,683                 | 95.6                            | 97.2                     | 19,179              | 98.2                             | 0.9                                 | 0.7                             | 99.8                     |
| <b>World Total</b>           | <b>25,138,682</b>       | <b>95.7</b>                     | <b>98.6</b>              | <b>3,932,217</b>    | <b>73.2</b>                      | <b>7.0</b>                          | <b>17.4</b>                     | <b>97.8</b>              |

Source: WIPO Statistics Database, May 2023.

Note: This list includes the top 20 countries that account for and ordered by the highest combined shares of patents and scientific articles. PCT inventor addresses were geocoded to the highest level of detail. Due to their much larger volume, scientific author addresses were geocoded to the city level only.

## Notes

- 1 In previous editions, PCT publications years were aligned with SCIE publication years, as SCIE data is available with a one-year lag. This year we decided to change to “most recently available data” in order to more accurately reflect the most recent innovation.
- 2 ESRI ArcGIS World Geocoder service: [www.esri.com/en-us/arcgis/products/arcgis-world-geocoder](http://www.esri.com/en-us/arcgis/products/arcgis-world-geocoder).
- 3 GeoNames: <http://geonames.org>.
- 4 The mergers involved the following clusters: Aurora with Chicago; Baltimore with Washington DC; Boulder with Denver; Cheonan-si with Seoul; Irvine with Los Angeles; Jerusalem with Tel Aviv; Matsudo with Tokyo-Yokohama; Rotterdam with Amsterdam; Suzhou with Shanghai; Wilmington with Philadelphia; Worcester with Boston-Cambridge, MA.
- 5 See Schiavina *et al.* (2023).
- 6 See Bergquist and Fink (2020: 61–63) for a more detailed description of how population data were matched to clusters.

## References

Bergquist, K. and C. Fink (2000). The top 100 science and technology clusters. In Dutta, S., B. Lanvin and S. Wunsch-Vincent (eds), *The Global Innovation Index 2000: Who Will Finance Innovation?* Ithaca, NY, Fontainebleau and Geneva: Cornell University, INSEAD and World Intellectual Property Organization. Available at: [www.wipo.int/edocs/pubdocs/en/wipo\\_pub\\_gii\\_2020.pdf](http://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf).

Schiavina M., S. Freire, A. Carioli and K. MacManus (2023). GHS-POP R2023A – GHS population grid multitemporal (1975–2030). Brussels: European Commission, Joint Research Centre (JRC). Available at: <http://data.europa.eu/89h/2ff68a52-5b5b-4a22-8f40-c41da8332cfe>.

The *Global Innovation Index 2023* (GII) takes the pulse of innovation against a background of an economic and geopolitical environment fraught with uncertainty.

Tracking the most recent global innovation trends, the GII finds that – despite a climate of disquiet and a decline in risk capital investment – opportunities abound as a result of the incipient *Digital Age* and *Deep Science* innovation waves.

At its core, the GII 2023 reveals who is leading in global innovation, ranking the innovation performance of 132 economies and highlighting their strengths and weaknesses. In addition, it identifies the world's top 100 science and technology clusters.

The GII is a “tool for action” regarding innovation policy. Governments around the world have used the GII to benchmark innovation performance, perfect innovation metrics and, ultimately, to shape evidence-based innovation policymaking.

In the context of the United Nations Sustainable Development Goals (SDGs), since 2019, the GII has been recognized by the United Nations General Assembly to be a benchmark for measuring innovation, including more recently in a post-pandemic environment.

The full report can be downloaded at [www.wipo.int/global\\_innovation\\_index](http://www.wipo.int/global_innovation_index).

The 132 interactive GII economy briefs can be accessed at [www.wipo.int/gii-ranking](http://www.wipo.int/gii-ranking).