README for the Reproducibility Package for Concentration of critical mining assets and the geoeconomic fragmentation

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Overview

The code in this replication package constructs the analysis file from five data sources: S&P et al. (2023), Global Trade Alert (2024), Geopolical Distance, Trade codes, and IEA (2024), using Python. A single main file runs all the code necessary to process the data for the 18 figures and 3 tables in the paper. Replicators should expect the code to run for approximately 2 hours minutes. To decrease computation time, the construction of the GPD dataset may be commented out (in Module_GPD.py). This will decrease the computation time to 10 minutes.

Due to the proprietary nature of the S&P dataset, replicators must possess an S&P license to run the code, as the data cannot be provided. On the S&P platform, data have been collected through the screener tab by selecting all the minerals mentioned in the paper.

Data Availability and Provenance Statements

Statement about Rights

- ☒ I certify that the author(s) of the manuscript have legitimate access to and permission to use the data used in this manuscript.
- ☐ I certify that the author(s) of the manuscript have documented permission to redistribute/publish the data contained within this replication package. Appropriate permission are documented in the LICENSE.txt file.

Summary of Availability

- ☐ All data **are** publicly available.
- ☒ Some data **cannot be made** publicly available.
- ☐ **No data can be made** publicly available.

See overview section for more info.

Details on each Data Source

Data.Name	Data.Files	Location	Provided	Citation	URL	Date of access	Comments
"Global Trade Alert 2024"	GTA+ Database+ 2008-latest. Rdata	Dataset/ GTA	TRUE	GTA, 2024	https:// www.old. global trade alert.org/ data_extraction	July, 2024	The data was collected on a version of the website that does not exist anymore. Users can download the data using the new website: https:// globaltradealert.org /data-center

Data.Name	Data.Files	Location	Provided	Citation	URL	Date of access	Comments
"Geopolical Distance"	UNVotes_ new.RData	Dataset/ Geopolical Distance/	TRUE	GPD, 2024	https:// dataverse. har- vard.edu/ dataset.xhtml? persisten- tId=hdl:1902.1/ 12379&ver- sion=32.0	July, 2024	The file on the dataverse website to download is UNVotes.RData
"IEA policies"	iea_ poli- cies.json	Dataset/	TRUE	IEA, 2024	https:// www.iea.org/ data-and- statistics/ data-tools/ critical- minerals- policy- tracker	July, 2024	The data was obtained from the data URL and saved in a JSON file via web scraping. We collected data on all the policies listed (blue dots on the data URL) on the date of access.
"Trade codes"	Trade_ codes_ HS.xlsx	Dataset/ Trade Codes	TRUE	NA	https:// publica- tions.jrc. ec.europa.eu/ reposi- tory/handle/ JRC136041	July, 2024	All the data were extracted manually from that PDF.
"S&P"	Not available	Dataset/	FALSE	S&P (2023)	https:// www.sp global.com/ market- intelli- gence/ en/campaigns/ metals- mining	November, 2023	

Data files of data source "S&P"

File location	Provided	Date of access
Dataset/S&P/COMPANY_NAME (updated).xlsx	FALSE	November, 2023
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Dataset/S&P/Company_country/company_master_file_ISO.csv	FALSE	November, 2023
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Dataset/S&P/HHI_reserves_geo_project/Chromium.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Cobalt.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Copper.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Diamonds.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Gold.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Graphite.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Iron.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Lanthanides.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Lanthanum.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Lead.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Lithium.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Manganese.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Nickel.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Palladium.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Phosphate.xlsx	FALSE	November, 2023

File location	Provided	Date of access
Dataset/S&P/HHI_reserves_geo_project/Platinum.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Silver.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Tin.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Tungsten.xlsx	FALSE	November, 2023
Dataset/S&P/HHI_reserves_geo_project/Zinc.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Alloy_mines_ownership_part1.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Alloy_mines_ownership_part2.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Bauxite-alu_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Chrome_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Coal_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Cobalt_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Copper_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Diamants_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Gold.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Graphite_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Iron_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Lead_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Lithium_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Manganese_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Molybnenum_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Nickel_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Pala-plat_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Phosphate-Potash_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/REE_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Silver_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Tin_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Tungsten_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Uranium_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/mergedup10/Zinc_mines_ownership.xls.xlsx.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Antimony.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Bauxite.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Chromite.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Coal.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Cobalt.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Copper.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Diamonds.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Ferrovanadium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Gold.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Graphite.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Iron.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Lanthanides.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Lanthanum.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Lead.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Lithium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Manganese.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Nickel.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Niobium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Palladium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Phosphate.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Platinum.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Scandium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Silver.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Tantalum.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Tin.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Titanium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Tungsten.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Uranium.xlsx	FALSE	November, 2023

File location	Provided	Date of access
Dataset/S&P/Production_clean/Vanadium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Yttrium.xlsx	FALSE	November, 2023
Dataset/S&P/Production_clean/Zinc.xlsx	FALSE	November, 2023
Dataset/S&P/Projects/prodandreserve_proj-clean.csv	FALSE	November, 2023
Dataset/S&P/Projects/prodandreserve_proj-clean.xlsx	FALSE	November, 2023
Dataset/S&P/Projects/prodandreserve_proj.csv	FALSE	November, 2023
Dataset/S&P/Projects/project_id.csv	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Bauxite.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Chromium.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Cobalt.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Copper.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Diamonds.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Gold.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Graphite.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Iron.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Lanthanides.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Lanthanum.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Lead.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Lithium.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Manganese.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Nickel.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Palladium.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Phosphate.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Platinum.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Silver.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Tin.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Tungsten.xlsx	FALSE	November, 2023
Dataset/S&P/Reserves_clean/Zinc.xlsx	FALSE	November, 2023

Software Requirements

- Python 3.12.5
    - `pandas` 2.2.2
    - `numpy` 1.26.4
    - `plotly` 5.21.0
    - `pycountry` 23.12.11
    - `pyreadr` 0.5.2
    - `matplotlib` 3.8.4
    - `altair` 5.5.0
    - `sklearn` 1.4.2

Summary

Approximate time needed to reproduce the analyses on a standard (CURRENT YEAR) desktop machine:

☐ <10 minutes
☐ 10-60 minutes
☒ 1-2 hours
☐ 2-8 hours
☐ 8-24 hours
☐ 1-3 days
☐ 3-14 days
☐ > 14 days

Approximate storage space needed:

☐ < 25 MBytes

☒ 25 MB - 250 MB

☐ 250 MB - 2 GB

☐ 2 GB - 25 GB

☐ 25 GB - 250 GB

☐ > 250 GB

☐ Not feasible to run on a desktop machine, as described below.

Details

The code was last run on a **8-core AMD-based Desktop with Windows 10**.

Computation took **two hours**.

Description of programs/code

- Programs in `Code_articleBM` will generate all tables and figures in the main body of the article. The file `Core.py` will run them all.
- `load_func.py` regroups the main functions used

Instructions to Replicators

- Edit `Core.py` to adjust the default path
- Run `Core.py` to run all modules in sequence.

Details

- `Core.py`: is used to set paths, to define parameters and process raw data. When run, it also run all modules below in sequence.
- `load_func.py`: Contains all important functions for data procession and the analysis.
- `Module_statistics.py`: Produces the statistics figures.
- `Module_production.py`: Computes HHI for production and produces the HHI production figures.
- `Module_reserves.py`: Computes HHI for reserves and produces the HHI reserves figures.
- `Module_GPD.py`: Process the GPD data and produces GPD related figures.
- `Module_other_figures.py`: Produces figures 14a and 14b.
- `Module_alter_measures.py`: Produces figures in the annex.

List of tables and programs

The provided code reproduces:

☐ All numbers provided in text in the paper
☒ All figures and tables in the paper
☐ Selected tables and figures in the paper, as explained and justified below.

Figure/Table #	Program	Output file	Note
Figure 1	Module_ statistics.py	Figure1.png	Source: Global Trade Alert (2024)
Figure 2	Module_ statistics.py	Figure2.png	Source: IEA (2024)
Figure 4	Module_ GPD.py	Figure4.png	Requires S&P data (non publicly available)

Figure/Table #	Program	Output file	Note
Figure 5	Module_ statistics.py	Figure5.png	Requires S&P data (non publicly available)
Figure 6	Module_ statistics.py	Figure6.png	Requires S&P data (non publicly available)
Figure 7	Module_ production.py	Figure7.png	Requires S&P data (non publicly available)
Figure 8	Module_ production.py	Figure8.png	Requires S&P data (non publicly available)
Figure 9	Module_ production.py	Figure9.png	Requires S&P data (non publicly available)
Figure 10	Module_ production.py	Figure10.png	Requires S&P data (non publicly available)
Figure 11	Module_ reserves.py	Figure11.png	Requires S&P data (non publicly available)
Figure 12	Module_ reserves.py	Figure12.png	Requires S&P data (non publicly available)
Figure 13	Module_ reserves.py	Figure13.png	Requires S&P data (non publicly available)
Figure 14.a	Module_ other_figures.py	Figure14a.png	Requires S&P data (non publicly available)
Figure 14.b	Module_ other_figures.py	Figure14b.png	Requires S&P data (non publicly available)
Figure 15	Module_ GPD.py	Figure15.png	Requires S&P data (non publicly available)
Figure X	Module_ alter_measures.py	FigureX.png	Requires S&P data (non publicly available)
Figure Y	Module_ alter_measures.py	FigureY.png	Requires S&P data (non publicly available)
Figure Z	Module_ alter_measures.py	FigureZ.png	Requires S&P data (non publicly available)
Table 1	Module_ statistics.py	mining_assets.xlsx	Requires S&P data (non publicly available)
Table 2	Module_ production.py	table_df_production_ combine.xlsx	Requires S&P data (non publicly available)
Table 3	Module_ reserves.py	table_df_reserves_ combine.xlsx	Requires S&P data (non publicly available)

Acknowledgements