



RELATIVE NATIONAL POWER (POWER) CODEBOOK

VERSION NUMBER: 7.2.2018

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ACKNOWLEDGMENTS

The authors would like to thank John McPhee for playing a key leadership role in maintaining and overseeing 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. 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. Energy Exports minus Imports	13
4. Imports plus Exports	14
5. ICT Capital Stock	14
6. Military Spending at MER	14
7. FDI Inflows	14
8. Population	14
9. R&D Spending	15
SEMI-SOVEREIGN ASSET REALLOCATION	15
VETTING METHODOLOGY	16
NOTES	17
COMPARING INDICES	17
THE GLOBAL POWER INDEX: MEASURING POWER PRIOR TO 1960	17
SUMMARY STATISTICS & SELECT VISUALIZATIONS	17
WORKS CITED IN CODEBOOK	22





DIPLOMETRICS

INTRODUCTION

DIPLOMETRICS

The Diplometrics project at the Pardee Center 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. The project expects to add to this data collection effort by producing data on non-state actors including international non-governmental organizations, multinational corporations, and transnational organized crime. We have also developed tools to help visualize the data, the Diplomatic Dashboard¹ analyze and aggregate our data.² 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).³ 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 Center 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-

¹ Explore the Diplomatic Dashboard here: <<http://diplodash.pardee.du.edu/>>

² Explore Pardee's online aggregation tool DataGator here: <datagator.org>

³ More information about IFs and a link to use the online model can be found here: <[http://pardee.du.edu:8088/index.php?title=International_Futures_\(IFs\)](http://pardee.du.edu:8088/index.php?title=International_Futures_(IFs))>



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 186 countries in the model to 2100.

CITATION

Cite data as follows:

Moyer, Jonathan D., Alanna Markle. "Relative National Power Codebook." Diplometrics. Denver, CO: Frederick S. Pardee Center for International Futures, Josef Korbel School of International Studies, University of Denver, 2017.

⁴ More information on CINC is available here: <<http://www.correlatesofwar.org/data-sets/national-material-capabilities/national-material-capabilities-v4-0>>



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 186 countries. The use of this list allows them to be fully integrated into the model.

In addition, the data is available using the standard COW⁶ 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 four 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).

⁵ This codebook will primarily document the three indices starting in 1960 for simplicity and meaningful comparison. Please see the Notes section for further details on the GPI's composition in earlier years.

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
					1960-1990	1990-2005	2005+	
Military								
Military Personnel	Global share of military spending at MER	$\frac{\text{Military Personnel at MER}}{\sum_{c=1}^{186} \text{Military Personnel at MER}}$	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%
Military spending at MER	Global share of military spending at MER[1]	$\frac{\text{Military Spending at MER}}{\sum_{c=1}^{186} \text{Military Spending at MER}}$	16.67%	29.00%	30.00%	20.00%	20.00%	22.80%
Nuclear Weapons	Global share of nuclear weapons (logged)	$\frac{\text{Log(Nukes)}}{\sum_{c=1}^{186} \text{Nukes}}$	0.00%	0.00%	10.00%	5.00%	5.00%	6.30%
Demography								
Urban Population	Urban population	$\frac{\text{Urban Population}}{\sum_{c=1}^{186} \text{Urban Population}}$	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%
Population	Global share of population	$\frac{\text{Population}}{\sum_{c=1}^{186} \text{Population}}$	16.67%	26.00%	10.00%	10.00%	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	$\frac{\text{Effective Human Capital}}{\sum_{c=1}^{186} \text{Effective Human Capital}}$ <p><i>Effective Human Capital: Working age population living above the \$3.10⁸ a day poverty line weighted by the squared value of HDI. In the model this is achieved by:</i></p> $\left[(\text{Population} - \text{Population living under } \$3.10 \text{ a day}) \right. \\ \left. * \left(\frac{\text{Population 15 to 65}}{\text{Population}} \right) \right] * \text{HDI}^2$	0.00%	0.00%	0.00%	0.00%	10.00%	0.00%

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

⁸ All dollar amounts and related estimates are in 2011 USD



Economy								
Energy Exports	Global share of energy exports minus global share of energy imports (can be negative)	$\frac{Energy\ Exports}{\sum_{c=1}^{186} Energy\ Exports}$	0.00%	0.00%	0.00%	0.00%	5.00%	0.00%
Foreign Direct Investment (FDI) Inflow	Global share of foreign direct investment	$\frac{FDI\ inflows}{\sum_{c=1}^{186} FDI\ inflows}$	0.00%	0.00%	0.00%	0.00%	5.00%	0.00%
GDP at PPP	Global share of GDP at PPP	$\frac{GDP\ at\ PPP}{\sum_{c=1}^{186} GDP\ at\ PPP}$	0.00%	35.00%	25.00%	25.00%	20.00%	27.80%
Trade	Global share of trade (exports plus imports)	$\frac{Exports + Imports}{\sum_{c=1}^{186} Exports + Imports}$	0.00%	0.00%	5.00%	15.00%	5.00%	0.00%
Iron and Steel Production	Global share of iron and steel production	$\frac{Energy\ Production}{\sum_{c=1}^{186} Energy\ Production}$	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%
Energy Consumption	Global share of energy consumption	$\frac{Energy\ Consumption}{\sum_{c=1}^{186} Energy\ Consumption}$	16.67%	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	$\frac{(GDP\ at\ MER)(GDP\ per\ capita\ at\ PPP)}{\sum_{c=1}^{186} (GDP\ at\ MER)(GDP\ per\ capita\ at\ PPP)}$	0.00%	10.00%	0.00%	0.00%	0.00%	7.60%
Research and Development (R&D) Spending	Global share of R&D expenditures	$\frac{R\&D\ Spending}{\sum_{c=1}^{186} R\&D\ Spending}$	0.00%	0.00%	10.00%	10.00%	5.00%	0.00%
Information Communication Technology (ICT) capital stock	Global share of ICT capital stock	$\frac{ICT\ Capital\ Stock}{\sum_{c=1}^{186} ICT\ Capital\ Stock}$	0.00%	0.00%	0.00%	0.00%	5.00%	0.00%



International Interactions								
Foreign Aid	Global share of foreign aid donations	$\frac{\text{Aid Donations}}{\sum_{c=1}^{186} \text{Aid Donations}}$	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	$\frac{(\text{Diplomatic Exchanges})/(\text{Possible Diplomatic Exchanges})}{\sum_{c=1}^{186} (\text{Diplomatic Exchanges})/(\text{Possible Diplomatic Exchanges})}$	0.00%	0.00%	0.00%	0.00%	0.00%	7.60%
IGOs	Global share of IGO memberships weighted by importance as a percent of total possible weighted memberships	$\frac{(\text{IGO Score})(\text{Possible IGO Score})}{\sum_{c=1}^{186} (\text{IGO Score})(\text{Possible IGO Score})}$ <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>	0.00%	0.00%	0.00%	0.00%	0.00%	5.10%
Treaties	Global share of treaty signing and ratifications weighted by importance as percent of total possible weighted participation	$\frac{(\text{Treaty Score})(\text{Possible Treaty Score})}{\sum_{c=1}^{186} (\text{Treaty Score})(\text{Possible Treaty Score})}$ <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>	0.00%	0.00%	0.00%	0.00%	0.00%	2.50%
Diplomatic Power Index (DPI)	Global share of diplomatic power) times government revenue	$\frac{\text{Diplomatic Power Index} * \text{Government Revenue}}{\sum_{c=1}^{186} \text{Diplomatic Power Index} * \text{Government Revenue}}$ <i>Diplomatic Power Index (DPI): The DPI is the weighted sum of Diplomatic connections, IGO membership, and Treaty signing/ratifications, where the Diplomatic Connections component receives a weight of 0.5, the IGO membership component receives a weight of 0.33, and the Treaty component receives a weight of 0.17.</i>	0.00%	0.00%	10.00%	15.00%	15.00%	0.00%
			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 five variables listed and defined in Table 2. Data on IGO membership, treaties, and embassies⁹ is collected and maintained by the Pardee Center 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	3%
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	7%
Number of Embassies Out	New diplomatic connection data was created using the Europa World Yearbook. ¹¹	0	10%
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. It divides the three sub-measures by the highest country-year score in IGOs, treaties, and embassies weighted at 0.33, 0.17, and 0.5 respectively.	15-20%	0%

⁹ Codebooks for the IGO membership, treaties, and embassies databases can be found here: <http://pardee.du.edu/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 4 lists the sources for each variable and/or the input series used to construct it. Variables are organized by dimension of power.

Table 4

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			
Nuclear Weapons	Global share of nuclear weapons (logged)	Total nuclear warheads	Bulletin of the Atomic Scientists	No	Yes	Yes
Demography						
Population	Global share of population	Population	United Nations Development Program	Yes	Yes	Yes
Economy						
FDI inflow	Global share of external investment	GDP at MER	WDI, World Bank	No	No	Yes
		FDI Inflows at a percent of GDP	WDI, World Bank			
GDP at PPP	Global share of GDP at PPP	GDP at PPP	WDI, World Bank	Yes	Yes	Yes
Trade	Global share of trade (exports plus imports)	GDP at MER	WDI, World Bank	No	No	Yes
		Trade as a percent of GDP	WDI, World Bank & Direction of Trade Statistics, IMF ¹³			
Energy Production	Global share of energy production	Energy production	IEA	No	No	Yes

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.



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			
Technology						
R&D spending	Global share of R&D expenditures	GDP at MER	WDI, World Bank	No	No	Yes
		R&D spending as a percent of GDP	United Nations Educational, Scientific, and Cultural Organization (UNESCO)			
ICT stock	Global share of ICT capital stock	Capital stock in ICT	GTAP	No	No	Yes
International Interactions						
Foreign Aid	Global share of 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 Center for International Futures	No	Yes	No
IGOs	Global share of IGO memberships weighted by importance	Weighted IGO membership	Frederick S. Pardee Center 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 Center for International Futures	No	Yes	No
Diplomatic Power Index (DPI)	Global share of diplomatic power times government revenue	Diplomatic Power Index	Frederick S. Pardee Center for International Futures	No	No	Yes

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.

1. DPI Times Government Revenues

Original Source: Frederick S. Pardee Center 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 Center 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. Energy Exports minus Imports

Original Source: International Energy Agency (IEA)

Notes: Net energy import countries are given values of zero (this contribution to power cannot be negative). Data is estimated historically when estimated values for most recent data are

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



above zero. The most recent five country-year data points are used to historically extrapolate values where data does not exist.

4. 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.

5. 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

6. Military Spending at MER

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

Notes: Data from SIPRI were prioritized, followed by data from ACDA. 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.

7. 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.

8. 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.

¹⁵ More information about the IFs economics module can be found here:
<<http://pardee.du.edu:8088/index.php?title=Economics>>



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 exports 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.

THE GLOBAL POWER INDEX: MEASURING POWER PRIOR TO 1960

The GPI is calculated starting in 1816; however, the pre-1960 index is less comprehensive and relies solely on material capabilities to measure states' relative power. Table 5 lists the variables used to calculate the index from 1816 to 1959 and their respective weights.

Table 5

	1816 (%)	1945 (%)
Military Expenditures (CINC)	40	35
Nuclear weapons	-	10
Iron and steel production	25	20
Energy consumption	25	25

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 2015 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. 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 first by China and, eventually, India. The rate of these transitions 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 6 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 all three indices (US, China, and India). 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 (1 in the HHMI).

Table 6

	1960	1980	2000	2020	2040
HHI					
MAJOR	2	2	2	2	3
MIDDLE	7	8	8	7	3
LESSER	177	176	176	177	180
HHMI					
MAJOR	2	2	1	2	3
MIDDLE	7	8	9	5	1
LESSER	177	176	176	179	182
GPI					
MAJOR	3	2	1	2	3
MIDDLE	5	7	10	7	6
LESSER	178	177	175	177	177



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

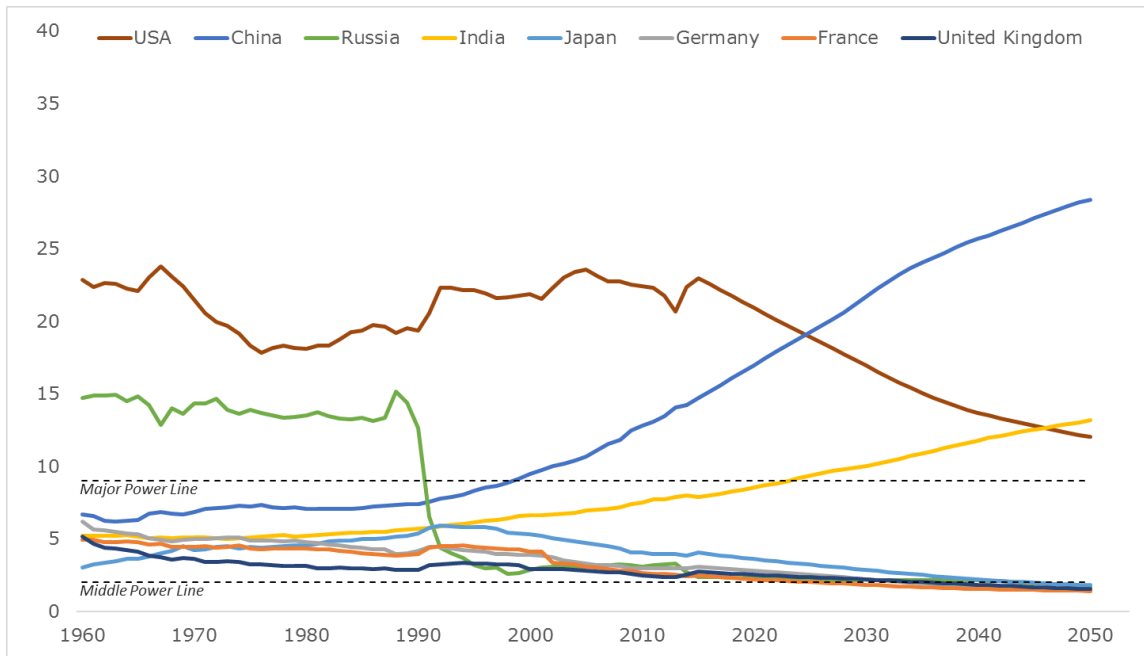


Figure 2: HHMI, Relative Power of Select Major and Middle Powers, History and Forecast

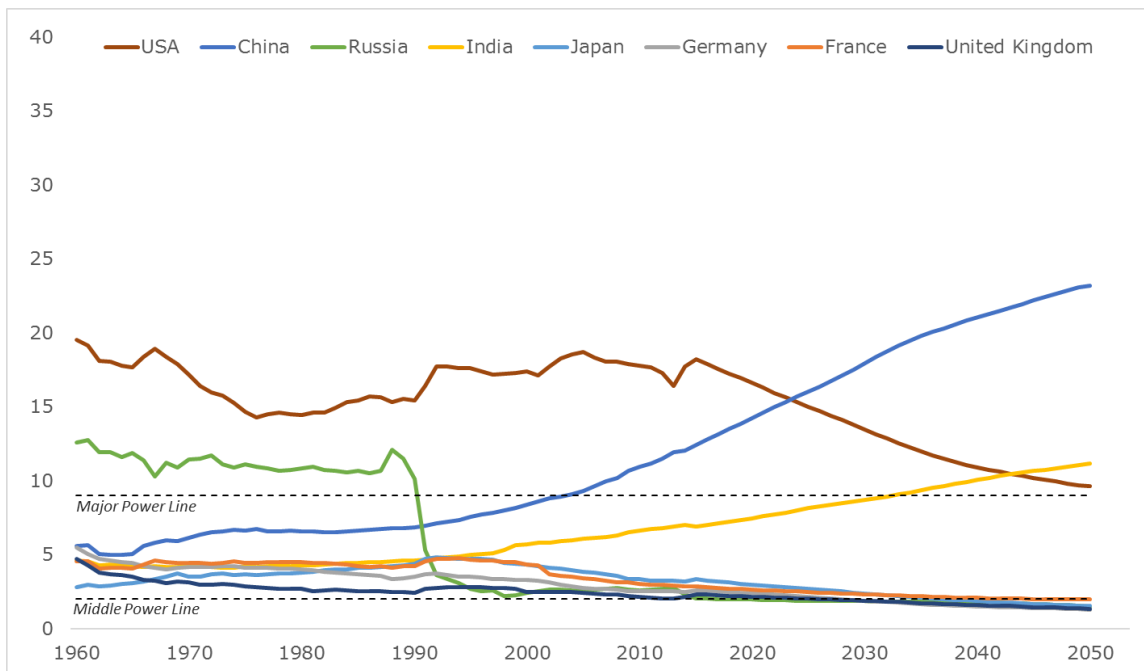
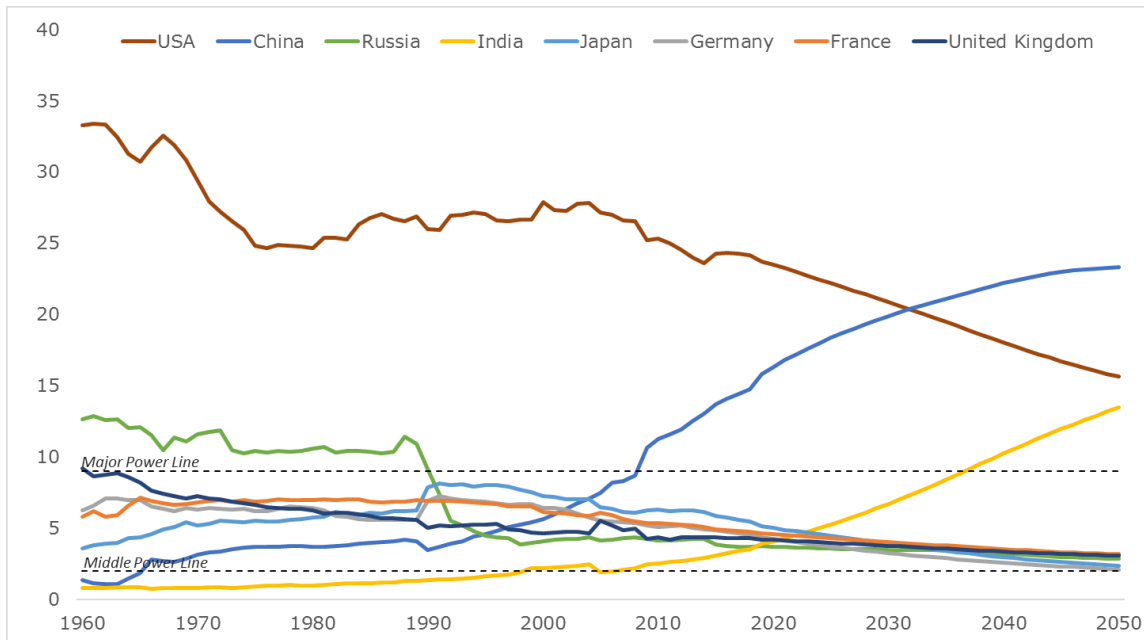


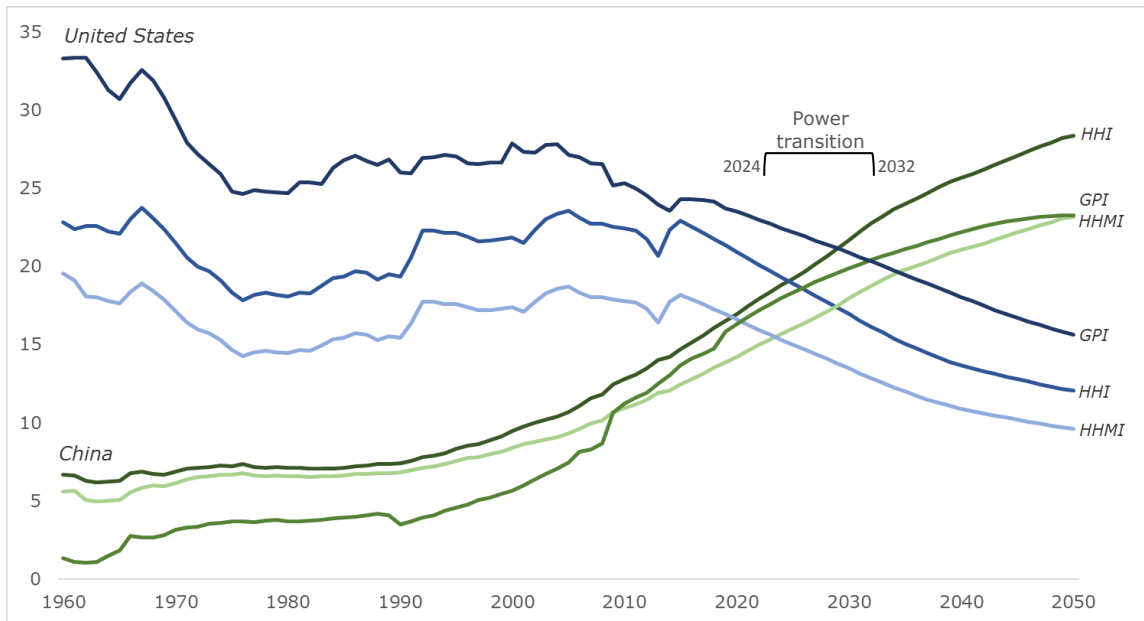
Figure 3: GPI, Relative Power of Select Major and Middle Powers, History and Forecast



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 HHMI (2024) and latest in the GPI (2032). The HHI falls just after HHMI at 2025. 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.



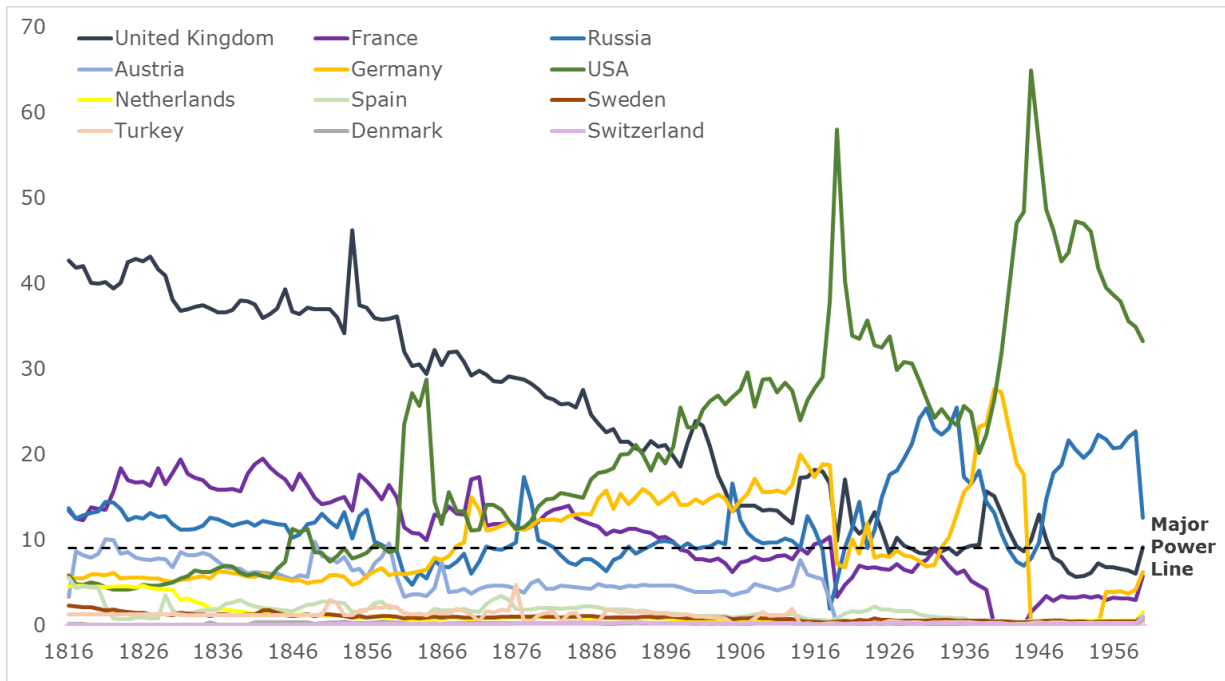
Figure 4: Relative Power of China and the United States, History and Forecast



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.



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



WORKS CITED IN CODEBOOK

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