Data Group 2

Geoeconomic Dependency

Abstract

This presentation details the improvements made to the Geoeconomic Dependency Sub-Index, specifically focusing on database size and structure, data sources, and indexing methods.

The index was expanded to include data for 2021 and 2022, as well as extending availability for the period 2007-2015, using reliable sources such as the World Bank database and the World Intellectual Property Organization.

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Introduction

2024: 3rd Edition of the Geopolitical Risk Index (GRI) Project

Geoeconomic dependency sub-index

- Captures risk of economic interconnections among countries.
- Expressed in a scale of 0 to 10 (with 0 being "no risk" and 10 "highest risk").
- Originally composed of 7 equally weighted sub-sub-indexes: energy, raw materials, agriculture, global value chain (GVC), technology, finance and foreign aid.
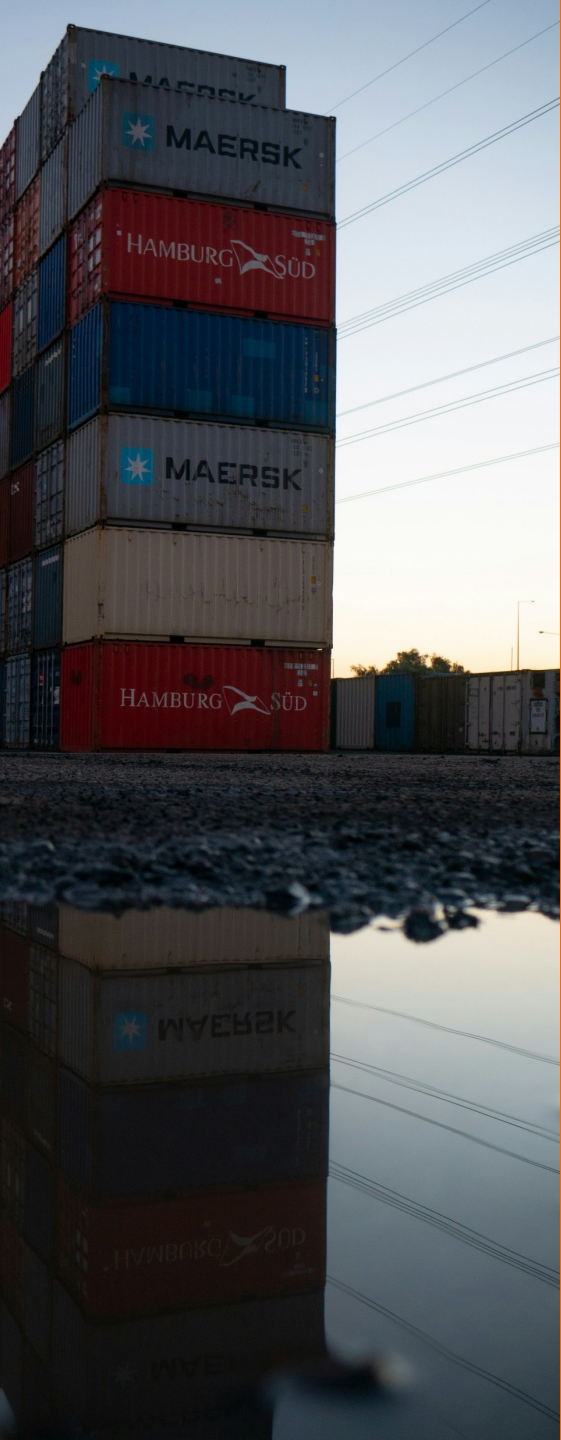
Modifications introduced in the 2023 edition

- Removal of the GVC sub-sub-index.
- New approach to unavailable data.
- Inclusion of 2020 and approximated data for 2021.

Our objectives for 2024 GRI project

- Expand the sub-index historically and geographically.
- Enhance the transparency of the database for future editions.
- Increase the accuracy and reliability of the data.

Improvements in the 2024 edition

- **Index Historical Depth**: increased from 5 (2016-2020 in 2023 edition) to 16 (2007-2022) available years.
- **Indexation Method**: implemented percentile standardization to tackle problems caused by outliers.
- **Structure of the Database:** created a complete loop including sources, raw data, calculation and indexation

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Rectification of Previous Work

Global Value Chain (GVC) Exclusion

- In the 2023 edition, GVC Sub-sub-index was excluded due to limited data availability (2016-2018).

- The written documents, both the presentation and report, incorrectly identified Foreign Aid as the removed sub-sub-index instead of GVC.

- In the 2024 Database and Report we have clearly identified the correct excluded sub-sub-index to increase the accuracy and transparency of the Sub-index.

Approach to missing data

- In 2023, instead of leaving missing data as empty cells, they were replaced by non-available ("n.a.") values. The goal was to avoid underestimation in the final score.

- Still a discrepancy with the Finance Sub-sub-index was found due to high occurrences of zero values instead of "n.a.".

- Therefore in 2024, countries with "n.a." values for all years were excluded from the final sample, leading to a more accurate database with thirteen fewer countries.

Interpolation

- A limited fraction of countries has "n.a." values for some years due to data inconsistencies.

- Retaining "n.a." values in the final score would have caused issues in calculating the final index, while removing countries with only few "n.a." values would limit the index's coverage.

- "N.a." values were replaced with interpolated data using linear regression for countries with past data and assigning values from the nearest available year for those missing past data.

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Geoeconomic Dependency Sub-sub indexes

ENERGY

Measures the reliance of a country's economy on imports and exports of fuel and energy

RAW MATERIALS

Reflects the vulnerability of an economy to the international flow of raw materials and commodities

FOOD

Quantifies the dependency of a country's economy on food import or export

TECHNOLOGY

Evaluates a country's dependence on technological innovation for its economic development

FINANCE

Estimates the financial dependency of a country, specifically exposure to foreign entities through debt and investments

FOREIGN AID

Assesses a country's dependence on foreign aid for its own development

Energy sub-sub index

Evaluates a nation's economic vulnerability based on its dependence on **imports & exports of energy and fuel**. A high Energy Dependency score suggests that a country's economy is at significant risk of being impacted by fluctuations in fuel imports or exports.

Meaning

$$\frac{\text{Fuel exports}}{\text{Merchandise exports}} + \frac{\text{Fuel Imports}}{\text{Merchandise imports}}$$

Formula: Energy dependency

Aside from the forthcoming explanation of adjustments to the indexation method, the primary improvements revolve around the inclusion of **additional years**.

The original data sources were kept, as well as the original sub-sub index calculation method.

Updates

Managed to incorporate data from 2022, as well as from 1962 to 2015. This is a substantial improvement over the previous version, which only covered the years 2016 to 2020.

As a result, the historical depth of the sub-sub-index expanded significantly, increasing by tenfold to encompass a total of **61 years**.

Results

Technology sub-sub index

- Geoeconomic dependency doesn't solely rely on raw materials but also on a country's innovation capacity.
- The Global Innovation Index (GII), an annual ranking by the World Intellectual Property Organization (WIPO), is a key tool to measure countries' innovation capacity.
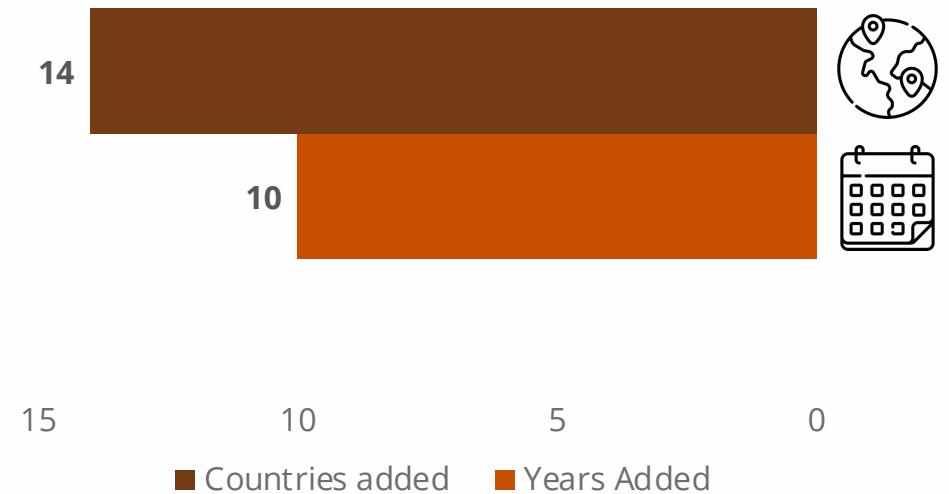
2 **Data Standardization and Enhancement**

A Retrieval efforts expanded historical data coverage from 2016-2022 to 2007-2023.

B Identified and rectified inaccuracies in previous index values.

C More transparent calculations in the database.

D Developed a revised formula for standardization to improve accuracy and reliability.

E Harmonized differently scaled data to enhance the interpretability of findings.

Formulas **1**

$$GII = \frac{Innovation\ input\ score + Innovation\ Output\ score}{2}$$

$$Technology\ sub - sub\ index = 100 - GII$$

Sub-sub index development **3**

14 — Countries added

10 — Years Added

| 15 | 10 | 5 | 0 |

■ Countries added   ■ Years Added

Geoeconomic Dependency – Data 2| Geopolitical Risk Index - 2024

Foreign aid sub-sub index

- Measures country's dependence on foreign aid for its own development.
- Original formula: **Net ODA / Central Government Expense**.
- **Official Development Assistance** (ODA): government aid designed to promote developing countries' economic development and welfare.

2 **Reasons for changes in index calculation**

A **Greater data availability:** new method yields data for 174 countries in 2020, compared to 72 nations with the previous approach (+141%).

B **Comprehensive Measure of National Economy:** Gross National Income (GNI) provides a holistic view of a country's economic status.

C **Economic strength:** GNI reflects a nation's overall economic health and self-sufficiency.

D **Stability Against Fluctuations:** GNI is less prone to fluctuations caused by political or economic factors.

E **Comparability Across Countries:** GNI allows for fairer comparisons of foreign aid dependency among countries with different levels of government expenditure.

1 **New formula**

$$\text{Foreign Aid dependency} = \frac{\text{Net ODA}}{\text{Gross National Income}}$$

3 **Sub-sub index development**

102

56

| 120 | 100 | 80 | 60 | 40 | 20 | 0 |

■ Countries added ■ Years Added
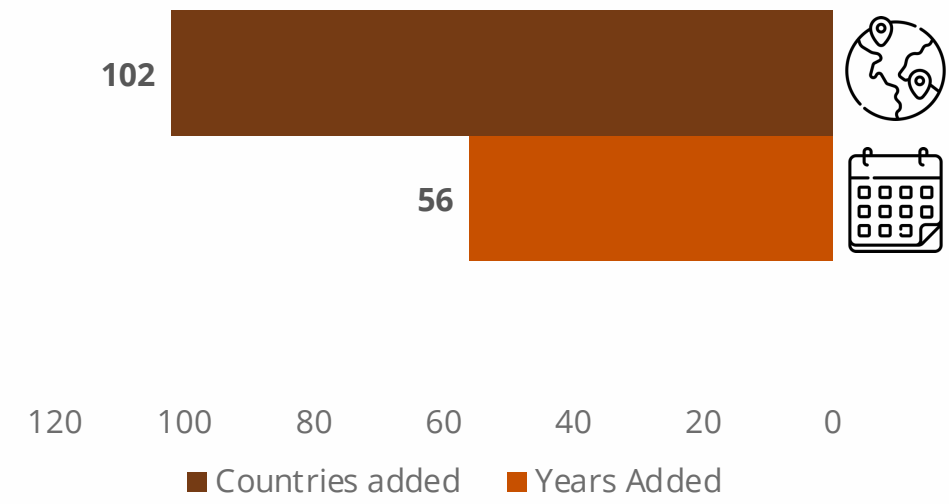
Raw Material sub-sub index

- **Purpose:** Measures economic vulnerability to fluctuations in the global raw materials market**:**

- **Original Formula:**

$$Raw\ Materials\ dependency = \frac{Raw\ Materials\ Exports}{GDP} + \frac{Raw\ Materials\ Imports}{GDP}$$

2 **2024 Index Updates**

- **Data Source**: now using World Bank data for enhanced granularity and availability.
- **Separation of Categories**: The "Ores & Metals" and "Agricultural Raw Materials" categories have now been defined independently to prevent overlap with the Energy and Food indexes. Each index exclusively analyses distinct sectors without data redundancy.

1 **New formula**

$$Raw\ Materials\ Dependency = \frac{1}{2} * (\ Ores\ \&\ Metals\ dep. + Agricultural\ R.M.dep.\ )$$

$$Ores\ \&\ Metal\ dep. = \frac{Ores\ \&\ Metal\ Exports}{Merchandise\ Exports} + \frac{Ores\ \&\ Metal.Imports}{Merchandise\ Imports}$$

$$Agricultural\ R.M.dep. = \frac{Agricultural\ R.M.Exports}{Merchandise\ Exports} + \frac{Agricultural\ R.M.Imports}{Merchandise\ Imports}$$

3 **Reasons for changes in index calculation**

A **Data Accuracy:** includes updated data up to 2022.

B **Consistency:** aligns methodologies across all sub-sub-indexes, using Merchandise Exports/Imports as the scaling factor.

C **Extended data range:** covers data from 1962 to 2022 for broader analysis.

D **Improved Classification:** reduces redundancy and focuses on economic activities.

E **Stronger economic linkage:** ensures the index reflects true economic activities, minimizing distortion from GDP metrics.

4 **Overall impact**

Geographic and Temporal Expansion: Broadens the index's scope, now encompassing data from 1962 to 2022, extending the coverage to 61 years and by 30 more countries.

Framework alignment: Addressing one of the limitations of the original sub-index, the sources and method of calculations for the import/export based sub-sub-indexes have been unified.

Food sub-sub index

- Quantifies the dependency of a country's economy on food import or export.

- Original formula:

$$Agriculture\ dependency = \frac{Agriculture\ Exports}{GDP} + \frac{Agriculture\ Imports}{GDP}$$

- In order to avoid any misidentification issues with the newly introduced "Agricultural Raw Materials" and to provide a more appropriate label, we have changed the name of the sub-sub-index form "Agriculture" to "Food".

2 **Reasons for changes in index calculation**

A **Greater data availability:** The Food Sub-sub-index now fully includes World Bank data from 1962 to 2022.

B **Adoption of World Bank data** on Food imports and exports ensures use of the latest information up to 2022.

C **Updates to the source and calculation method** enhance the index's consistency and allow for precise comparisons with other indices.
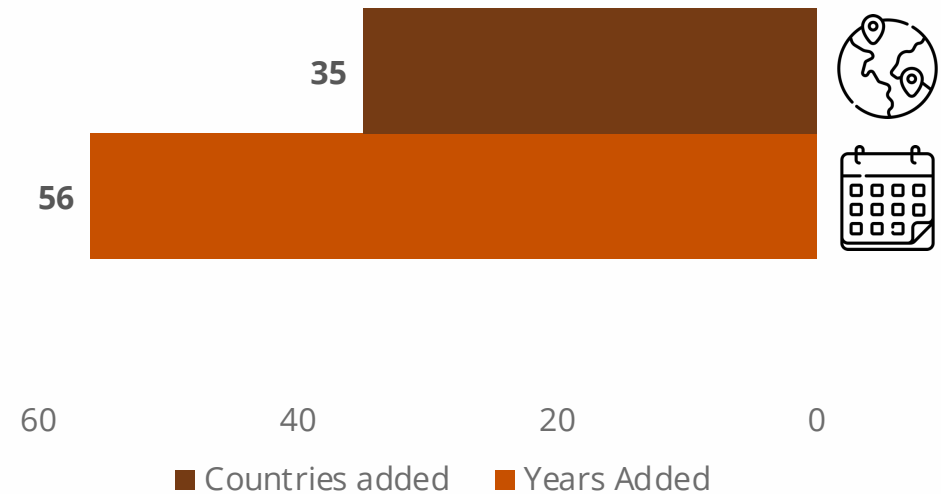
1 **New formula**

$$Food\ dependency = \frac{Food\ Exports}{Merchandise\ Exports} + \frac{Food\ Imports}{Merchandise\ Imports}$$

3 **Sub-sub index development**

35

56

60   40   20   0

■ Countries added   ■ Years Added

Geoeconomic Dependency – Data 2| Geopolitical Risk Index - 2024

Finance sub-sub index

The Finance Sub-sub-index evaluates economic vulnerability through two main components:

- **Debt-linked dependency**: measures the percentage of debt owned by foreign entities relative to GDP.
- **FDI-linked dependency**: assesses the impact of net foreign direct investment inflows as a percentage of GDP.

The raw data has been extracted from the World Bank Database.

2024 **2**

$$Debt - linked\ dependency = \frac{\%\ of\ debt\ owned\ by\ foreign\ entities}{GDP}$$

$$Debt - linked\ dependency = \frac{External\ debt\ stock}{GDP}$$

$$FDI - linked\ dependency = \frac{net\ FDI\ inflow}{GDP}$$

The formula **3**

$$Financial\ dependency = \frac{1}{2} * (\ Debt - linked\ dependency + FDI - linked\ dependency)$$

4

Reasons for changes in data sources

A **Transparency:** clear path from data to final scores, incorporating detailed calculations directly in the excel database.

B **Accessibility:** utilization of easily accessible and updated World Bank data sources.

C **Historical Depth:** Expanded data coverage from 2016-2020 to a comprehensive range from 1970-2022, greatly increasing the temporal scope of analysis.

D **Consistency:** Standardization across the approach to "n.a." values enhances the reliability and comparability with other sub-sub-indexes.
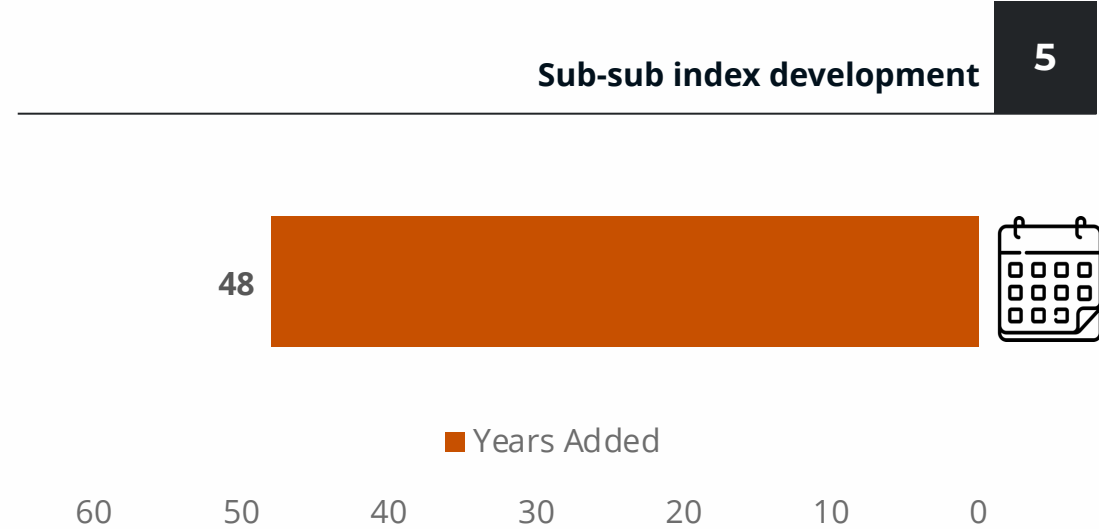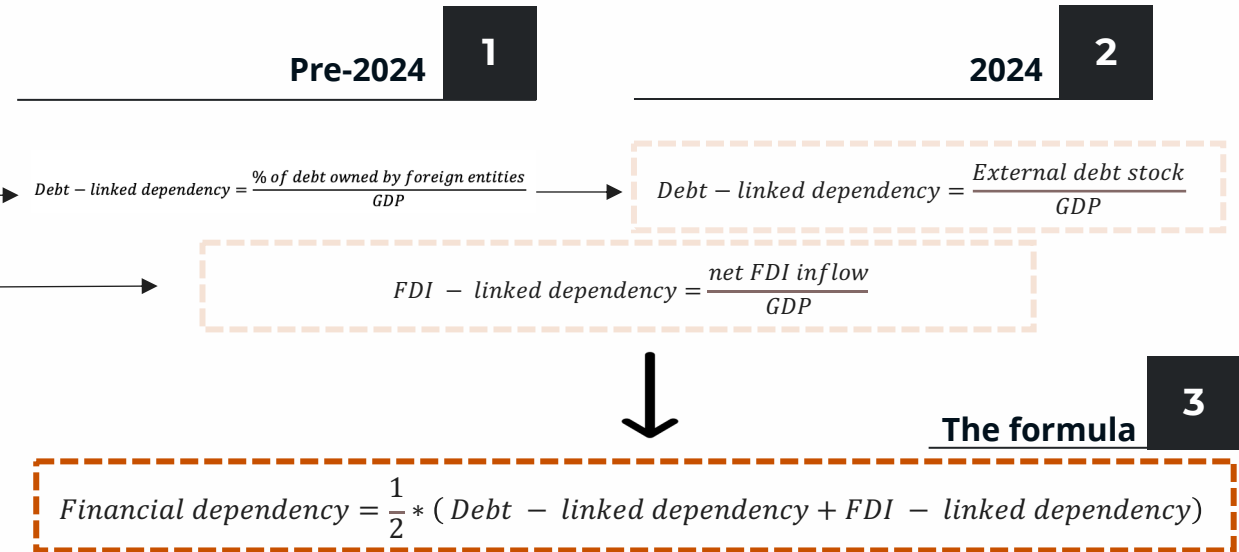
Sub-sub index development **5**

48

■ Years Added

60   50   40   30   20   10   0

Sub-sub indexes

14

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Structure of the database

Data input

The 2023 Database lacked data source references, hindering interpretation.

Corrective measures:
- Direct links to data sources were added in each sub-sub-index sheet.
- Raw data from sources was inserted for transparency and reliability of the database

Formula adjustment

The 2023 database lacked formulas, making data interpretation difficult.

Improvements made:
- Formulas linking raw data to final values
- Correct formulas for deriving indexed values
- Data source references and calculation formulas.

Method of indexation

New indexation method

- For each year of each sub-sub index, 20 percentiles are calculated.
- Scores from 0 to 10 are assigned to each percentile, using a Vlookup formula to match the unindexed raw values with the closest percentile

Problems with previous method: the index was negatively impacted by data distribution and outliers

Reasons for change

Percentile Indexation:

- Avoids exclusion of available data, which is crucial for maintaining geographical reach.
- Accurately represents extreme values.
- Ensures consistency by applying a coherent statistical approach to all data.
- Builds on a proven approach used in the Globalization Sub-Index since 2022, adapting it for the Geoeconomic Dependency Sub-index.

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Limitations

Historical limitations

Data up to 2007 Only
The Sub-Index is limited by the lack of data beyond 2007 for the Technology sub-sub-index.

Exhaustion of the source
All the available years for the GII have been included. Further expansion will require a new source.

Blank spots in the Database

Trade-off between Accuracy and Size
The data from the World Bank covers an extensive size both in time and geography but includes some missing values and blank spots depending on the year, country or index type. The analysis requires adopting a specific approach to treat the "n.a." values.
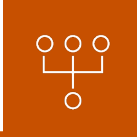
Structure of sub-sub-indexes

Global Analysis
Focuses on Import/Export and Finance without exploring bilateral interconnections

Hidden Risks
Countries with non-diversified exports are more exposed to risks tied to single trading partners.

Future developments

Alternate Data Sources
Explore new data sources to enhance historical analysis.

Advanced Techniques
Use of interpolation methods and approximations to improve index precision

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Conclusions:

The 2024 Geoeconomic Dependency Sub-index has been significantly improved in historical depth and reliability, now including data from 2007-2022 for 252 countries. It features enhanced accuracy and usability with clearer documentation and streamlined spreadsheet structures. These improvements have made it a more robust and easier to use tool for geopolitical risk assessment.

The new Sub-Index is broader, more accurate, updated and easier to comprehend

Historical depth & Geography
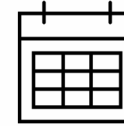
Temporal Expansion: From 5 years (2016-2020) to 16 years (2007-2022).
Geographical reach: Improvement at sub-sub-index level and removal of incorrect values from 14 countries.

Transparency and Accessibility

Sources: Inclusion in the database of the relevant sources and raw data.
**Calculations**: Introduction of formulas in all the sheets to provide a completely automated update process.

Rectification of previous work

GVC Exclusion: Correctly identified GVC as the removed sub-sub-index.
Approach to missing values: Ensured the complete application of the approach to all sub-sub-indexes and addressed the connected problems.
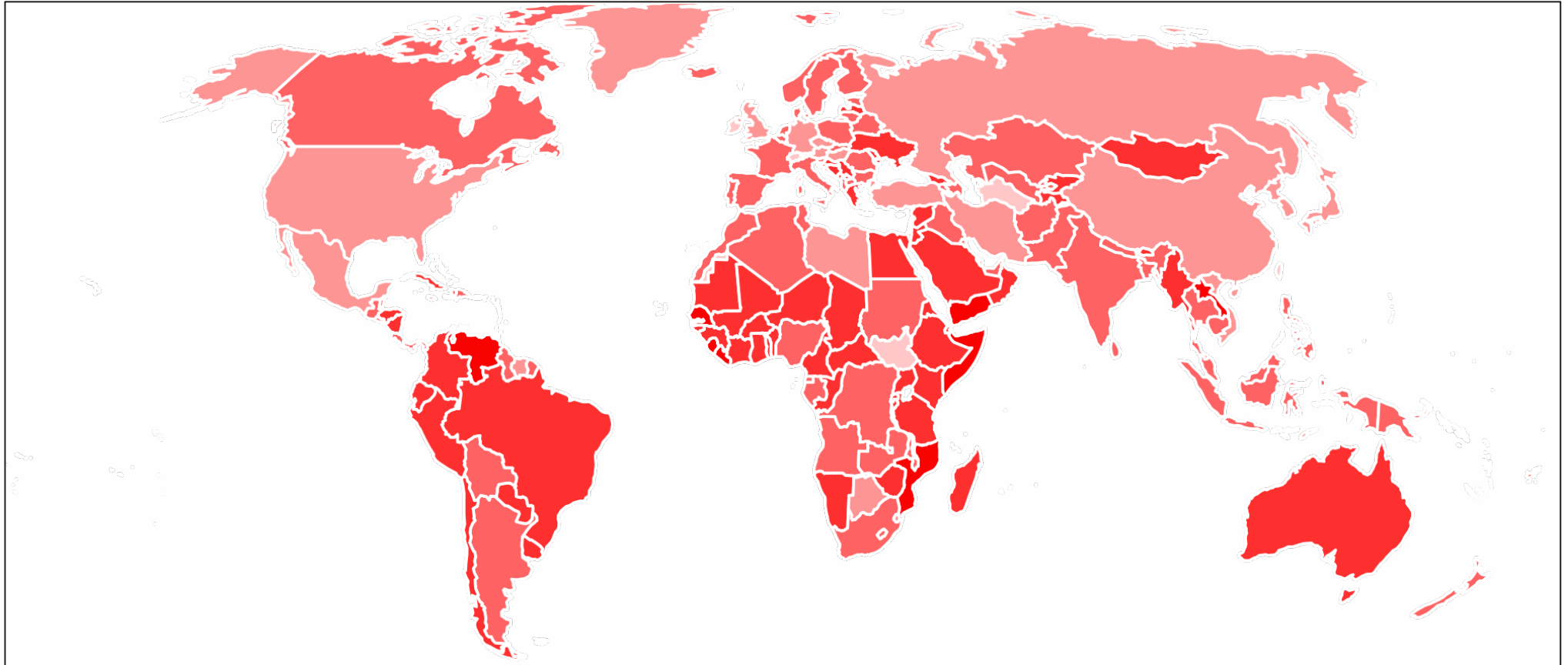
Renewed Methodology
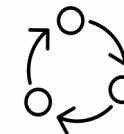
New Indexation Method: Solves underestimation problems caused by outliers.
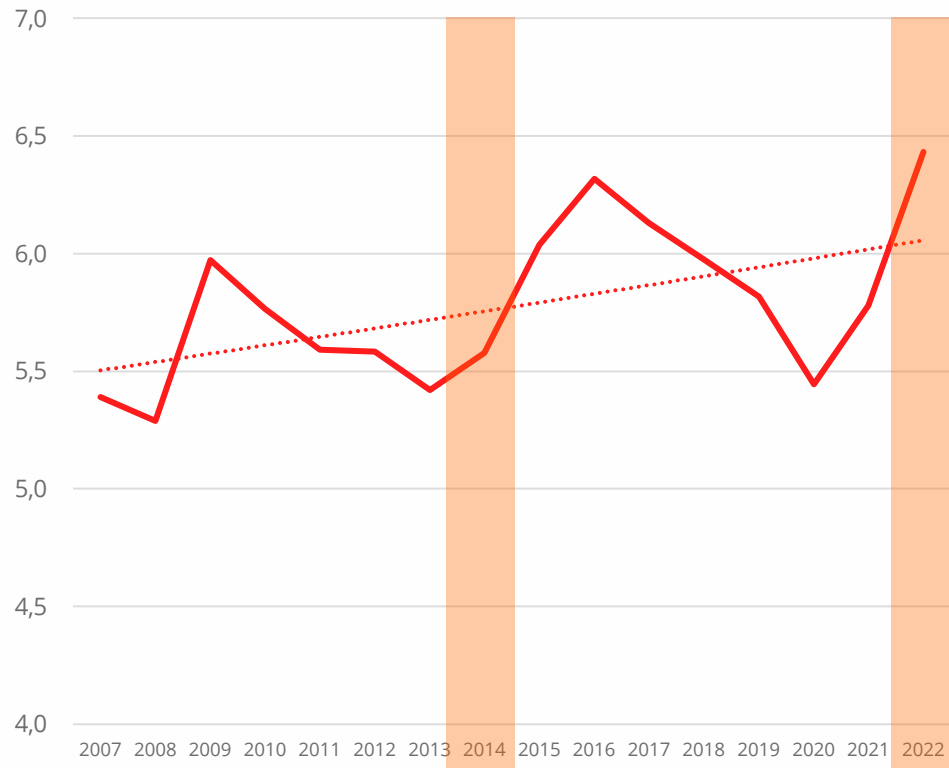**Changed Scaling Unit**: Improves comparability of Import/Export-based measures.

2022 Geoeconomic Dependency Risk Map
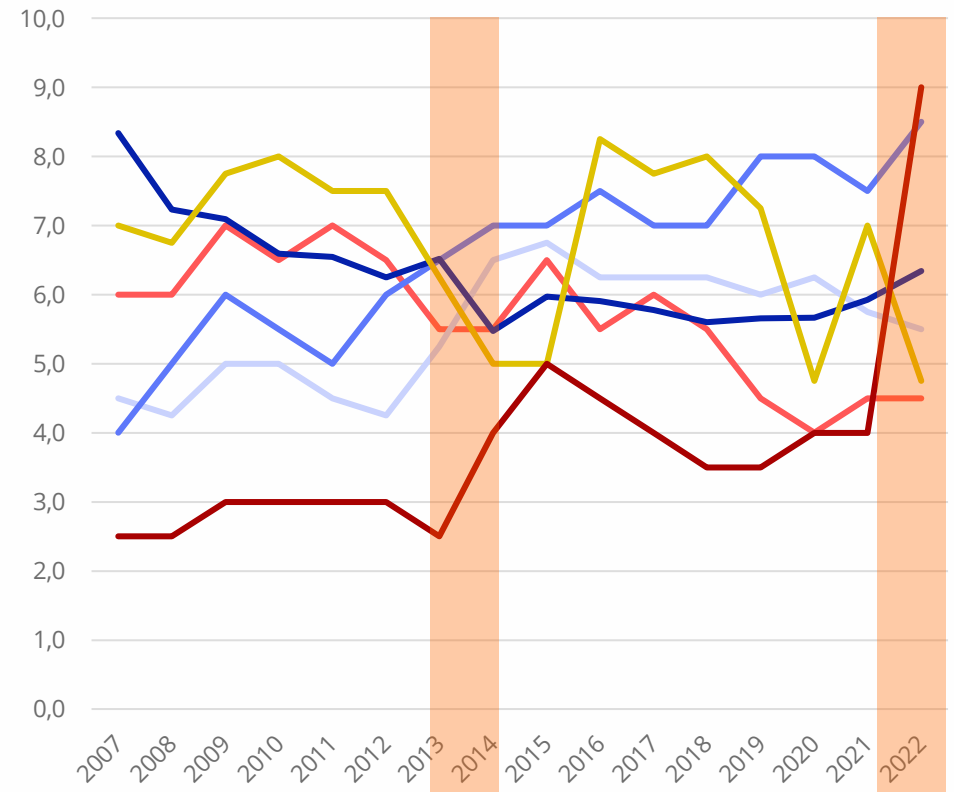
Geoeconomic Dependency Case Study

Ukraine Geoeconomic Dependency

Ukraine Sub-sub-Indexes

Crimean Crisis

Russian Invasion

Energy   Raw Materials   Food   Technology   Finance   Foreign Aid

Conclusions

References

Sub-sub-Index	Source	Name	Type	Website
Energy	World Bank	Fuel	Import	https://data.worldbank.org/indicator/TM.VAL.FUEL.ZS.UN
Energy	World Bank	Fuel	Export	https://data.worldbank.org/indicator/TX.VAL.FUEL.ZS.UN
Raw Materials	World Bank	Ores & Metals	Import	https://data.worldbank.org/indicator/TM.VAL.MMTL.ZS.UN
Raw Materials	World Bank	Ores & Metals	Export	https://data.worldbank.org/indicator/TX.VAL.MMTL.ZS.UN
Raw Materials	World Bank	Agricultural Raw Materials	Import	https://data.worldbank.org/indicator/TM.VAL.AGRI.ZS.UN
Raw Materials	World Bank	Agricultural Raw Materials	Export	https://data.worldbank.org/indicator/TX.VAL.AGRI.ZS.UN
Food	World Bank	Food	Import	https://data.worldbank.org/indicator/TM.VAL.FOOD.ZS.UN
Food	World Bank	Food	Export	https://data.worldbank.org/indicator/TX.VAL.FOOD.ZS.UN
Technology	World Intellectual Property Organization	Global Innovation Index	Index	https://www.wipo.int/publications/en/details
Finance	World Bank	External Debt	Debt Stock	https://data.worldbank.org/indicator/DT.DOD.DECT.CD
Finance	World Bank	External Debt	GDP	https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
Finance	World Bank	Foreign Direct Investment	Net FDI	https://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS
Foreign Aid	World Bank	Official Development Assistance	Net ODA	https://data.worldbank.org/indicator/DT.ODA.ODAT.GN.ZS