

Experiment Summary: Country Innovation Index Analysis

Research questions

Right from the outset our main point of emphasis was to gain insights with regard to the following research questions:

What common drivers behind countries improving or deteriorating substantially with regard to their innovation levels may be identified?

In what manner are the innovation indices as well as their underlying drivers correlated?

Are innovation indices published by an official EU organization biased in a way that they rather favor European countries?

Data Source:

Main Source: Global Innovation Index (GII): 2013 - 2021

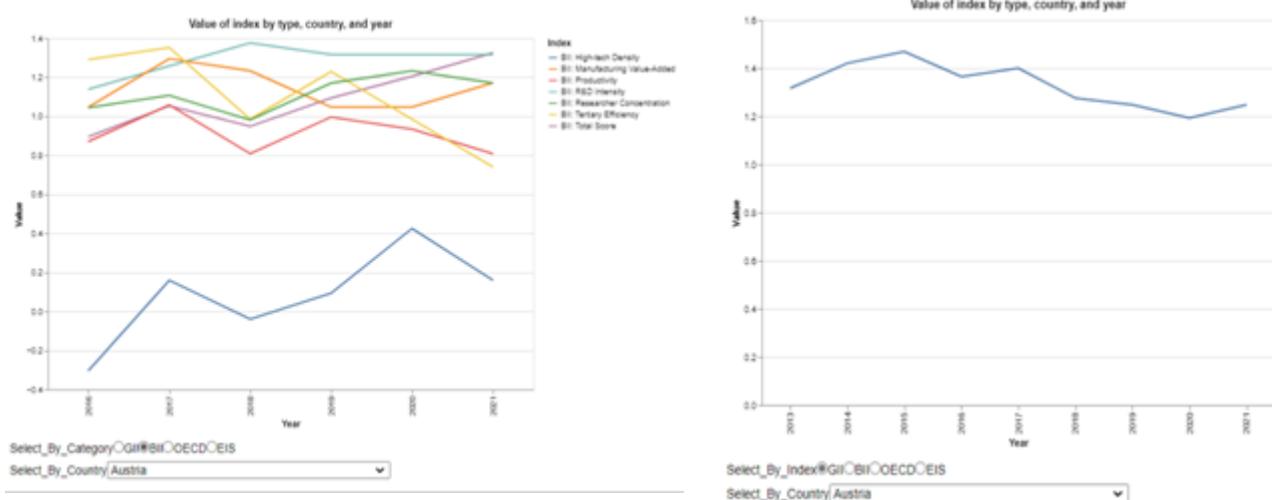
Alternative Sources for comparison:

- Bloomberg Innovation Index (BII): 2016 - 2021
- European Innovation Scoreboard (EIS): 2014 - 2021
- OECD Business Innovation Statistics: 2013 - 2019

Approach of analysis

For the sake of finding appropriate answers to the initial research questions as posted above, our main starting point was to analyze the **Global Innovation Index (GII)** data representing one of the most relevant publications in that context worldwide. Additionally, alternative sources of indices measuring the innovation factors for countries around the globe were considered, in particular the Bloomberg Innovation Index (BII), European Innovation Scoreboard (EIS) as well as the OECD Business innovation statistics data.

Exploratory Data Analysis



Data Pre-Processing

All datasets are initially standardized for consistency with regard to data types, indexes, naming conventions as well as column groups before merging them altogether and scoring them appropriately for coherent querying later on. Thereby, no further action is required.

was undertaken regarding missing values due to the fact that only particularly relevant countries and indices were considered later on.

- Obtaining an initial overview for all data sets considered
- Implementing common standards for consistency regarding naming conventions, data types, indices and column groups
- Merging all data with straightforward multi-index format for simple querying
- Other Pre-Processing steps:
 - NaN values: No further action as just the relevant and available rows & columns are considered
 - Outliers not present
- Applying a z-score standardization and transformation of ranks for better comparability of factors

Data Analysis

- Correlations between the indices

Correlating all sub-factors to the main indices we compared (GII, BII, EIS) gives us a better understanding on what drives innovation. Overall, *human capital* and *research and development* seem to be the most important factors. The factors from the OECD business innovation data set have very little importance on the overall innovation score of the other indices indicating that self reported “innovativeness” on a business level has no effect on the actual performance of a country. *Political stability* and the *quality of institutions* and *infrastructure* are also very important factors. The ease of getting credit was even negatively correlated to the GII. Education, maybe unintuitively, seems to play a minor role in the innovativeness of a country.

- Analysis of Top 10 Innovation Leaders and Laggards

Based on the real long-term changes for individual countries between 2021 and 2013 normalized for overall mean changes in the underlying indicators and z-score standardized for better comparability, the Top 10 countries having either improved or deteriorated remarkably in these Innovation indices can be identified as Innovation “Leaders” and “Laggards” respectively. Concrete examples for the first group are particularly China, South Korea and Iran whereas Uganda, Lebanon, Kuwait, Qatar and Saudi Arabia - for instance - belong to the latter cluster.

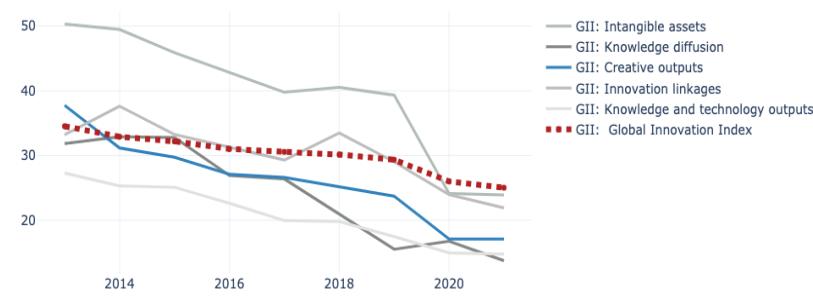
Key Factors improving for Top 10 Innovation Leaders



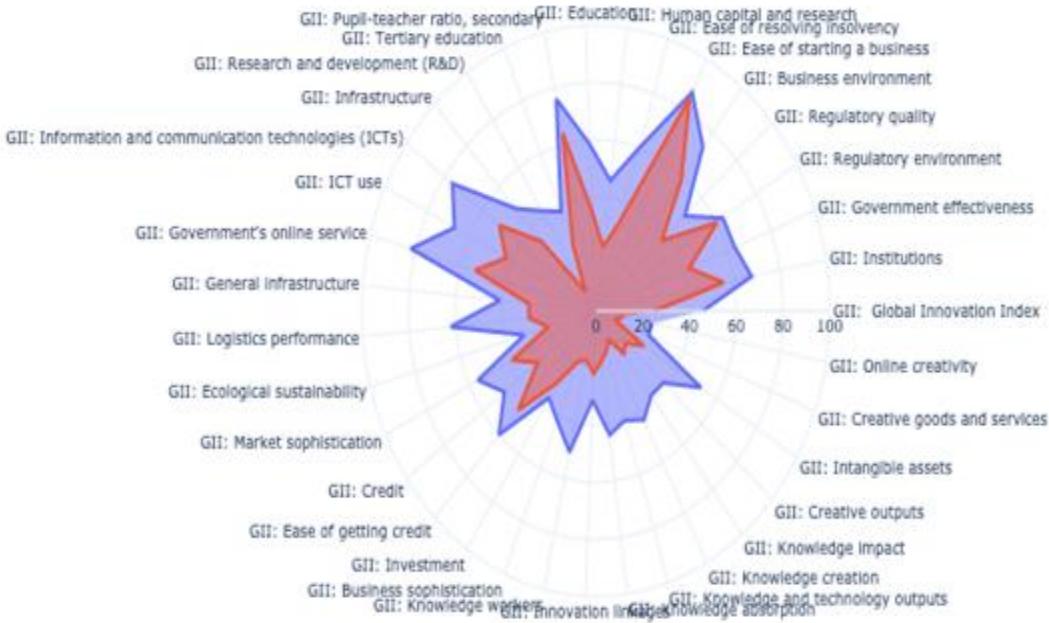
Thereby, for the so-called Innovation Leaders, compared to the mean development, especially intangible assets, knowledge absorption, creative outputs as well as knowledge diffusion appear to have - on average - particularly contributed to the rise in innovation levels for these countries. Essentially, all of these factors relate to the general concept of knowledge generation and retention which appears to have a strong impact on propelling innovation. However, interestingly, these countries also tend to underperform within the checked time frame regarding investment, ecological sustainability, ease of getting credit and starting a business as well as knowledge impact.

In contrast, the most notable key factors contributing to the over-proportion decline in scores for the Innovation Laggards group include intangible assets, knowledge diffusion and creative outputs, all of which were previously identified - in reverse - as core strengths for the Leaders. Likewise, the Innovation Laggards tend to outperform the other countries in general with regard to improvements in ecological sustainability, ease of starting a business, credit, government effectiveness and environmental performance, whereby the Leaders - in turn - fared rather poorly in these categories.

Key Factors deteriorating for Bottom 10 Innovation Laggards



- Radar Plot for Average Innovation Leaders and Laggards



- Bias regarding EU and Non-EU member states

Due to the fact that many different parameters weigh in on the innovativeness of a country with multiple institutions assigning diverging importances to these factors, we have decided to check in further detail how the GII, BII and EIS indices view the EU member states and whether some sort of favorable or even adverse bias maybe present. Specifically, two comparisons were made in that context, namely between the GII and the EIS as well as between GII and BII. Hence, the overall score value of the index was used for the comparison whereby a z-score standardization approach was previously considered.

European Innovation Scoreboard

In this context, exclusively countries from the EIS were considered which, for the year 2021, include 27 EU and 21 non-EU countries. Thereby, the resulting mean scores for EU countries were 0.10 on the GII and 0.12 on the EIS while non-EU countries achieved values of -0.13 and -0.18 for the GII and EIS respectively. Hence, the consequential delta (-0.04 for non-EU countries and 0.03 for EU countries) between the groups might provide an indicator for bias in the EIS. However, the absolute difference of 0.07 standard deviations is almost insignificantly small.

Still, member states of the EU tend to have a comparatively better score on the EIS than on the GII while non-EU members achieve relatively poor results.

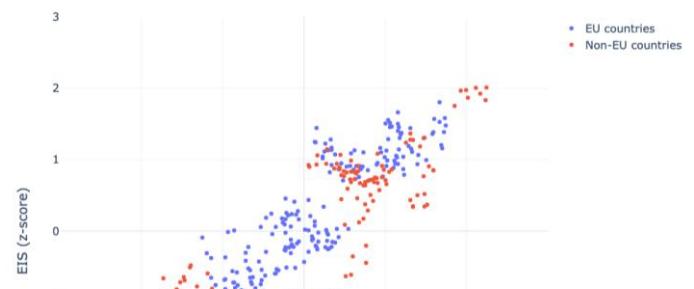
Bloomberg Innovation Index

Within this analysis, only countries ranked by Bloomberg in the year 2021 were considered which represent 27 EU and 32 non-EU countries. As a result, mean scores regarding EU countries of 0.18 for the GII and 0.14 for the BII were achieved while non-EU countries attained equivalent parameters of -0.17 and -0.13 for the BII respectively. Hence, similarly to the EIS comparison, the difference of 0.08 standard deviations is almost unrecognizable. Nonetheless, one may discern that EU member states have a comparatively worse score on the BII than on the GII while non-EU countries achieved rather better values in that context.

Conclusion and key insights

In a nutshell, responding to the research questions posed at the outset of our analysis, the following key takeaways and insights could be established based on the data sets and innovation indices under scrutiny:

Analyzing bias for EU countries versus Global Innovation Index



Analyzing bias for EU countries versus Bloomberg (BII)



- When computing correlation scores for all individual indices and underlying factors considered, particularly the parameters for human capital, R&D, political stability and infrastructure exhibited the strongest positive relationship to the Global Innovation Index score whereas ease of getting credit even appears to negatively impact the GII.
- Based on normalized long-term developments, so-called Innovation Leaders as well as Laggards could be identified which either improved or deteriorated remarkably in the considered time frame. Thereby, changes in key drivers such as intangible assets, creative outputs and knowledge diffusion appeared to play a particularly substantial role in both the incline and demise of the innovation for the countries considered. In contrast, parameters such as ecological sustainability as well as ease of starting a business or getting credit interestingly tend to point in the exact opposite direction for both groups.
- Checking for bias concerning diverging innovation scores issued by official European institutions for EU countries rather than Non-EU member states and comparing these indicators to the equivalent values from the GII and BII yielded minor hints that EU countries are somewhat preferred within the EIS ranking compared to other countries. Yet, the recognized delta resides well within standard error and being able to issue reliable statements at this point definitely requires further analysis in that direction.