



RELATIVE NATIONAL POWER (POWER) CODEBOOK

VERSION NUMBER: 2.2.2024

AUTHORS

Jonathan D. Moyer, PhD

Alanna Markle

Collin J. Meisel

Adam Szymanski-Burgos

Pardee Institute for International Futures | Josef Korbel School of International
Studies University of Denver | 2201 South Gaylord Street | Denver, Colorado | 80210

Contact: pardee.center@du.edu

ACKNOWLEDGMENTS

The authors would like to thank John McPhee for playing a key leadership role in maintaining and overseeing initial updates of the Relative Power Indices, along with Drew Bowsby and Adam Enes for assisting in updates and data management for the project, and Whitney Doran for management of the project in its early stages. This project would not have been possible without their perseverance and hard work. We would also like to thank Professor Barry Hughes for his invaluable insight and support from conceptualization of this subject to data collection and analysis. Lastly, we extend our gratitude to the U.S. government for providing support for this project.



CONTENTS

INTRODUCTION	4
DIPLOMETRICS	4
GOALS OF THE RELATIVE NATIONAL POWER PROJECT	4
BACKGROUND	5
CITATION	5
DATASETS AND VARIABLES	6
DATASETS	6
COMPATIBILITY WITH OTHER DATASETS	6
VARIABLES	6
COUNTRY ENGAGEMENT WITH THE DIPLOMATIC SYSTEM	10
DATA COLLECTION METHODOLOGY	11
GAP-FILLING	12
1. DPI Times Government Revenues	13
2. Effective Population	13
3. Imports plus Exports	14
4. ICT Capital Stock	14
5. Military Spending at MER	14
6. FDI Inflows	14
7. Population	14
8. R&D Spending	14
SEMI-SOVEREIGN ASSET REALLOCATION	15
VETTING METHODOLOGY	16
NOTES	17
COMPARING INDICES	17
SUMMARY STATISTICS & SELECT VISUALIZATIONS	17
WORKS CITED IN CODEBOOK	23





DIPLOMETRICS

INTRODUCTION

DIPLOMETRICS

The Diplometrics project at the Pardee Institute focuses on building databases, constructing tools and performing analysis focused on international relations theory. To date, the project has built databases on international organizations, diplomatic exchange, and treaties held by the United Nations. This data feeds a research agenda that is interested in measuring and modeling international relations, specifically how global governance is likely to shift across time, which will inform the international politics submodule of International Futures (IFs). Both IFs and Diplometrics datasets are open and free to the public. Diplometrics projects draw only from open-source information.

GOALS OF THE RELATIVE NATIONAL POWER PROJECT

The goal of this project is to build upon previous initiatives to measure and forecast power within the international system. To this end, the Pardee Institute has developed two unique, multidimensional indices for measuring state power that conceptualize power as the potential for a state to realize its desired outcomes in the international system: the Global Power Index (GPI) and the Hillebrand-Herman-Moyer Index (HHMI). The latter is an adaptation of the Hillebrand-Herman Index (HHI), an externally developed index that is also included in this codebook.



BACKGROUND

The Relative National Power project represents both an extension and a departure from the two most popular means of measuring state power in quantitative research: first, the Composite Index of National Capabilities (CINC)⁴ from the Correlates of War (COW) project; and second, economic size as measured by gross domestic product (GDP) at market exchange rates (MER), GDP at purchasing power parity (PPP), or gross national product (GNP) at MER. CINC, GPI, HHMI, and HHI all capture material capabilities, but the latter three indices go beyond CINC by incorporating nuclear weapons, technology, and international interactions (diplomatic networks and alliance networks). The GPI, HHMI, and HHI are also integrated into the IFs modeling platform, allowing users to forecast and build scenarios that reflect the changing distribution of power among the 188 countries in the model to 2100.

CITATION

Cite data as follows:

Moyer, Jonathan D., Markle, Alanna., Meisel, Collin J., Szymanski-Burgos, Adam. "Relative National Power Codebook." Diplometrics. Denver, CO: Frederick S. Pardee Institute for International Futures, Josef Korbel School of International Studies, University of Denver, 2024.

⁴ More information on CINC is available here: <<https://correlatesofwar.org/data-sets/national-material-capabilities/>>



DATASETS AND VARIABLES

DATASETS

Country-Index-Year: This dataset represents three indexed measurements of a country's share of power in the international system by year. The GPI is calculated starting in 1816.⁵ The HHMI and HHI are calculated starting in 1960.

COMPATIBILITY WITH OTHER DATASETS

The Relative Power Indices use the IFs country list of 188 countries. The use of this list allows them to be fully integrated into the model.

In addition, the data is available using the standard COW country codes. Though COW codes are not included in the dataset itself, a concordance list is included in the members of interstate system (MIS) database.

VARIABLES

Table 1 lists each variable used to calculate the HHI, HHMI, and GPI grouped by the following dimensions of power: military, demography, economy, technology, and international interactions. It includes the equation used to calculate the variable's value on a country-year basis; a description of the variable; and the weight of the variable in each index. The GPI is divided into six time periods, each of which has a unique weighting scheme. The annual country-level value of each variable is divided by the world total to yield a relative figure for that country-year pairing. In addition, several variables require additional transformation (e.g. Nuclear Weapons are logged) or are calculated using two or more "input variables" (e.g. Poverty Adjusted Population uses working age population and population living under the poverty line).

⁶ More information about the Correlates of War Project can be found here: <<http://www.correlatesofwar.org/>>



Table 1

Variable	Description	Equation	CINC	HHI	GPI						HHMI
					1816-1944	1945-1959	1960-1972	1973-1989	1990-2004	2005+	
			Military								
Military Personnel	Global share of military personnel	$\frac{\text{Military Personnel}}{\sum_{c=1}^{188} \text{Military Personnel}}$	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Military spending at MER	Global share of military spending at MER[1]	$\frac{\text{Military Spending at MER}}{\sum_{c=1}^{188} \text{Military Spending at MER}}$	16.67%	29.00%	40.00%	35.00%	35.00%	30.0%	20.00%	20.00%	22.80%
Nuclear Weapons	Global share of nuclear weapons (logged)	$\frac{\text{Log(Nukes)}}{\sum_{c=1}^{188} \text{Nukes}}$	0.00%	0.00%	0.00%	10.00%	10.00%	10.00%	5.00%	5.00%	6.30%
			Demography								
Urban Population	Urban population	$\frac{\text{Urban Population}}{\sum_{c=1}^{188} \text{Urban Population}}$	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Population	Global share of population	$\frac{\text{Population}}{\sum_{c=1}^{188} \text{Population}}$	16.67%	26.00%	10.00%	10.00%	0.00%	0.00%	0.00%	0.00%	20.30%
Poverty Adjusted Population	Global share of working age population living above the \$3.10 a day poverty line weighted by the Human Development Index (HDI) ⁷	$\frac{\text{Effective Human Capital}}{\sum_{c=1}^{188} \text{Effective Human Capital}}$ <p><i>Effective Human Capital: Working age population living above the \$3.10⁸ a day poverty line weighted by the squared value of HDI (2010 formulation). In the model this is achieved by:</i></p> $\frac{[(\text{Population} - \text{Population living under } \$3.10 \text{ a day}) * \text{Population 15 to 65}]}{*\text{HDI}^2 * \text{Population}}$	0.00%	0.00%	0.00%	0.00%	5.00%	5.00%	5.00%	5.00%	0.00%

⁷ More information about the HDI is available here: <http://hdr.undp.org/en/content/human-development-index-hdi>

⁸ Poverty defined as \$2.00/day from 2005 to 2014; \$3.10/day onward. All dollar amounts and related estimates are in 2017 USD



			Economy								
Energy Production	Global share of energy production	$\frac{\text{Energy Production}}{\sum_{c=1}^{188} \text{Energy Production}}$	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	5.00%	5.00%	0.00%
Foreign Direct Investment (FDI) Net Inflow	Global share of foreign direct investment net inflows	$\frac{FDI \text{ inflows}}{\sum_{c=1}^{188} FDI \text{ inflows}}$	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	0.00%
GDP at PPP	Global share of GDP at PPP	$\frac{GDP \text{ at PPP}}{\sum_{c=1}^{188} GDP \text{ at PPP}}$	0.00%	35.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	27.80%
GDP at MER	Global share of GDP at MER	$\frac{GDP \text{ at MER}}{\sum_{c=1}^{188} GDP \text{ at MER}}$	0.00%	0.00%	0.00%	0.00%	20.00%	20.00%	30.00%	20.00%	0.00%
Trade	Global share of trade (exports plus imports)	$\frac{\text{Exports} + \text{Imports}}{\sum_{c=1}^{188} \text{Exports} + \text{Imports}}$	0.00%	0.00%	0.00%	0.00%	5.00%	5.00%	5.00%	5.00%	0.00%
Iron and Steel Production	Global share of iron and steel production	$\frac{\text{Energy Production}}{\sum_{c=1}^{188} \text{Energy Production}}$	16.67%	0.00%	25.00%	20.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Energy Consumption	Global share of energy consumption	$\frac{\text{Energy Consumption}}{\sum_{c=1}^{188} \text{Energy Consumption}}$	16.67%	0.00%	25.00%	25.00%	0.00%	0.00%	0.00%	0.00%	0.00%
			Technology								
GDP at MER x GDP per capita at PPP	Global share of GDP at PPP times GDP per capita at PPP	$\frac{(GDP \text{ at MER})(GDP \text{ per capita at PPP})}{\sum_{c=1}^{188} (GDP \text{ at MER})(GDP \text{ per capita at PPP})}$	0.00%	10.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.60%
Research and Development (R&D) Spending	Global share of R&D expenditures	$\frac{R\&D \text{ Spending}}{\sum_{c=1}^{188} R\&D \text{ Spending}}$	0.00%	0.00%	0.00%	0.00%	10.00%	10.00%	10.00%	5.00%	0.00%
Information Communication on Technology (ICT) capital stock	Global share of ICT capital stock	$\frac{ICT \text{ Capital Stock}}{\sum_{c=1}^{188} ICT \text{ Capital Stock}}$	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	0.00%



			International Interactions								
Foreign Aid	Global share of net foreign aid donations	$\frac{Net\ Aid\ Donations}{\sum_{c=1}^{188} Net\ Aid\ Donations}$	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	0.00%
Embassies	Global share of number of embassies held in other countries as a percent of total possible embassies	$\frac{(Diplomatic\ Exchanges)}{(Possible\ Diplomatic\ Exchanges)}$	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.60%
		$\sum_{c=1}^{188} \frac{(Diplomatic\ Exchanges)}{(Possible\ Diplomatic\ Exchanges)}$									
IGOs	Global share of IGO memberships weighted by importance as a percent of total possible weighted memberships	$\frac{(IGO\ Score)(Possible\ IGO\ Score)}{\sum_{c=1}^{188} (IGO\ Score)(Possible\ IGO\ Score)}$	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.10%
		<i>IGO score: For a given country-IGO pair, full membership receives the full credit of the treaty's importance score and partial membership receives half credit. These scores are then summed by country-year.</i>									
Treaties	Global share of treaty signing and ratifications weighted by importance as percent of total possible weighted participation	$\frac{(Treaty\ Score)(Possible\ Treaty\ Score)}{\sum_{c=1}^{188} (Treaty\ Score)(Possible\ Treaty\ Score)}$	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.50%
		<i>Treaty score: For a given country-treaty pair, ratifications receive the full credit of the treaty's importance score and signatures receive half credit. These scores are then summed by country-year.</i>									
Diplomatic Power Index (DPI)	Global share of diplomatic power) times government revenue	$\frac{Diplomatic\ Power\ Index * Government\ Revenue}{\sum_{c=1}^{188} Diplomatic\ Power\ Index * Government\ Revenue}$	0.00%	0.00%	0.00%	0.00%	15.00%	15.00%	20.00%	20.00%	0.00%
		<i>Diplomatic Power Index (DPI): The DPI is the weighted sum of Diplomatic connections, IGO membership, and Treaty signing/ratifications. DPI is calculated as follows: (99.83*((Embassies/EmbassiesMAX)^2)) + (35.49*((IGOs/IGOsMAX)^2)) + (7.34*((Treaties/TreatiesMAX)^1.5))</i>									
			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%



COUNTRY ENGAGEMENT WITH THE DIPLOMATIC SYSTEM

GPI and HHMI capture a country's engagement with the international system using the four variables listed and defined in Table 2. Data on IGO membership, treaties, and embassies⁹ is collected and maintained by the Pardee Institute as part of the Diplometrics project.

Table 2

Variable Name	Description	Weight for GPI	Weight for HHMI
Membership in International Governmental Organizations Weighted by Importance	New data on IGOs were created using the Volgy et al. (2008) inclusion criteria. IGO importance weights were calculated by searching for the organization name on Foreign Broadcast Information Service or World News Connection and normalized across databases.	0	5.1%
Signing/Ratification of Treaties Held by the United Nations Secretariat Weighted by Importance	Ratifying a treaty counts twice as much as signing a treaty. Treaty importance is weighted by searching on the Hein Online Law Journal Library. ¹⁰	0	2.5%
Number of Embassies Out	New diplomatic connection data was created using the Europa World Yearbook. ¹¹	0	7.6%
Diplomatic Power Index	The DPI combines the weighted membership in IGOs, weighted signing/ratification of treaties held by the United Nations Secretary General, and number of embassies countries have deployed abroad. DPI is calculated as follows: $(99.83 * ((\text{Embassies} / \text{EmbassiesMAX})^2))$ $+ (35.49 * ((\text{IGOs} / \text{IGOsMAX})^2))$ $+ (7.34 * ((\text{Treaties} / \text{TreatiesMAX})^{1.5}))$	15-20%	0%

⁹ Codebooks for the IGO membership, treaties, and embassies databases can be found here:

<<https://korbel.du.edu/pardee/content/diplometrics>>

¹⁰ More information on the Hein Online Law Journal Library can be found here:

<<https://home.heinonline.org/content/law-journal-library/>>

¹¹ More information on the Europa World Yearbook series can be found here:

<<http://www.europaworld.com/pub/>>



DATA COLLECTION METHODOLOGY

Secondary data are used to construct the Relative Power Indices and are gathered from various sources. When performing updates, most series are pulled from the IFs model, which is regularly updated to include the most recent data available across modules. Table 3 lists the sources for each variable and/or the input series used to construct it. Variables are organized by dimension of power.

Table 3

Component	Description	Input Variables	Source	HHI	HHMI	GPI
Military						
Military spending at MER	Global share of military spending at MER	GDP at MER	WDI, World Bank	Yes	Yes	Yes
		Military spending as a percent of GDP	Stockholm Institute for Peace and Security ¹² ; Arms Control and Disarmament Agency; World Military Expenditures and Arms Transfers			
Nuclear Weapons	Global share of nuclear weapons (logged)	Total nuclear warheads	Federation of American Scientists	No	Yes	Yes
Demography						
Population	Global share of population	Population	United Nations Development Program; WDI, World Bank	Yes	Yes	Yes
Economy						
FDI net inflow	Global share of external investment	FDI Net Inflows	WDI, World Bank	No	No	Yes
GDP at PPP/MER	Global share of GDP at PPP/MER	GDP at PPP/MER	WDI, World Bank	Yes	Yes	Yes
Trade	Global share of trade (exports plus imports)	Exports	WDI, World Bank & Direction of Trade Statistics, IMF ¹³	No	No	Yes
		Imports	WDI, World Bank & Direction of Trade Statistics, IMF ¹³			
Energy Production	Global share of energy production	Energy production	IEA	No	No	Yes
GDP at MER x GDP per capita at PPP	Global share of GDP at PPP times GDP per capita at PPP	GDP at PPP	WDI, World Bank	Yes	Yes	No
		GDP at MER	WDI, World Bank			

¹² More information about SIPRI can be found here: <http://www.sipri.org/research/armaments/milex/milex_database>

¹³ IFs uses pooled trade data, making it impossible to distinguish between extra-Soviet and intra-Soviet trade for Russia and Germany during the Cold War. To solve this problem, the GPI's trade series blends IFs/WDI data with data from the International Monetary Fund's Direction of Trade Statistics (DOTS) data. DOTS data is used from 1960 to 1990 for both countries.



Technology						
R&D spending	Global share of R&D expenditures	R&D spending as a percent of GDP	OECD Basic Science and Tech Stats, Government expenditure on R&D (GOVERD)	No	No	Yes
ICT stock	Global share of ICT capital stock	Capital stock in ICT	GTAP	No	No	Yes
International Interactions						
Foreign Aid	Global share of net foreign aid donations	Net aid given	WDI, World Bank; Organization for Economic Development and Cooperation (OECD); & UN Statistics Division (UNSD)	No	No	Yes
Embassies	Global share of number of embassies held in other countries as a percent of total possible embassies	Number of embassies out	Frederick S. Pardee Institute for International Futures	No	Yes	No
IGOs	Global share of IGO memberships weighted by importance	Weighted IGO membership	Frederick S. Pardee Institute for International Futures	No	Yes	No
Treaties	Global share of treaty signing and ratifications weighted by importance as percent of total possible weighted participation	Treaties by country (weighted)	Frederick S. Pardee Institute for International Futures	No	Yes	No
Diplomatic Power Index (DPI)	Global share of diplomatic power times government revenue	Government Revenue	IMF Government Finance Statistics	No	No	Yes
		Diplomatic Power Index	Frederick S. Pardee Institute for International Futures			

GAP-FILLING

Each relative measure of power is calculated by dividing the level of a resource possessed by one country in each year by the total amount of that resource available globally for that year. Creating a country-year measure of relative national power over long time horizons therefore requires accounting for all resources available globally in each year; however, annual data are often not available for all



countries. To address this issue, GPI and HHMI estimate where there are gaps in data. The historical data estimation techniques used are explained below. CINC was used to fill holes for all GPI variables pre-1960.

1. DPI Times Government Revenues

Original Source: Frederick S. Pardee Institute for International Futures; International Monetary Fund (IMF)

Notes: No data is estimated for membership in international organizations; the weight of international organizations; treaties signed and ratified held by the United Nations Secretary General; the importance of various treaties; or the number of “out embassies” a country possessed. A very large number of values for government revenue are estimated and re-adjusted to reflect forecast values that differed. All government revenue data are estimated as a share of GDP, with all values interpolated back to 1960. In addition, the forecast values for government revenue in IFs can differ from historical values. This reflects significant inconsistencies in cross-national comparability in government revenue. When government revenue is adjusted in IFs it considers government spending across all consumption categories, tax revenues, and foreign aid donations. Historical data and estimated values are chained to most recent¹⁴ estimates (and forecasts) for government revenue as a share of GDP, which is then multiplied by the Diplomatic Power Index.

2. Effective Population

Original Source: Frederick S. Pardee Institute for International Futures; United Nations Population Division (UNPD); World Development Indicators (WDI), World Bank

Notes: Where needed, the population who lives on less than \$3.10 per day are estimated using historical extrapolation (using the most recent five country-years for a baseline). The working age population (between 15 and 65 years) is calculated by using a historical forecast within IFs and then chained to most recent values (representing data). Additionally, where needed, the HDI is extrapolated historically using five country-years to establish a baseline.

3. Imports plus Exports

Original Source: WDI, World Bank

Notes: The IFs historical forecast is used to estimate imports plus exports as a share of GDP. This value is then multiplied by GDP at MER.

¹⁴ “Most recent” refers to the most recent values representing historical data



4. ICT Capital Stock

Original Source: Global Trade Analysis Project (GTAP)

Notes: Historical forecast (from 1960 to 2010) of ICT capital stock are taken using IFs. These values are chained to most recent values to produce an estimate of the total ICT capital stock in a country.¹⁵

5. Military Spending at MER

Original Source: Stockholm International Peace Research Institute (SIPRI); Arms Control and Disarmament Agency (ACDA); World Military Expenditures and Arms Transfers (WMEAT)

Notes: Data from SIPRI were prioritized, followed by data from ACDA and WMEAT. Holes were filled using interpolation and extrapolation. Data was gathered as military spending as a share of GDP or GNP and then multiplied by GDP at MER.

6. FDI Inflows

Original Source: World Development Indicators (WDI), World Bank

Notes: Negative values were turned to zero. Net FDI can be zero when there is a net reduction in foreign assets in a country in a given year.

7. Population

Original Source: United Nations Population Division (UNPD)

Notes: Very little hole-filling needed. When hole-filling was done it was through historical extrapolation using the previous five years of data.

8. R&D Spending

Original Source: OECD Basic Science and Tech Stats, Government expenditure on R&D (GOVERD)

Notes: Where necessary, R&D spending as a share of GDP is historically estimated by using the most recent value or the most recent estimate from IFs. These values were then multiplied by GDP at MER.

¹⁵ More information about the IFs economics module can be found here:
<<https://pardeewiki.du.edu//index.php?title=Economics>>



SEMI-SOVEREIGN ASSET REALLOCATION

To create a relative measure on the country-year level that accounts for total global resources, the index must account for all resources controlled by semi-sovereign bodies along with sovereign states. The GPI and HHMI do this by allocating values for semi-sovereign states to their sovereign power for each country-year pair. Table 4 lists each sovereign power to which one or more semi-sovereign bodies' values are aggregated.

Table 4

Assets controlled by country A (in header) until/between:

Australia		Portugal		United Kingdom	
Papua New Guinea	1976	Angola	1968	Bahamas	1973
Belgium		Cape Verde	1975	Bahrain	1971
Burundi	1962	Guinea-Bissau	1975	Barbados	1966
Rwanda	1962	Mozambique	1974	Belize	1981
China		Sao Tome and Principe	1975	Botswana	1966
Hong Kong	1998 - 2060	Russian Federation		Brunei	1984
Czech Republic		Armenia	1991	Fiji	1970
Slovak Republic	1993	Azerbaijan	1991	Gambia, The	1965
Ethiopia		Belarus	1991	Grenada	1974
Eritrea	1991	Estonia	1991	Guyana	1966
France		Georgia	1991	Hong Kong	1997
Algeria	1962	Kazakhstan	1991	Jamaica	1962
Comoros	1975	Kyrgyz Republic	1991	Kenya	1963
Djibouti	1977	Latvia	1991	Kuwait	1961
Mauritania	1961	Lithuania	1990	Lesotho	1966
Indonesia		Moldova	1991	Malawi	1964
Timor Leste	2001	Tajikistan	1991	Maldives	1965
		Turkmenistan	1991	Malta	1964
		Ukraine	1991	Mauritius	1968
		Uzbekistan	1991	Qatar	1971
		Serbia		Sierra Leone	1961
				Singapore	1964
				Solomon Islands	1978



Malaysia	
Singapore	
Netherlands	
Suriname	1975
New Zealand	
Samoa	1964-1964
Pakistan	
Bangladesh	1971

Bosnia and Herzegovina	1992
Croatia	1991
Macedonia, Former Yugoslav Republic of	1993
Montenegro	2006
Slovenia	1991
Kosovo	2008
South Africa	
Namibia	1975
Spain	
Equatorial Guinea	1993
Sudan	
South Sudan	2011

Saint Lucia	1979
Saint Vincent and the Grenadines	1979
Seychelles	1974
Swaziland	1967
Tanzania	1961
Tonga	1999
Trinidad and Tobago	1962
Uganda	1962
United Arab Emirates	1971
Vanuatu	1981
Zambia	1964
Zimbabwe	1965
United States	
Micronesia, Fed. States	1990
Puerto Rico	1960

VETTING METHODOLOGY

At every stage of data collection and/or updates to the Relative Power Indices, data are examined to ensure: 1) new data is from the same series and source as the original; 2) there are no major inconsistencies between the original data and new data (both pre- and post-transformation); 3) country aggregation was successful for all series; 4) there are no outliers or inconsistencies due to errors in the raw data or data input process; 5) any other data-integrity issues.

Once all input series have been updated, each year is vetted to ensure the index consistently sums to 100 and that the index history and forecast are reasonable and consistent with our theoretical framework. Moreover, vetting requires examining the values for several example states to ensure logical consistency within historical data and forecast trends. The vetting process relies heavily on data visualization.



NOTES

COMPARING INDICES

The three Relative Power Indices yield unique values for each country-year pairing that reflect their differential incorporation of input variables and weighting schemes, and there are advantages and disadvantages to using each for analysis. Importantly, the GPI includes a broader range of more specific variables than does the HHI. For example, it adjusts absolute population by the number of people who live in poverty and includes energy production and ICT capital stock. In contrast, the HHMI is adapted from the HHI and uses fewer and more generalized variables. Because the GPI uses more specific inputs, forecast scenarios that explore the impact of specific policy choices can be made using the index. On the other hand, the HHMI's more general set of variables means that it is less prone to changes in specific technologies associated with the national projection of power.

SUMMARY STATISTICS & SELECT VISUALIZATIONS

The Relative Power Indices allow one to view the relative power position of every country starting in 1960. The indices' values rely on historical data to 2019 as of the most recent update and can be forecast using the IFs model. Figures 1 - 3 provide a visual representation of each index over time, with forecasts from 2019 onward using IFs version 8.14. Using the indices, one can observe evidence of major events, such as the end of the Cold War and dissolution of the Soviet Union which was accompanied by a sudden drop in Russia's power metric. In addition, all three indices forecast a decline in US power such that it is eclipsed by China with India beginning a process of catch-up in the later period. The rate of transition varies depending upon the index.



In addition, the indices can be used to classify and analyze the number of major, middle, and lesser powers. Major powers are those defined as having more than 9% of global power. Middle powers have more than 2% but less than 9% of global power, and lesser powers are those below 2%. Table 5 summarizes the number of major, middle, and lesser powers every twenty years from 1960 to 2040 in each index. The period of unipolarity in which the US is the sole major power is relatively short (in HHI lasting from 1990 to 1998), and by 2040 three major powers are identified in the HHI and HHMI (US, China, and India) but only the US and China are identified as major powers in the GPI. In addition, the number of middle powers is also forecast to decline in all three indices, though there is significant discretion by 2040 between the largest (6 in the GPI) and smallest estimates (3 in the HHMI).

Table 5

	1960	1980	2000	2020	2040
HHI					
MAJOR	2	2	2	2	3
MIDDLE	7	8	8	7	4
LESSER	179	178	178	179	181
HHMI					
MAJOR	2	2	1	2	3
MIDDLE	7	8	9	6	3
LESSER	179	178	178	180	182
GPI					
MAJOR	3	2	1	2	2
MIDDLE	5	7	10	6	6
LESSER	180	179	177	180	180



Figure 1: HHI, Relative Power of Select Major and Middle Powers, History and Forecast

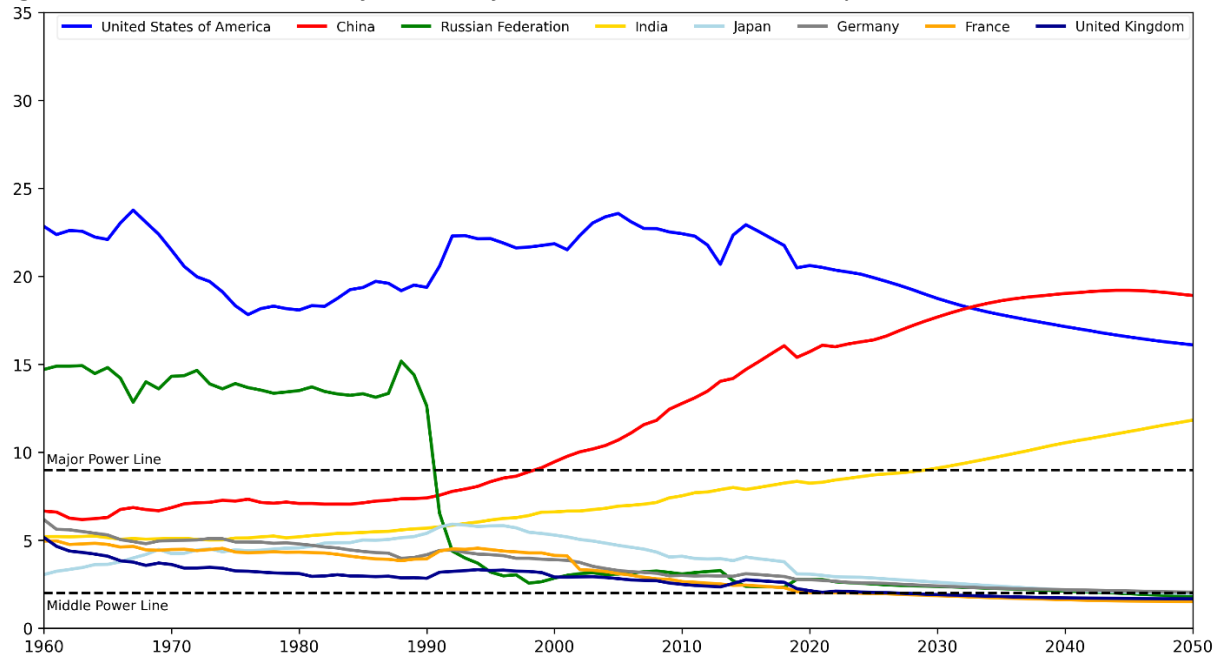


Figure 2: HHMI, Relative Power of Select Major and Middle Powers, History and Forecast

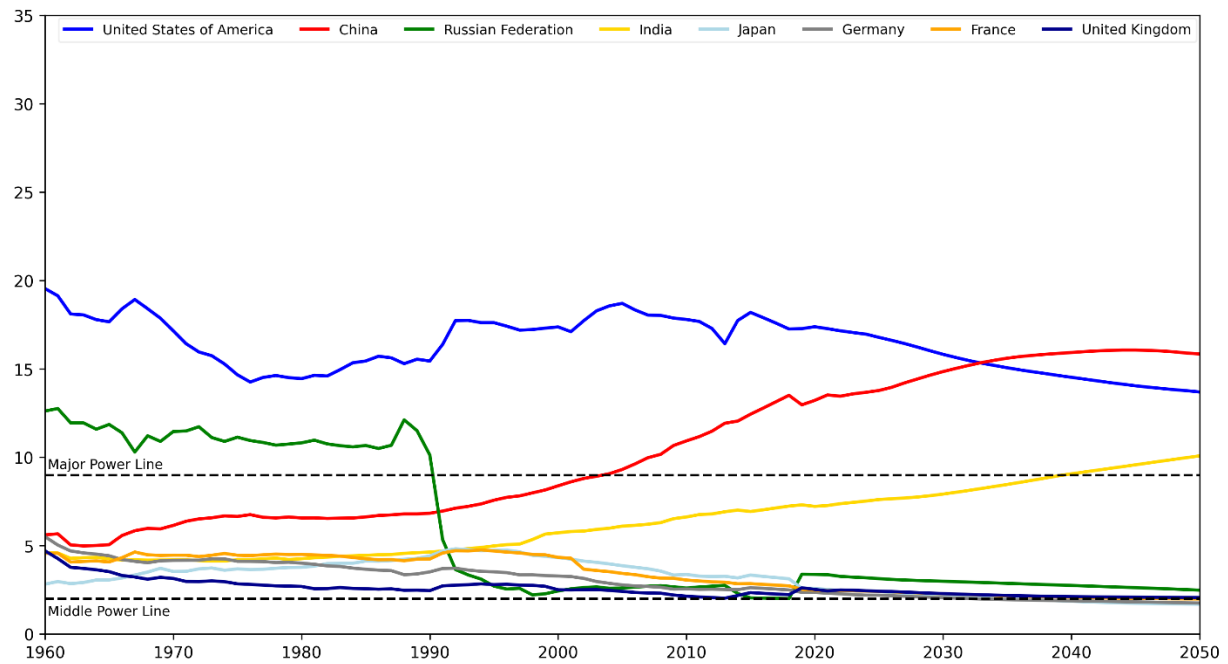


Figure 3: GPI, Relative Power of Select Major and Middle Powers, History and Forecast

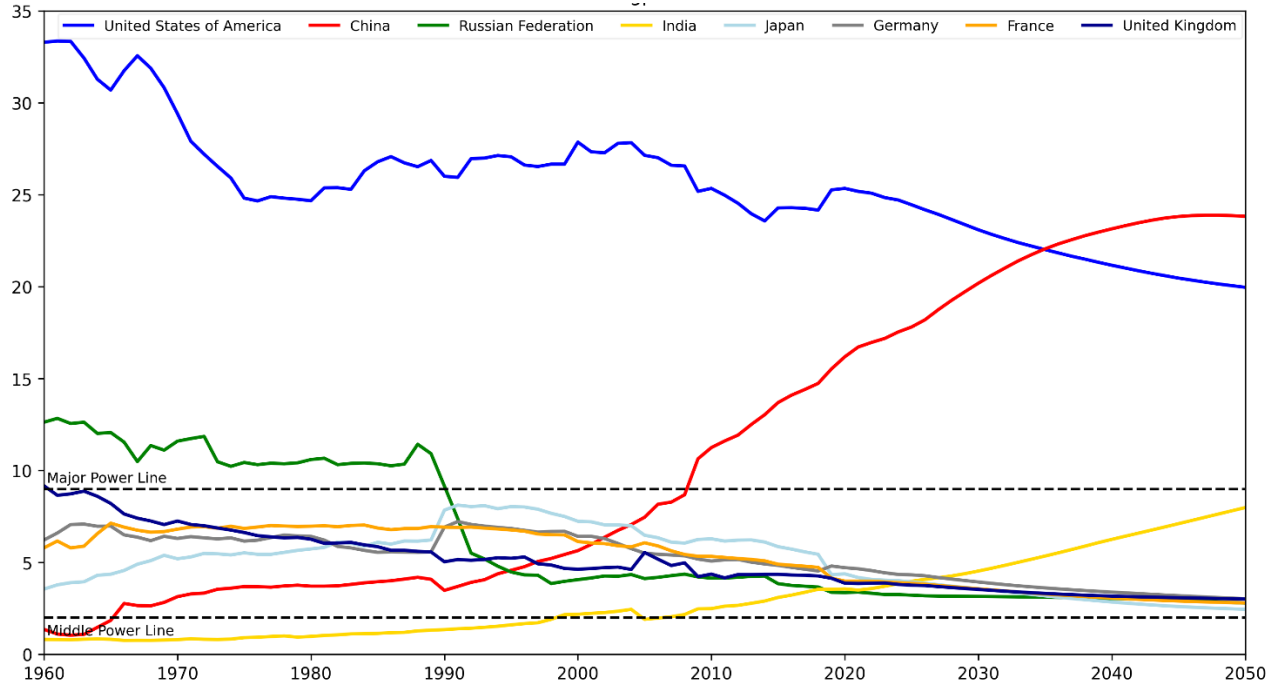
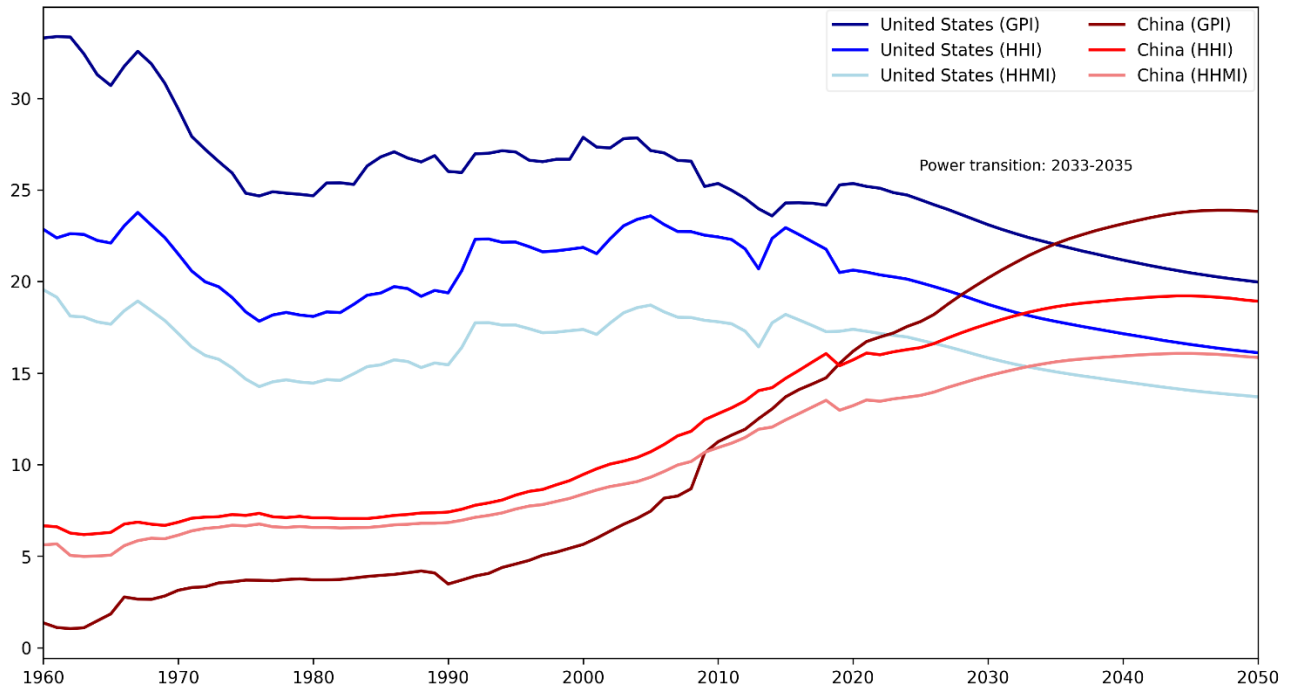


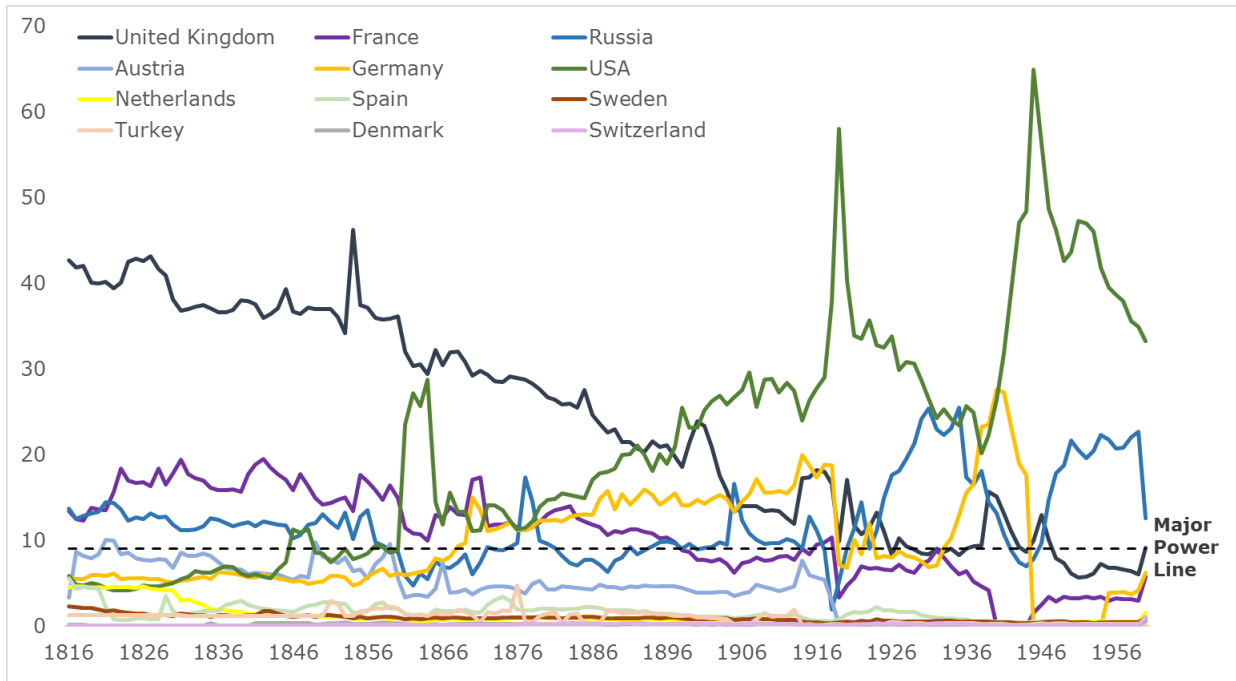
Figure 4: Relative Power of China and the United States, History and Forecast



The imminent power transition between the US and China is a point of great interest to many within the international relations policy and academic communities. Figure 4 presents the relative power scores for the US and China across the HHI, HHMI, and GPI. Within the indices presented here, this transition happens earliest in the HHI and the HHMI which see transition in the same year (2033) and latest in the GPI (2035). In either case, the Relative Power Project forecasts China's power exceeding that of the US within the next fifteen years. The outcome of such a transition is unclear and the source of frequent speculation.



Figure 5, GPI, Relative Power from 1816 to 1960 for Select Countries



The GPI measures relative power from 1816 to 1960 using solely material capabilities (military spending, nuclear weapons, iron and steel production, and energy consumption). However, only 12 countries have GPI metrics available starting as far back as 1816; these are depicted in Figure 5. One notable difference between the period prior to 1960 is the relatively larger number of major powers at any given time. Whereas there have been no more than three major powers at once since 1960 (and more often two or one), in the pre-1960 era there were regularly as many as four major powers at once. Only one major power (Russia) managed to maintain that status relatively consistently over the entire period. By the end of the Second World War, France and the UK had fallen into middle power range, overtaken by a power-dominant US.



WORKS CITED IN CODEBOOK

Volgy, T. J., Fausett, E., Grant, K. A., & Rodgers, S. (2008). Identifying Formal Intergovernmental Organizations. *Journal of Peace Research*, 45(6), 837–850.
<https://doi.org/10.1177/0022343308096159>

