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## Data Article

# Pillars of the Global Innovation Index by income level of economies: longitudinal data (2011–2022) for researchers' use

Gonçalo Rodrigues Brás

IN+, LARSyS, Center for Innovation, Technology and Policy Research, 'Instituto Superior Técnico', 'Universidade de Lisboa', Lisbon, Portugal

Centre for Business and Economics Research (CeBER), Faculty of Economics, University of Coimbra, Coimbra, Portugal

ISLA - Instituto Superior de Gestão e Administração de Santarém, Santarém, Portugal

DEGEIT, University of Aveiro, Aveiro, Portugal

DINÂMIA'CET-Iscte, Centre for Socioeconomic and Territorial Studies, Lisbon, Portugal

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## ABSTRACT

It is widely known that the Global Innovation Index reports are of unique value for research purposes. The aim of this work is to provide a panel data file with all pillars of the Global Innovation Index from 2011 until 2022, covering all available economies (149 in total) by income level. After the secondary data was gathered, it was reshaped in an exhaustive process that involved directly importing it from databases or manual insertion. Based on successive Global Innovation Index reports and World Bank data, this work attempts to provide a whole set of data on the incomes of world economies by using Gross Domestic Product per capita based on purchasing power parity (constant 2017 international \$ and current international \$) and Gross National Income per capita in current U.S. dollars (Atlas method). A descriptive analysis is also provided of data and inferences drawn based on the income differences between economies. The data compilation shared here has a singular relevance as it makes a large amount of structured information easier to access. Moreover, data from subsequent years or even from new entries of economies in the Global Innovation Index reports could be added to the data file. As a practical implica-

E-mail address: [goncalo.bras@tecnico.ulisboa.pt](mailto:goncalo.bras@tecnico.ulisboa.pt)

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tion, this work should be considered a reliable tool for quantitative research directly or indirectly related with innovation topics (policies, ecosystems, technologies, programmes, among others), as it reduces the time-consuming process of gathering data.

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## 1 Specifications table

Subject	Business, Management and decision sciences/Management of Technology and Innovation
Specific subject area	The panel data describes the pillars of Global Innovation Index by economic income level from 2011 until 2022
Type of data	Tables and Figures
How the data were acquired	Secondary data were automatically imported from an excel file provided by the Global Innovation Index (GII) (2013-2022) and the remaining secondary data were manually inserted based on GI reports (2011-2012). The income of the world's economies from 2011 to 2021 (last year available) was obtained through the World Bank database.
Data format	Raw and Analysed
Description of data collection	Data were reshaped from wide to long Panel data. Excel commands were helpful, but several manual insertions were required in the excel data files to harmonise the names of the economies. Additionally, differences were identified between the excel data files downloaded from the World Intellectual Property Organization website and the GI reports. More specifically, in 2015 and 2016 some economies presented values in the excel data file that were not included in the final GI reports. In order to meet criteria for the inclusion vs. exclusion of economies from the report, only the economies presented in GI reports were maintained.
Data source location	Global Innovation Index:World Intellectual Property OrganizationCity: GenevaCountry: SwitzerlandURL: <a href="https://www.globalinnovationindex.org/analysis-indicator">https://www.globalinnovationindex.org/analysis-indicator</a> Income World Bank City: Washington, D.C. Country: United States URLs: <a href="https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD">https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD</a> <a href="https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD">https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD</a> <a href="https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD">https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD</a>
Data accessibility	Repository name: Mendeley Data Data identification number: 10.17632/cvkdzr8tv3.4. Direct URL to data: <a href="https://data.mendeley.com/datasets/cvkdzr8tv3/4">https://data.mendeley.com/datasets/cvkdzr8tv3/4</a>

## 2 Value of the data

- The different dimensions of innovation are now emergent hot topics and researchers have used Global Innovation Index reports as a reliable source for their studies. However, shaping a panel data file to structure information is a time-consuming process, particularly a panel data model covering several years.
- These data are useful because just one excel file brings together very harmonised data on the seven GI pillars (scores/values and rank-ordered) by income, covering all the available economies.
- These data are particularly relevant for researchers directly or indirectly interested in developing quantitative studies about innovation, national innovation systems, innovation ecosystems, innovation policies or innovation technology topics. Such data can obviously be combined with data from other research topics, particularly for quantitative studies. This work aims to act as a starting point to leverage research on innovation and related topics by offering a panel database and therefore bypassing the time-consuming process of initial data collection.

17 • The panel data are ready for other researchers to use in studies directly or indirectly re-  
18 lated with innovation topics. Unlike the successive reports and databases from different  
19 years of the GII, the nomenclature of the economies has now been uniformised into a  
20 single file from 2011 until 2022.

## 21 1. Objective

22 It is known that successive GII reports have been used for research purposes, particularly  
23 in domains such as innovation, national innovation systems, innovation ecosystems, innovation  
24 policies or innovation technology. The first edition of the GII report was in 2007 and the data has  
25 since been publicly available. The data has been subjected to a number of technical and method-  
26 ological changes over the years, adapting its metrics to the evolution of innovation ecosystems  
27 and following some trends in innovation domains. Despite these changes, since 2011 there has  
28 been a clear attempt to stabilise the metrics over time and only minor year on year changes  
29 have been made. However, there are no known database containing the compilation of GII pil-  
30 lars (scores/values and rank-ordered), at least for the purposes of comparing year on year data  
31 (from 2011). This work strives to address this gap by providing a panel data file with all GII  
32 pillars from 2011 until 2022 for researchers seeking data on GII scores/values or the economies'  
33 GII' rankings.

## 34 2. Data description

35 The analysis was conducted using the panel framework for the period 2011 to 2022 with the  
36 seven GII pillars covering 149 economies by income – Gross National Income (GNI) per capita in  
37 current U.S. dollars, Gross Domestic Product (GDP) per capita based on purchasing power parity  
38 (constant 2017 international \$) and GDP per capita based on purchasing power parity (current  
39 international \$). In addition to the overall value of GII, the seven GII pillars are: institutions  
40 (I), human capital and research (HC&R), infrastructure (Inf), market sophistication (MS), busi-  
41 ness sophistication (BS), knowledge and technology outputs (K&TO), and creative outputs (CO).  
42 All of them are typical index variables, ranging from 0 to 100 and ranked from 1 (highest per-  
43 formance) to N economies (lowest performance), depending on the economies covered in each  
44 year. Considering only these score variables from the GII for the referred period and economies,  
45 unbalanced panel data were obtained with 1597 complete observations for each group variable.  
46 Some descriptive statistics are available in [Table 1](#).

47 Briefly summarising the measures of central tendency and variability presented in [Table 1](#),  
48 the mean and median measures of the variable 'Institutions' (I) present far higher values in re-  
49 lation to other variables; it also presents greater variability in comparison to other variables with  
50 a standard deviation of 16.042. Regarding univariate normality, based on kurtosis and skewness  
51 criteria defended by Huck [1] in which normality may be indicated up to the absolute value of  
52 1, [Table 1](#) suggests the absence of severe deviations from normality in data-generating process.  
53 [Fig. 1](#) shows the mean values (averages) of all variables between 2011–2022.

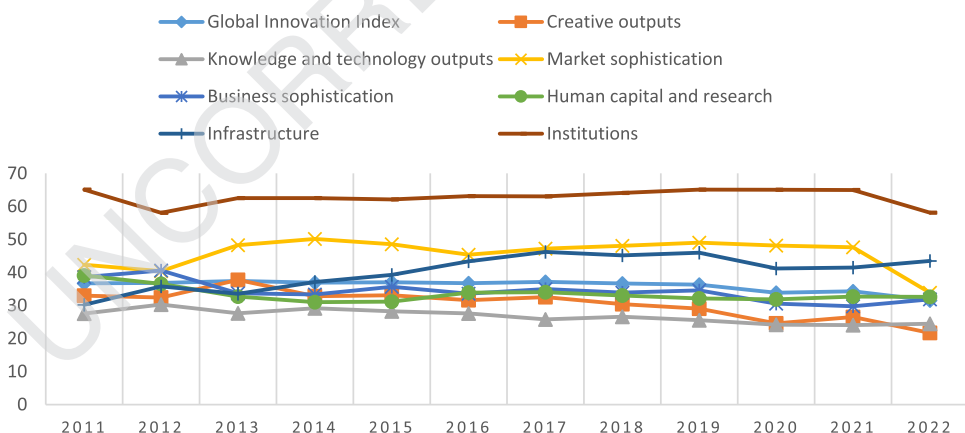
54 The mean values of all variables except 'market sophistication' and 'infrastructure' remain  
55 very stable between 2011 and 2021. Nevertheless, [Fig. 1](#) also shows a steady decline in some  
56 variables in the same period, namely: 'knowledge and technology outputs', 'business sophisti-  
57 cation', 'creative outputs', 'human and capital research', and 'global innovation index'. Overall,  
58 despite the reduced volatility in all GII pillars between 2011 and 2022, special note goes to the  
59 sharp decrease in the 'institutions' and 'market sophistication' pillars between 2021 and 2022. In  
60 fact, this significant decrease can be explained by methodological differences in these two pil-  
61 lars in the 2021 and 2022 GII editions. Turning our focus to the main innovation variable, [Fig. 2](#)  
62 shows the distribution of GII by year.

63 [Fig. 2](#) shows that between 2011 and 2019 the central tendency indicators of GII (median  
64 and mean values) remain stable followed by a slight downward trend. Regarding the dispersion

**Table 1**

Main descriptive statistics (score variables from GII pillars)

Variable	Mean	Median	Minimum	Maximum
<i>I</i>	62.745	61.100	15.400	95.900
<i>HC&amp;R</i>	33.354	31.400	0.70000	74.700
<i>Inf</i>	40.124	39.500	6.2000	69.900
<i>MS</i>	45.775	44.900	4.4000	88.600
<i>BS</i>	34.272	31.800	8.6000	79.100
<i>K&amp;TO</i>	26.806	23.900	1.6000	74.900
<i>CO</i>	30.529	29.400	0.30000	73.700
<i>GII (overall)</i>	35.963	33.600	11.600	68.400
Variable	Std. Dev.	C.V.	Skewness	Ex. Kurtosis
<i>I</i>	16.042	0.25567	0.13247	-0.62350
<i>HC&amp;R</i>	15.105	0.45286	0.36922	-0.71777
<i>Inf</i>	13.617	0.33938	0.11777	-0.97227
<i>MS</i>	12.827	0.28022	0.33207	0.58611
<i>BS</i>	12.564	0.36659	0.68020	-0.14120
<i>K&amp;TO</i>	13.649	0.50918	0.80723	0.15657
<i>CO</i>	13.774	0.45118	0.22578	-0.35896
<i>GII (overall)</i>	12.068	0.33556	0.57835	-0.52049
Variable	5% Perc.	95% Perc.	IQ range	Missing obs.
<i>I</i>	39.000	90.420	23.850	191
<i>HC&amp;R</i>	11.700	60.810	22.750	191
<i>Inf</i>	19.490	62.610	22.450	191
<i>MS</i>	26.090	68.410	15.300	191
<i>BS</i>	17.600	58.110	17.150	191
<i>K&amp;TO</i>	8.9000	54.810	17.650	191
<i>CO</i>	8.5900	54.000	19.750	191
<i>GII (overall)</i>	19.799	58.510	16.450	191

**Fig. 1.** Evolution of GII and GII pillars (mean values by year)

65 domain, we can see that 2013, 2014, and 2015 exhibit much more homogenous values than the  
 66 remaining years, where the dispersion is more visible (particularly a right-skewed distribution  
 67 corresponding to a longer upper tail).

68 Despite some limitations for country comparisons over time, Gross National Income per  
 69 capita in current U.S. dollars (Atlas method) is useful as the World Bank (WB) defines different  
 70 thresholds by year classifying economies into four groups: low-income (1), lower middle-income  
 71 (2), upper middle-income (3), high-income (4). These thresholds are not invariant in time and

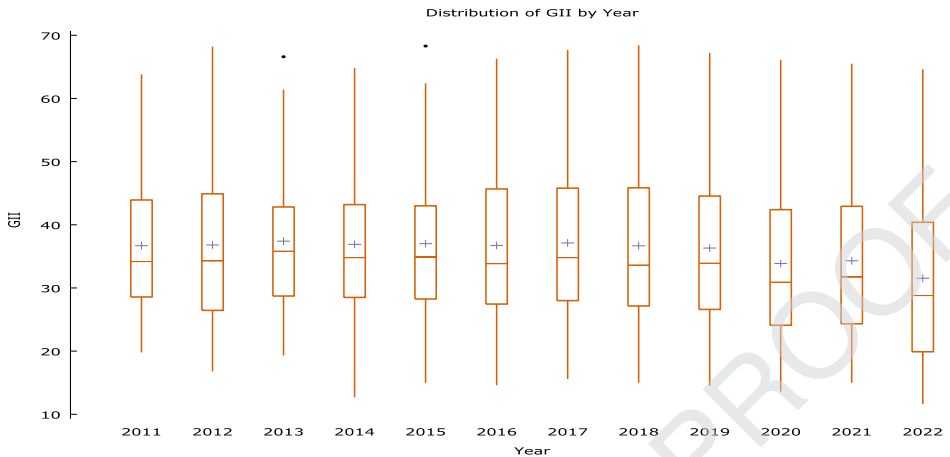


Fig. 2. Distribution of GII (2011-2022) by quartiles and mean values

— Low-income economies      — Lower middle-income economies  
— Upper middle-income economies      — High-income economies

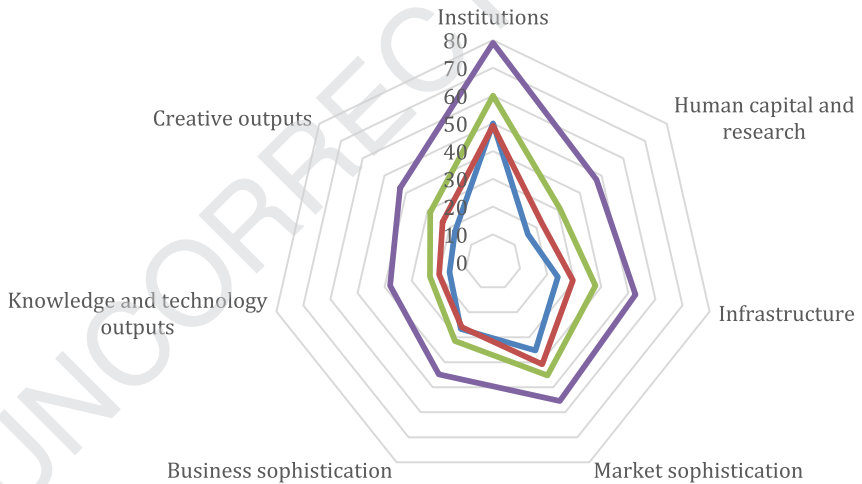


Fig. 3. Average values of GII pillars (2011-2021) per income level

72 also present income level per economy and year in the panel database; the thresholds are also  
 73 presented in a separate spreadsheet. Hence, Fig. 3 is based on the mean values (averages) for  
 74 the seven GII pillars between 2011 and 2021 grouped by income level of economies.

75 Considering the mean values (averages), Fig. 3 shows that high-income economies clearly  
 76 outperform the other groups of economies in each GII pillar. It also seems clear that low-income  
 77 economies and lower middle-income economies present similar mean values (averages) for all  
 78 the GII pillars.

79 In addition to the score for each economy, the GII also report ranks economies and thus  
 80 indicates the performance of innovation systems from best to worst. The GII economies' rankings  
 81 can also be analysed by income and a description given of some generic patterns or trends in

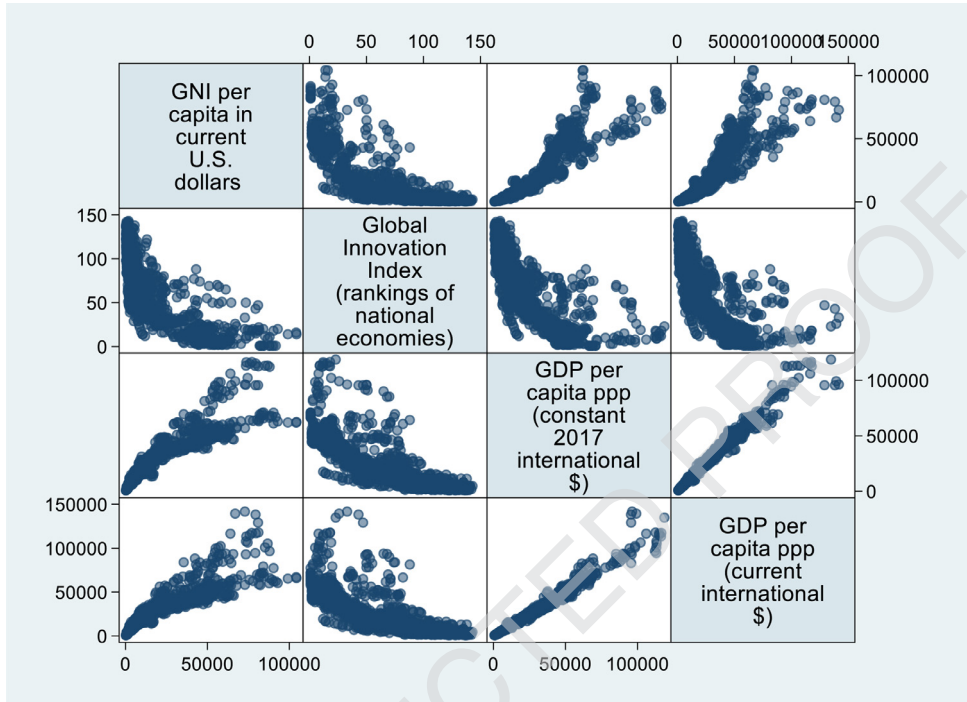


Fig. 4. Distribution of ranked economies in GII per income

82 the income measure published by the WB – 2021 was the last available year. Thereafter, when  
 83 GII rankings are crossed with the income level of economies, the number of observations goes  
 84 down to 1462 between 2011 and 2021. As the income level of economies is only available until  
 85 2021 and Iraq and Mauritania were introduced in the 2022 GII edition, the number of economies  
 86 falls to 147. Fig. 4 describes the distribution of ranked national economies in GII by income (per  
 87 capita).

88 Fig. 4 clearly shows that higher-income economies (per capita) are more likely to achieve the  
 89 top positions of GII than the lower-income economies (per capita) between 2011 and 2021.

### 90 3. Experimental design, materials and methods

#### 91 3.1. Secondary data reliability

92 The ‘World Intellectual Property Organization’ (WIPO) now publishes the GII report in part-  
 93 nership with the Portulans Institute, with corporate and academic partners and in collaboration  
 94 with the GII Advisory Board. However, the GII project started with Professor Soumitra Dutta and  
 95 the first edition brought INSEAD together with a British magazine called World Business back  
 96 in 2007. INSEAD has continued to be part of subsequent editions with several partnerships, the  
 97 most notable of which is the Confederation of Indian Industry; the WIPO’s first support of the  
 98 project in 2011 is also noteworthy. The 2012 GII report was published by INSEAD and WIPO,  
 99 and Cornell University joined this partnership to publish editions from 2013 to 2020. Studies on  
 100 national innovation systems are frequently supported by GII reports [2–5].

101 The International Bank for Reconstruction and Development, also known as WB, was founded  
 102 in 1944 and has proved a reliable and reputable source for a wide range of studies across the

103 globe. When GDP per capita based on constant and current PPPs is sourced from the WB, it  
104 favours year and country comparisons and is therefore used in various longitudinal studies with  
105 panel data models [6–8]; on the other hand, GNI per capita in current U.S. dollars using the  
106 Atlas method is often chosen as a measure to define the income level of economies and applied  
107 to a range of scientific areas [9–13].

### 108 3.2. Institutional methods and data comparability

109 Irrespective of the institutions that have contributed to the different GII reports over time,  
110 particularly since 2011, there has been a clear effort to harmonise the data gathered and to  
111 standardise methodology. For instance, there are few differences between the seven pillars of  
112 the 2011 edition (80 indicators) and the most recent edition (81 indicators in 2022). Although  
113 the designation of the sixth pillar changed from 2011 to 2022, the factors did not. Fig. 5 depicts  
114 the GII pillars and their corresponding factors by comparing 2011 and 2022.

115 On the one hand, it is true that the methods used for gathering some indicators may vary  
116 slightly from year to year, that some indicators measuring the same factor changed, and even  
117 that some new factors appeared (for instance, the introduction of the ecological sustainability  
118 factor in the ‘infrastructure’ pillar) while others were removed. However, the main structure of  
119 factors has remained almost unchanged since 2011. Therefore, the scores/values from 2011 to  
120 2022 tend to be comparable and, despite slight differences year on year, each GII report contin-  
121 ues to be an admirable effort to capture the innovation ecosystem performance and to track the  
122 global innovation trends.

123 On the other hand, it is not possible to confirm there is no common method bias despite  
124 the fact that data collection was obtained from the same economies, in the same measurement  
125 context, using the same factor context and similar factor characteristics. Hence, a panel data set  
126 using ordinal (rank-ordered) scores per year is also provided as a normalisation process that  
127 eliminates all potential invariance issues from the GII scores/values.

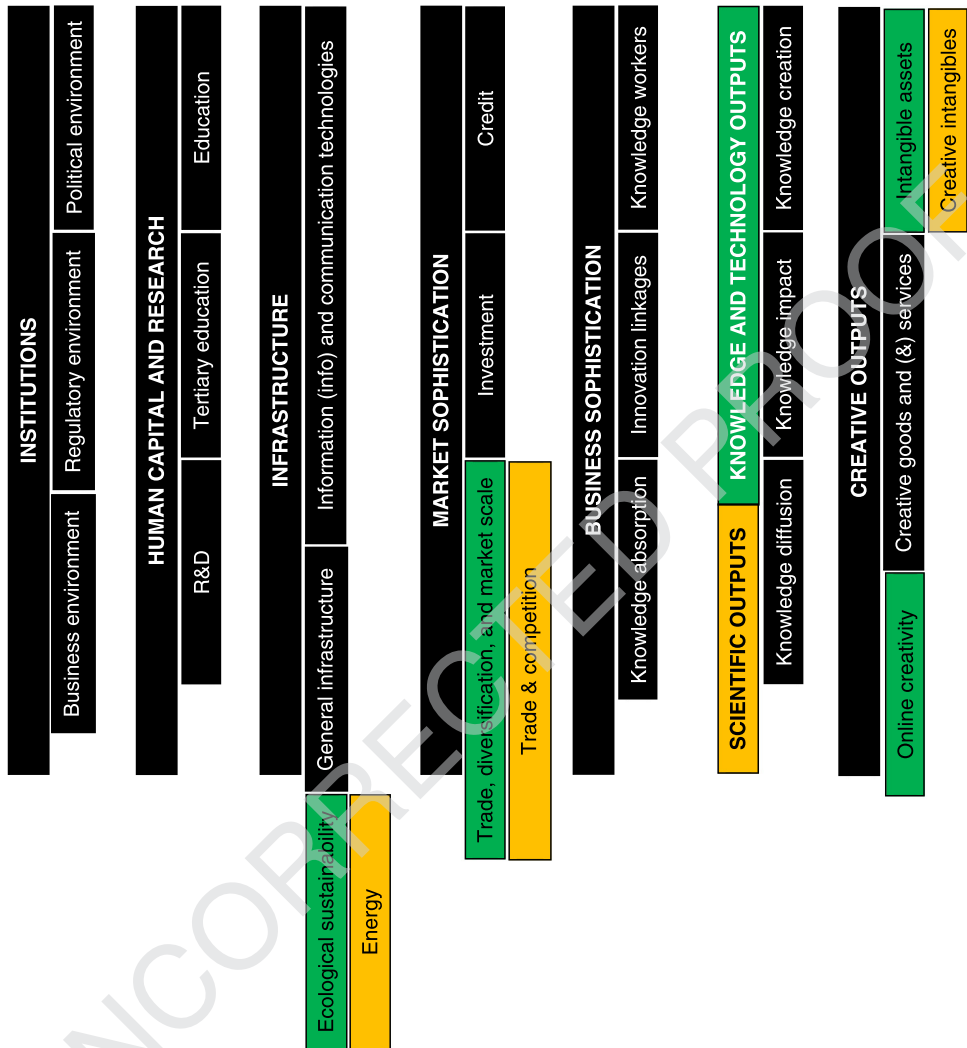
128 Lastly, whether by constant or current international \$, GDP per capita based on purchasing  
129 power parity (PPP) is a widely used measure for country comparisons over time. GNI per capita  
130 in current U.S. dollars using the Atlas method has the advantage of defining income groups but  
131 is limited for country comparisons over time. The three income measures were collected from  
132 the WB database.

### 133 3.3. Data collection

134 The data for each edition were collected from the GII excel files available from 2013 to 2022  
135 using the World Intellectual Property Organization website [14]. The data from 2011 and 2012  
136 were based on GII reports [15,16] and introduced manually. Excel commands helped merge all  
137 these data into one single file shaped into a panel data file in long format. This was a time-  
138 consuming process because some economies had been given different designations<sup>1</sup> in the excel  
139 files and the names of others changed<sup>2</sup>. Moreover, some economies were not included in the GII  
140 reports despite having values in excel data files (particularly in 2015 and 2016). Despite under-  
141 standing the criteria for the inclusion vs exclusion of economies from the GII reports, the excel  
142 files imported for 2015 and 2016 had to be corrected – please see economies dropped from  
143 analysis for these years in the worksheet entitled ‘incomplete data - removed’; these economies

<sup>1</sup> Examples include ‘Cabo Verde’ and ‘Cape Verde’, ‘United Republic of Tanzania (the)’ and ‘Tanzania, United Republic of’, ‘Venezuela, Bolivarian Republic of’ and ‘Venezuela, Bolivarian Rep.’ or ‘Hong Kong (China)’ and ‘Hong Kong, China’ and ‘Hong Kong’ among many others.

<sup>2</sup> The Former Yugoslav Republic (FYR) of Macedonia until 2018 and thereafter North Macedonia; Swaziland until 2016 and thereafter Eswatini.



Notes:  Common pillars/factors between 2011 and 2022;  Pillars/factors in 2022

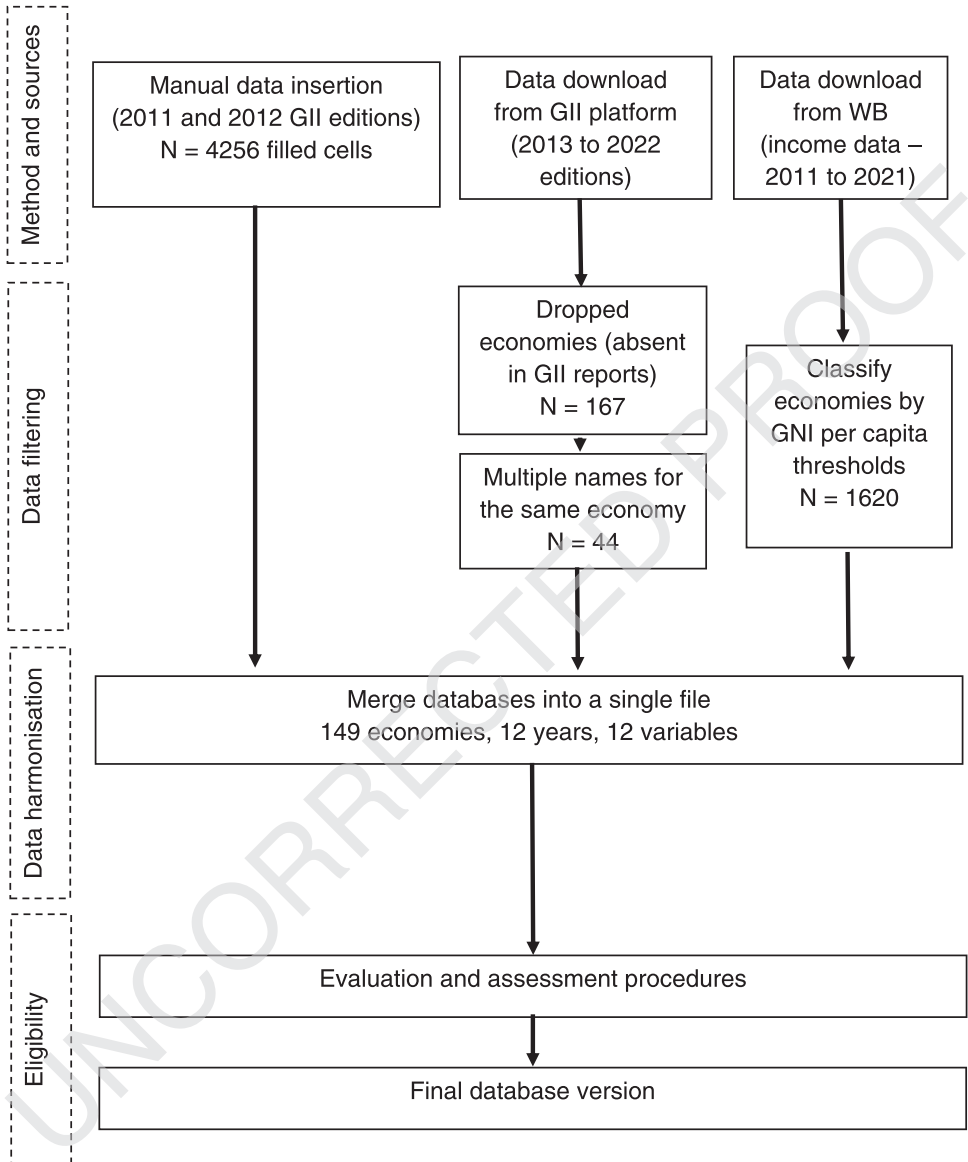
Pillars/factors in 2011

Fig. 5. GII pillars and factors (2011 and 2022)

144 were not included in the analysis (2011-2022) as they only have repeated values for 2015 and  
 145 2016 and incomplete data. After these procedures, only economies presented annually in GII re-  
 146 ports were considered in this analysis. The income data were imported directly from the WB  
 147 database. The GNI thresholds in each year were considered and the values were retained by  
 148 country over different years in order to cluster economies by income.

149 Evaluation and assessment procedures give consistency through comparisons between the  
 150 data downloaded and GII reports where a gap was found, i.e., although Morocco did not show  
 151 any rank-ordered score in the download file, it was present in the 2014 GII report. At this stage,  
 152 several data controls were performed through random sampling and amendments made using  
 153 some Excel commands to reach a final panel database [17]. Finally, Stata 16 software and Excel





**Fig. 6.** Information flow diagram of the data collection

154 were used for some of the data description in the previous main point. Fig. 6 summarises the  
 155 data collection.

## 156 Ethics statements

157 Since this dataset is used for scientific purposes and only contains public information from  
 158 Global Innovation Index (2011–2022), it meets all terms and conditions required from the men-  
 159 tioned institution.

160 **CRediT Author Statement**

161 **Gonçalo Rodrigues Brás:** Conceptualization, Data curation, Methodology, Writing-Reviewing  
162 and Editing.

163 **Declaration of Competing Interest**

164 The authors declare that they have no known competing financial interests or personal rela-  
165 tionships that could have appeared to influence the work reported in this paper.

166 The authors declare the following financial interests/personal relationships which may be  
167 considered as potential competing interests:

168 **Data Availability**

169 **Global Innovation Index: panel data (2011-2022) (Original data)** (Mendeley Data)

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