National power: what its elements and how to measure

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National power is the most important and fundamental tool for preserving the identity and achieving the national goals and interests of countries in geopolitics and the new global order. The purpose of this study is to design and implement a software for measuring the national power of countries that, using reliable and up-to-date data, enables users to provide comprehensive and accurate analyses of the national power status of countries. Initially, the article explores the definitions related to national power, models, and existing software related to the measurement of national power. Then, an attempt is made to design comprehensive and widespread software for measuring the national power of countries by examining their weaknesses and flaws. Consequently, the software for measuring national power is designed in a programming environment, encompassing applications such as scale definition, country entry and exit, index definition, year determination, data, charts, period compare-son, and comparison of different geopolitical regions. The software is designed in such a way to extract three categories of outputs related to national power in the form of tables, graphs, and maps. Moreover, maps are generated in the GIS environment to enhance the visual representation of dynamic national power.

Keywords:
national power,
models of national power,
national power assessment software,
visual representation of
national power

Introduction

Power is a vital factor for survival, and is then desirable to individuals, groups, and governments (Setayesh Menesh 2024). Power can be defined as a characteristic of a being that enables them to take action towards their desires and goals (Hafeznia 2016). Thus, power can be seen as an inherent capability and the relationship between various

factors (Dehghani 2023). When power is observed within a society or nation and takes the form of a political-spatial structure, it is known as national power. Such a power is a combination of positive and negative elements and foundations of a country, which is dynamic and understandable compared to other nations and countries (Hafeznia et al. 2019, Khanjani–Kargar 2023, Nasirzadeh et al. 2023, Rostami 2022). In essence, national power can be considered a geopolitical concept that reflects the collective attribute of individuals within a nation and simultaneously manifests as an individual attribute in relation to a country and government (Hafeznia–Salehabadi 2019, Hafeznia 2018, Hafeznia et al. 2021).

Measuring national power is crucial for countries worldwide because it provides a comprehensive understanding of a country's potential at various levels and facilitates a comparison of its power and socio-economic development with other countries (Bakhtizin et al. 2021, Askari–Shahbaz 2023). Our approach toward assessing national power follows Wrong (1979: p. 1), who contends that while we may not be able to measure power per se, we can measure "the power of being," or "an actor's general ability to produce successful performances." In other words, we can reasonably expect that these factors do generally correspond with A's ability to get B to do what it otherwise would not have done. These factors also undoubtedly underpin relations that produce power, as argued by Wendt (1999: p. 96, pp. 109–113) with his notion of "rump materialism". Therefore, an appropriate method is required to measure national power since the balance of power is the driving force behind global politics, playing a role as significant as energy in physics or monetary power in the economy. It is a key variable in theories of war and peace, international cooperation, state-building, trade, nuclear proliferation, and democratization (Beckley 2018).

It is important to measure and assess national power (Najafi et al. 2023). While many researchers have explored conceptual models (Cohen 1994, Liu 1980) and quantitative models (Aslani 2009, Cutright 1969, Nasirzadeh et al. 2023, Stewart 1948, Zarghani 2010) to study the sources of national power and design mathematical models for its measurement, there has been no study focusing on the design of software for measuring national power. Therefore, the present study aims to design software to measure the national power of countries using reports and visualizations (interactive charts and maps) that meet the different needs of users and help in strategic decision-making, because without the ability to measure national power, it cannot be managed effectively (Mitre-Hernández et al. 2014). In fact, the use of software based on intelligent algorithms and computer design can help process large volumes of data and utilize the results for measuring national power (Nouri–Sadeghi 2020). This article reports an attempt to design software based on a nine-fold model of power (economic factors, territory factors, political factors, scientific factors, social factors, cultural factors, military factors, transboundary factors, and spatial factors) and examine the concept of national power at the global, regional, organizational, and composite levels. The software is expected to measure the national power of desired countries in terms of each component or indicator in various dimensions, and to add

or remove countries and relevant indicators. Accordingly, the research objectives are as follows:

1. Designing dynamic software to measure national power.
2. Designing software for subjective measurement of national power in nine dimensions.
3. Developing an analytical and visual tool that allows users to assess the national power of countries in different dimensions and achieve more accurate comparisons and analysis.
4. This tool can be used in international negotiations, domestic policymaking, and academic research.

The study is organized into the following sections: first, definitions of national power, its sources, and measurement and evaluation methods are provided. Then, the national power measurement software is described. After discussing the research the design of the national power measurement model is presented and the software is introduced. Next, the verification capability of the software is examined. Finally, the study with a discussion of potential future research is concluded.

National power, sources, and measurement and evaluation methods

In general, national power elements can be divided into two categories: natural elements, including geography, population, and natural and underground resources, and non-natural elements, including economic, military, political, psychological, and informational factors (Abdolalipuor 2021, Ghorbi 2021, 2023, Maqsoodlou et al. 2023, Salehi et al. 2023, Zargar–Molaee 2022). Many scholars have examined national power (Salcedo-Sanz et al. 2020), focusing on quantitative variables such as gross domestic product (GDP), military power, population size, wealth, time, political capital, geographical extent, economic power, etc., while others have used mathematical models to determine the relationship and combination of variables (Arikan et al. 2020, Assa–Kvangraven 2021, Bellos–Golitsis 2023, Kadera–Sorokin 2004, Mottaghi et al. 2023, Nazari–Noori 2022, Wang et al. 2021). It is evident that to create a comprehensive model, one cannot achieve the desired goal without knowledge of others' work and criticism. For example, Josh Goldstein considers GDP (Faraji 2024), Sephernia (2022), the cultural and social factors, Poustinchi (2023), the mobilization of social groups, Pourshasab (2023), population, ideology, national spirit, and solidarity, Väyrynen (2022) emphasizes militarization, Muradi (2024), geographical factors, and Morales–Rocha (2022), material, semi-material, and non-material factors as the best indicators of national power measurement. It can be noted that many of these opinions have many commonalities and share common variables such as territory, economic, political, cultural, and social factors. Based on these theories, national power is divided into five categories: small powers, medium powers, regional powers, major powers, and superpowers. All nations in the world

are dynamically ranked, constantly striving for power in various dimensions and domains (Rowland et al. 2014, Sepehrzadeh 2022).

Assessing and measuring the power of nations has always been of interest to scholars. Alongside the examination of sources and origins of power, some scholars have also attempted to assess and evaluate the power of nations. The necessity of conducting the present research within this framework is that in the case of being unaware of the national power of other countries, it is not possible to establish relations with them (Zaree et al. 2023). In this regard, Eric Moore (2014) believes that national power can be measured as the economic power of a nation and can be defined by GDP or gross national product (GNP) of countries for comparing national power. Western researchers who believe in a univariate measurement for measuring national power include Alcock–Newcombe (1970), Fucks (1965), Brooks–Wohlforth (2015). Waltz (1979) suggested that the measurement of national power should include population and territory, resources, economic capability, military capability, political stability, and legitimacy (Saradzhyan–Abdullaev 2020). Interest in power relations, both militarily and geopolitically, has always attracted rulers and commanders, but after World War II, the increasing interest in estimating and measuring the power of governments was facilitated by unprecedented developments in information technology and advancements in formal sciences such as cybernetics, game theory, econometrics, and etc. (Sułek 2020). Some of these models can be mentioned as examples: Zaree et al. (2024) used the content analysis method with both the in-depth and breadth approaches. Alferenso (2021) measured naval power. He presented a model for measuring naval power that enables the evaluation and comparison of countries. For this purpose, he used fundamental conceptual beliefs on naval force to create clear and measurable definitions of concepts such as power, maritime development, maritime security, and naval force, supported by indicators that validate the model's credibility and reliability. NMD is an algorithm that aggregates indicators that measure the indicators; i.e. human capital (hC), plus physical capital (pC), multiplied by GDP with a technological aggregate (Tec) index, using a legal framework (Lf) sector index. This algorithm was constructed during the development of this study and solved using computer tools in Excel. Another method presented by the Chinese Military Academy on behalf of Suofeng is CNP, which should encompass organic integration of survivability, development, and coordination capacities; so he designed a "CNP dynamics equation" in which P is a fixed year; K is the coordination system, including factors such as national leaders' capacities for coordination and alignment; H is hardware, including all physical factors; and S is software, including ideal ethics, intelligence, and etc. The national power of a country in the cyber dimension can be measured. It is stated that the most comprehensive cyber power of a country is the one that (1) intends to pursue multiple national goals using cyber tools and (2) has the capacity to achieve those goal(s).

Table 1

Selected methods of measuring national power*

No. of variables	Country of origin	Author	No. of variables	Country of origin	Author
2	Germany	Friedensburg (1936)	2	Germany	Süßmilch (1765)
2	USA	Wright (1955)	3	USA	Stewart (1948, 1954)
5	USA	Guetzkow (1963)	20	UK	German (1960)
5	Japan	Shimbori et al. (1963)	3–6	UK	Cole (1963)
3	Germany	Fucks (1965)	7–9	USA	Cohen (1963)
3	USA	Shinn (1969)	3	Brazil, Argentina	Schwartzman–Mora Y Araujo (1966)
6	USA	Singer et al. (1972)	2–3	Canada	Alcock–Newcombe (1970)
8	USA	Ferris (1973)	236	USA	Rummel (1972)
25	USA	Rosecrance et al. (1974)	5	Canada, USA	Cox–Jacobson (1973)
12	USA	Cline (1975)	5	UK	Muir (1981)
3	USA	Udell (1975)	7	USA	Mildarsky (1975)
2	USA	Farrar (1981)	5	USA, Kuwait	Saaty–Khouja (1976)
17	Japan	EPA (1987)	5	Taiwan	Liu (1980)
4	China	Yu–Wang (1989)	3–5	USA	Beckman (1984)
3	Poland	Sułek (1990)	6–22	USA	Stoll–Ward (1989)
5	USA	Barcia (1993)	3	USA	Sullivan (1990)
6	China	Yan (1996)	64	China	Wang (1996)
38	China	Ou-yang (2006)	4	Russia	Khachaturov (1997)
11	China	Zhu–Xiao (1999)	5	Poland	Sułek (2020)
25	USA	Tellis et al. (2000)	4	France	Caro (1999)
23	China	Hu–Men (2002)	103	Japan	NIRA (2004)
8–11	Poland	Orłowski (2007)	22	USA	Sparks–Gates (2003)
2	India	Virmani (2004)	2	USA	Volgy–Bailin (2003)
55	USA	GlobalFirepower (2005)	39	Japan	Sodekawa (2004)
3	Brazil	Goncalves (2005)	5	USA	Treverton–Jones (2005)
86	Iran	Hafeznia et al. (2006)	128	China	Wang (2006)
6	The Republic of Korea	Kim (2007)	8	Germany	Höhn (2006)
8	Poland	Lach et al. (2008)	13	Russia	Melville (2007)
44	Индия	Jaishankar (2009)	13	The Republic of Korea	Hansun Foundation (2009)
25	Brazil	Zahreddine–Gomide (2009)	10	Turkey, Azerbaijan	Aslani (2009)
186	Brazil	Serrão–Longo (2011)	10	Poland, Germany	Milewicz (2010)
9	Moscow	Collective author, Report to be discussed, Moscow (2009)	7	Australia	Lowy Institute Asia Power Index (2024)

* Further details can be found at References.

Software for national power measurement

To assess the national power of a country, various indicators and methods are often used. These indicators usually include economic growth, scientific and technological capabilities, military strength, national wealth, and other factors that help measure the power of a country. Additionally, there are multiple software programs available for constructing and measuring different indicators of national power.

In relation to the assessment of military power of countries, the use of software for measuring national power and analyzing military forces is vital (Montgomery 2020). These software programs are employed for collecting and analyzing various military data, enabling the assessment of the capabilities and capacities of each military force to counter different threats and constraints (Downy et al. 2021). TiberCAD, for instance, designed and developed by the TiberCAD Research Institute in Italy, is recognized for its power and capability in analyzing military strength (Vichi et al. 2022). AWACS Planner is also designed by Boeing in the United States, developed for planning and evaluating military power enhancement (Bonsignore 2022). Furthermore, MOTB, created by "Groupa Haluzovoy Konsolidatsii" in Ukraine, is used for managing and planning military resources and measuring national power in the country (Živadinović et al. 2016). AEGIS is also developed by Lockheed Martin for use in air defense systems, which is capable of measuring national power (Khan 2020). Designed and developed by the U.S. Department of Defense, JCATS is used for military scenario simulation and analysis of national power (America 1999). Finally, C3I is designed and developed by various companies like Thales Group and Raytheon, and is used for managing and controlling military operations and measuring military power (Afina et al. 2020).

There are also instruments which are used for socioeconomic power assessment. corruption perceptions index (CPI), produced by Transparency International, is used for measuring the level of corruption in countries based on various indicators such as bribery, transparency in policies, and independent judiciary (Hosseini et al. 2020). human development index (HDI), also developed by the United Nations, is used to measure and rank the human development of countries, which includes three main parameters: life expectancy, education level, and country income. This index is employed to express the quality of life and well-being of populations at the national level (Omrani et al. 2020). Further, developed by the École Polytechnique Fédérale de Lausanne (EPFL) and the World Intellectual Property Organization (WIPO), Global Innovation Index (GII) is used to measure and rank the innovation power of countries via criteria such as innovation output, innovation capability, innovation infrastructure and transfer, knowledge creation and utilization, and innovation within organizations.

Assessing the national power of countries is a complex and multidimensional issue, and can have different approaches. Some studies may aim to consider all

dimensions of national power, but this can lead to unintended or incorrect combinations of factors and weaken the results. Some software programs may heavily focus on economic or military factors and overlook other aspects such as cultural and social influence. In some cases, accurately calculating the number and strength of a country's military forces, such as its air, sea, and land forces, can be challenging due to data opacity. The global conditions and the national power of countries can constantly change, so assessments conducted at different times may yield different results. The use of outdated data or incomplete information can also impact the accuracy of assessments. However, national power assessments remain valuable for sociological studies, policymaking, and planning. It is essential to consider these factors and give them the necessary attention when conducting such assessments.

Research methodology

The research methodology consists of the following stages:

Explanation of theoretical foundations and propositions related to the factors and variables of power: In this stage, theoretical discussions regarding the concepts of power, national power, foundations and sources of power, and methods of power calculation were examined. Data collection in this stage was based on library research methods, including the use of books, journals, periodicals, and articles in Persian and English.

Selection of a theoretical model on the foundations of national power as the main basis for designing the model: In this stage, 80 theoretical models proposed by internal and external experts on the foundations and sources of power of countries were examined and a theoretical framework consisting of nine factors was developed. This was more comprehensive than other models because of taking into account the diversity of variables, attention to various dimensions of national power, emphasis on the positive and negative effects of variables, and consideration of new dimensions of power such as spatial power; thus, designing the national power assessment model was carried out on the basis of this framework.

Collection of variables and indicators influencing national power: In this stage, a total of 400 variables and indicators influencing national power were collected from four sources: 80 theories on the foundations and elements of national power, databases of international institutions such as the World Bank and UNESCO, relevant websites, and expert opinions obtained through interviews and questionnaires.

Variable screening: Based on the main research objective, which is to optimize the model for measuring the national power of countries, variables were collected based on four criteria: availability of standardized and comprehensive data, quantifiability or the ability to convert them into quantitative measures, the presence of important qualitative variables, and accessibility of the variables. Evaluation and screening were conducted, resulting in the removal of 86 variables, while 314 variables were categorized into nine components (factors) including economic, political, military, social, etc.

Factor analysis: Factor analysis was used to prioritize and select the top variables in each factor. The main criterion in selecting the proposed variables for each factor was their contribution of 50% to the factor. In other words, the aim was to select a sufficient number of variables that have a greater impact on national power by selecting a larger number of variables.

Conversion of variable values into scores: Four different methods were used in this research to score the variables and indicators:

- *The proportional or percentage share method*: In this method, the score of each country is based on its share of the total value of the relevant variable.
- *Indexing method (Morris index)*: To determine an index from a variable, the maximum and minimum values of the variable are obtained, and then the score for each country is calculated using the following formula:

$$\text{Life expectancy} = \frac{Minimum(B) - real\ value(I)}{Maximum\ (A) - Minimum(B)} * 100$$

- *Contractual method*: In such a way that it is assessed for different variables considering the mean value of the variable taken as the numerical base, and then the obtained value for each country regarding each variable is evaluated according to that criterion.
- *Use of indicator values as scores*: The fourth method was primarily used for the indicators used in the model. Since indicators such as the human development index and the digital access index are the result of years of effort by experts and stakeholders, it is deemed appropriate to consider the country's score regarding the respective indicator.

Measurement of qualitative variables

First strategy: The use of quantifiable meaningful indicators for qualitative variables using official statistics and international institutions. National characteristics were examined based on quantitative statistics such as national vitality, life satisfaction, personal benevolence, resilience, and belief in God (beliefs). Institutional quality was examined based on statistics related to organizational quality, political institutional quality, and economic institutional quality. Service quality was examined based on relevant quantitative statistics such as customs, international shipments, adequate provisions, tracking and tracing, and timely delivery of goods. Social cohesion and unity were examined based on variables such as ethnic diversity, linguistic diversity, religious diversity, religious tolerance, level of violence and discrimination against minorities, social trust, social participation, and cultural diversity. To measure the shape of the country and its impact on national power, the importance of each country was assessed based on the opinions of domestic and foreign experts using a questionnaire, and coefficients were assigned based on factors such as compactness, length, continuity, etc.

Second strategy: The use of internationally constructed indicators by research centers. World Bank data was used to measure the quality of ports. Shanghai and CEST data were used to measure the scientific quality of universities, research institutions, and research quality. The Global Competitiveness Report 2012–2013 data was used to measure the quality of the education system, educational quality, mathematical quality, and scientific education. The Global Competitiveness Report 2012–2013 data was used to measure the quality of air, rail, and road transportation infrastructure. Data on consensus, resource management, international cooperation, and managerial capability were used to measure political management quality. Finally, World Bank data was used to measure the quality of regulations and legal provisions.

Research findings

The identified indicators based on the nine-component model of national power sources are as follows:

Table 2

Identified indicators based on the nine-component model of national power

Component	Indicator
Territory	Climatic conditions, precipitation level, temperature, access to freshwater bodies, length of coastline, non-metallic mineral resources, metallic mineral resources, number of strategic mines, gas reserves, oil reserves, number of straits, number of airports, number of ports, length of roads, length of airports, length of railways, soil per capita, food production index, per capita renewable freshwater, vegetation coverage, solar, water, and wind energy production, country shape, topography, border status, environmental sustainability index, length of land borders, number of land neighbours, territory size, per capita spatial density, percentage of water bodies to cultivable land, total area of forested regions, rural population ratio to cultivable land (rural population density).
Economic	Share in global trade, national savings as a percentage of GDP, business mobility, rank in economic infrastructure, current workforce skill in the economy, workforce skill, future in the economy, capital flow, water production, goods efficiency, rank in labour productivity, inflation rate, unemployment rate, share of GDP in global level, GDP, per capita production, annual GDP growth rate, number of production human workforce, electricity production, maritime transportation, air transportation, rail transportation, government services provided for business improvement, hydropower production, wind power production, quality of air transportation infrastructure, quality of rail transportation infrastructure, quality of road infrastructure, overall quality of infrastructure, total road network, exchange rate of domestic currency to the US dollar, economic activity rate for women aged 15 and above, rank in Gini coefficient, quality of electricity supply, composition of agricultural, industrial, and service sectors, efficient allocation of resources, capital market development, technological level, market size, economic competitiveness, high-tech exports, economic complexity, economic freedom, share in global energy, exports, imports, quality of service provision, trade balance, share of food imports in GDP, total ICT exports , total exports, tourism, level of dominance on global markets, effectiveness of anti-monopoly policies, trade barriers, trade effects of laws related to FDI, foreign ownership, foreign direct investment inflows, foreign debt, outward foreign investment, inward foreign investment, international currency reserves, government budget balance, costs of terrorism, costs of crime and violence, access to capital, overall tax rate, development of financial markets, construction coefficient budget.

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Component	Indicator
Scientific	The number of universities, access to public knowledge, access to information and communication, availability of local specialized and research services, quality of the education system, quality of mathematics and scientific education, access to advanced education, number of R&D researchers per million people, number of researchers per million people, number of teachers per 1000 people, number of technicians in R&D, number of immigrant inventors and innovators, enrollment rate in higher education, number of foreign students in the country, student-to-teacher ratio in secondary education, the country's capacity to retain talented individuals, the country's capacity to attract talented individuals, enrollment in secondary schools, number of trained education staff, quality of education, digital access index, percentage of internet users out of the total population, high-tech technology exports (in million dollars), rank in attracting foreign investment and technology transfer, value added in high-tech industries as a percentage of GDP, volume of high-tech exports for each country (in million dollars), volume of medium- and high-tech exports as a percentage of global total, the share of medium- and high-tech in value-added production, each country's share of Nobel Prize winners, number of articles published in international journals, rank in intellectual property protection, country's rank in the H-index, average citation per article, number of internationally registered inventions, number of patent applications, number of domestic scientific articles (thousands), number of international scientific journals, number of scientific journals, number of published books by title, number of high school graduates, number of scientific research projects, education expenditure as a percentage of GDP, industrial share in GNP, per capita R&D budget (dollars), R&D budget in all sectors (million dollars), percentage of GDP spent on R&D, share of education budget in GDP, government expenditure on education, company expenditure on R&D, rank in the top 1000 universities worldwide, rank in industry-university collaboration in R&D, rank in the quality of scientific research institutions in innovation, country's rank in the knowledge-based economy index, quality of research and scientific institutions, innovation capacity, development of e-government, number of articles presented in the field of nanotechnology per million people, number of nuclear reactors, nuclear power generation level.
Cultural	Literacy rate, female literacy rate, gender gap, per capita radio, per capita television, per capita computer, number of internet users, per capita line telephone per 100 people, per capita mobile telephone, happiness index, educational expenditures as a percentage of GDP, cyber security, linguistic penetration rate, tolerance for emigrants, citizenship rights, cultural influence, importance of religiosity, national enthusiasm, life satisfaction, personal generosity, tolerance and adaptability, belief in God (religious beliefs), number of cultural heritage sites, length of the country's history.
Political	Internal security coefficient, number of coups, rank in the index of legal freedoms, freedom of the press, membership in major human rights conventions, number of refugees from the country of origin, civil liberties, political freedom, number of terrorist incidents, number of fatalities in terrorist incidents, number of injuries in terrorist incidents, rank in democracy, political stability, good relations with neighbors, acceptance of the rights of others, positive peace, women's representation in the legislative assembly, government efficiency, level of corruption, quality of institutions, responsiveness to the nation, government effectiveness, quality of regulations, quality of legal framework, number of political parties, bureaucracy efficiency (ease of doing business index), health of governments, public trust in the police services, public trust in politicians, level of organized crime, transparency in government policymaking, wastefulness in government spending, elections in government decision-making, judicial independence, national trust in the government.

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Component	Indicator
Social	Population, general mortality rate per 1000 people, life expectancy, percentage of young population, average intelligence quotient, maternal mortality rate per 100,000 live births, under-5 mortality rate, infant safety, social security, social network security, moral freedom, slavery, female labour force participation rate to male participation, percentage of population above 65 years old, net immigration per thousand people, prevalence of HIV in adults, prevalence of tuberculosis, annual population growth rate, per capita income, free flow of information, healthcare status, acceptance of the rights of others, access to drinking water, rural population composition, urban population composition, calorie consumption, human development, number of physicians per 1000 people, mortality rate due to natural disasters, per capita healthcare expenditure, per capita energy consumption, social progress, social support, level of crime and violent crime, ethnic diversity, cultural diversity, discrimination and violence against minorities, religious tolerance, linguistic diversity, religious diversity, social trust, social participation.
Military	Number of military airports, arsenals, aviation services, average railway length, average road and highway length, major ports and terminals, air patrols, total number of helicopters, military transport aircraft, logistic suitability, number of military personnel per 1000 population, percentage of armed forces in the total workforce, number of air force personnel, number of navy personnel, number of military personnel stationed abroad, ratio of military personnel to border length per kilometer, paramilitary forces, military staff, number of peacekeepers contributed to the United Nations by countries, number of pilots, instructors of combat aircraft, reserve forces, active forces, reaching military service age, number of available military personnel, multirole combat aircraft, ballistic missile submarines (SSBN, SSGN), automatic weapons, number of warships, number of combat helicopters, number of main battle tanks, number of combat aircraft, number of military submarines, missile launcher, aircraft carrier, total number of aircraft, number of nuclear bombs, heavy weapons, number of submarines, destroyers, missile projectors, armored vehicles, total military expenditure in million dollars, percentage of military expenditure from GDP, arms exports in million dollars, purchasing power parity, foreign exchange, maritime trade power, warships.
Transboundary	Number of trading partners, number of incoming tourists to the country, number of foreign tourists, number of flights, international student mobility, foreign-born population, FIFA ranking, permanent membership in the United Nations Security Council, temporary membership in the United Nations Security Council, international prestige, membership in international conventions, number of border crossings.
Spatial	Satellites (communication, surveillance, military, and geosciences), spacecraft, space budget.

Designing the pattern of national power assessment and introducing software

Determining the power of each country in the main components

We know that in each of the main components, there are several indices for evaluating countries. If we denote these indices as FI_i, and assign weights to each of these indices to prioritize and emphasize them, denoted as FIW_i, we can calculate the score of each country for each index using the following formula:

$$P = FIW_1 * FI_1 + FIW_2 * FI_2 + \cdots + FIW_n * FI_n \quad (1)$$

This formula can be simplified and edited mathematically as follows,

$$P = \sum_{i=1}^{n} FIW_i * FI_i \quad (2)$$

where, i is the number of indices in each component.

For example, the power of country i in the social component is determined as:

$$P_{Society} = \sum_{i=1}^{n} FIW_i * FL_i \quad (3)$$

Determining the power of each country among different components (selecting the most powerful country)

After obtaining the power of each country in different components, we can select the most powerful country. For this purpose, we need to assign a specific weight to each of the components, called MCW_i. Then, the most powerful country can be calculated using the following formula:

$$NP_i = \sum_i MCW_i(P) \quad (4)$$

where, NP_i is the score related to the power of each country, and based on that, countries can be ranked so that the country with the highest score is the most powerful country. By combining formulas 2 and 3, the final formula for calculating the power of countries is obtained, and considering that other components follow the conditions of the social component, the final formula for measuring national power is presented as follows:

$$NP_i = \sum_i MCW_i(\sum_j FIW_j * FI_j) \quad (5)$$

where, i is the desired component and j is the desired index.

For scaling positive data, the following formula is used:

$$r_{ij} = \frac{x_{ij}}{x_{jmax}}$$

And if the direction of the variable is negative, the following formula is used:

$$r_{ij} = \frac{x_{jmin}}{x_{ij}}$$

where, Rij = the standardized value of the variable, Xij = the value of the variable, Xjmax = the maximum value in the column corresponding to the variable, Xjmin = the minimum value in the column corresponding to the variable.

Finally, this formula converts all variables into decimal numbers less than 1.

Designing software for measuring the power of countries

The software was designed with the aim of measuring national power. The components and indices that affect the national power of countries in a hybrid manner were taken into account for weight determination. To this end, the software for measuring the national power of countries was designed in the Microsoft SQL server 2012–2014 programming environment, with applications such as defining scales, defining indices, defining years, data, charts, comparing countries with each other, analyzing data, drawing pyramids, drawing maps, and etc. In the first step, all

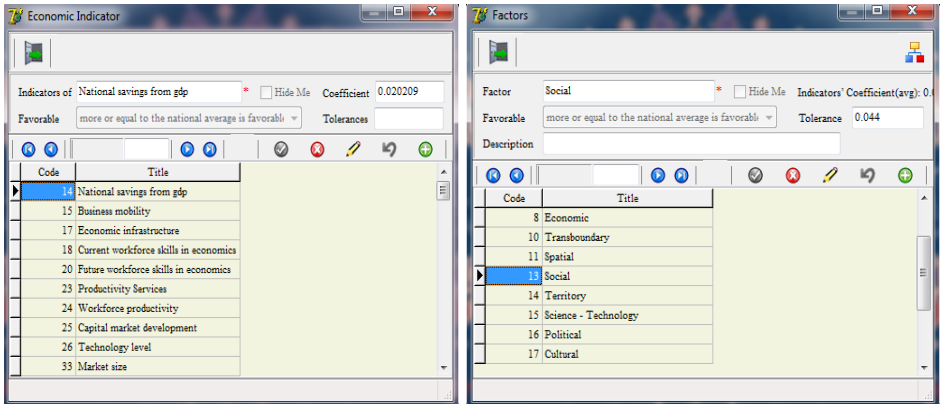
data related to countries were prepared in the form of nine components: cultural, territory, social, political, economic, scientific educational, military, spatial, and transboundary. Each of the nine components had an importance coefficient based on expert opinions, and then each component was divided into aforementioned variables and desired indices with the level of importance coefficient.

SQL is well suited for the database part of national power analysis software for the following reasons:

- Structured data management: national power data (GDP, military budget, human development indicators, etc.) are naturally structured and can be easily organized in SQL relational tables. Each table can represent a specific aspect of national power (e.g. GDP table, military indicators table, etc.).
- Efficiency and scalability: SQL databases are very efficient in managing large volumes of data and performing complex queries. A national power analysis software may deal with a large volume of data from different sources, and SQL can handle this challenge well.
- Data security: relational database management systems (RDBMS) have strong security mechanisms to control access and maintain data integrity. This feature is very important in a national power analysis software that deals with sensitive information.
- Standardization: SQL is an industry standard and is supported by many database management systems such as MySQL, PostgreSQL, Oracle, and SQL Server. This makes it easier to select and switch database systems.

Figure 1

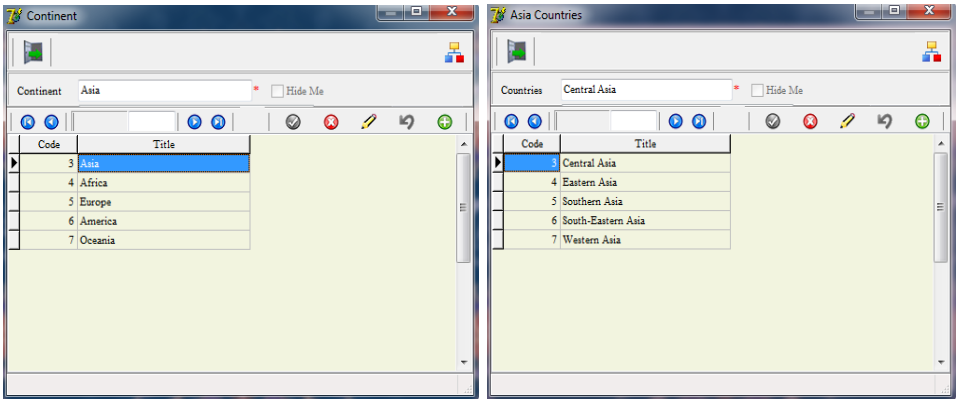
The nine components of national power and their indices



For more accuracy in measuring the variables involved in national power and to enable a suitable comparison between two countries or regions and continents, efforts were made to examine countries in the world based on continents and regions. For example, the continent of Asia is divided into five regions: Central Asia, East Asia, Southeast Asia, Southwest Asia and South Asia.

Figure 2

Division of the target areas



In this software, geographical and geopolitical regions are considered valuable based on one or more influential indicators on national power. The comparison between these regions is done in two ways: the first is a case-by-case comparison, where one of the indicators affecting the national power of countries is selected each time, and countries are measured against each other. The second method involves a general comparison and the selection of multiple indicators. In this method, the quantity of each region and country is determined, and countries and different geographical and geopolitical regions are ranked accordingly. In the data entry section of the software, 69 countries were filtered using the DATA feature with the ability to remove and add, and the relevant data for each of the nine-dimensional variables were entered into the software.

Figure 3

Data entry into the software

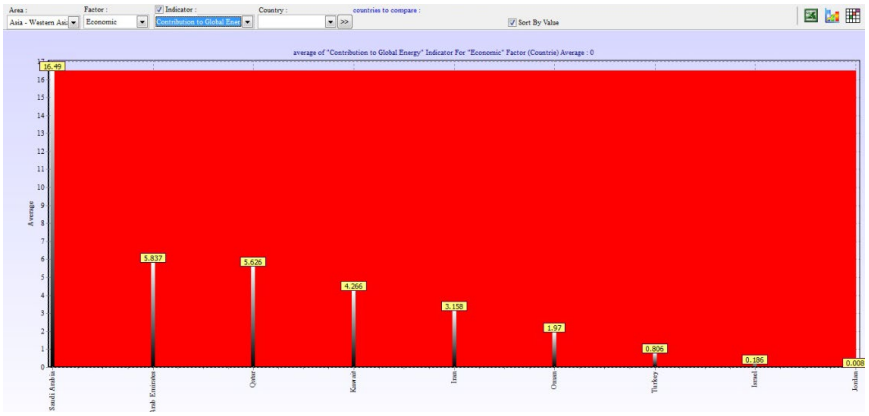
Drag a column header here to group by | Continent | Country : | Factor : | Indicator : | Excel Output | Show Chart

scale	factor	index	real value	importance coef.	weight
Africa	Cultural	Book circulation	0	0.014085	0
America	Cultural	Book circulation	0	0.014085	0
Asia	Cultural	Book circulation	0	0.014085	0
Europe	Cultural	Book circulation	0	0.014085	0
Oceania	Cultural	Book circulation	0	0.014085	0
Africa	Cultural	Citizenship	0	0.042254	0
America	Cultural	Citizenship	0	0.042254	0
Asia	Cultural	Citizenship	0	0.042254	0
Europe	Cultural	Citizenship	0	0.042254	0
Oceania	Cultural	Citizenship	0	0.042254	0
Africa	Cultural	Cultural influence	0	0.059859	0
America	Cultural	Cultural influence	0	0.059859	0
Asia	Cultural	Cultural influence	0	0.059859	0
Europe	Cultural	Cultural influence	0	0.059859	0
Oceania	Cultural	Cultural influence	0	0.059859	0
Africa	Cultural	cybersecurity	0	0.056338	0
America	Cultural	cybersecurity	0	0.056338	0
Asia	Cultural	cybersecurity	0	0.056338	0
Europe	Cultural	cybersecurity	0	0.056338	0
Oceania	Cultural	cybersecurity	0	0.056338	0
Africa	Cultural	Degree of literacy	0	0.070423	0
America	Cultural	Degree of literacy	0	0.070423	0
Asia	Cultural	Degree of literacy	0	0.070423	0
Europe	Cultural	Degree of literacy	0	0.070423	0
Oceania	Cultural	Degree of literacy	0	0.070423	0
Africa	Cultural	Education costs as a percentage of GDF	0	0.045775	0

In the CHART section of the software, the entered information can be used for comparative purposes for each country individually, or for comparing two countries or different regions. For example, in the West Asia region, the energy distribution component is displayed below. Saudi Arabia is shown to have a higher rank compared to other countries, while Jordan is shown to have the lowest rank.

Figure 4

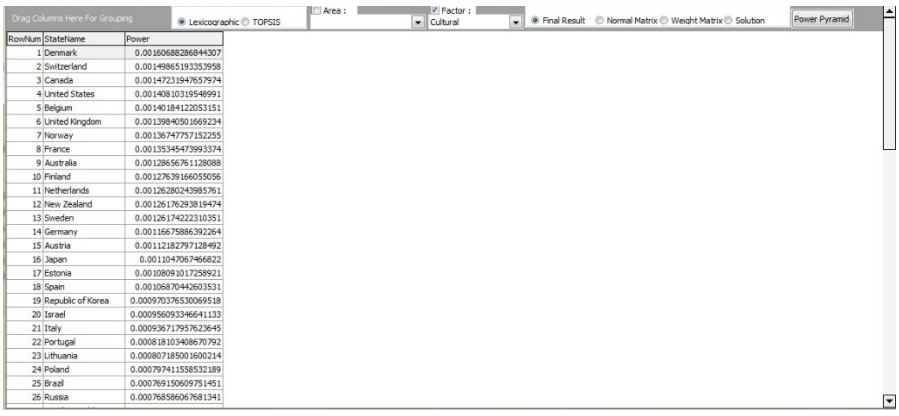
Comparative chart between countries in the energy distribution component



In the *data analysis* section, countries are ranked in each of the nine-dimensional components. In this section, the *final result* command can be used to view the final ranking. Additionally, the *normal matrix* command is used for data normalization, the *weight matrix* command displays the obtained component weights, and the *solution command* shows the maximization of the data. The power pyramid in geographical and geopolitical regions is drawn in three levels to provide a more accurate and better comparison of countries and their weights in national power. This software is capable of updating the pyramids and maps simultaneously with data updates.

Figure 5

Ranking of countries based on the cultural component



RowNum	StateName	Power
1	Denmark	0.0016068828684307
2	Switzerland	0.0014986519353958
3	Canada	0.0014723194765974
4	United States	0.0014081031954899
5	Belgium	0.0014018412205315
6	United Kingdom	0.0013984050166923
7	Norway	0.0013674775715255
8	France	0.0013534547399337
9	Australia	0.0012865676112808
10	Finland	0.0012763916605505
11	Netherlands	0.0012628024398576
12	New Zealand	0.0012617629381947
13	Sweden	0.0012617422231035
14	Germany	0.0011665788639226
15	Austria	0.0011218279712849
16	Japan	0.001104706746682
17	Estonia	0.0010809101725892
18	Spain	0.0010687044260353
19	Republic of Korea	0.0009703765300695
20	Israel	0.0009560933466413
21	Italy	0.0009367195762364
22	Portugal	0.0008181034086707
23	Lithuania	0.0008071850016002
24	Poland	0.0007974115585321
25	Brazil	0.0007691506097514
26	Russia	0.0007685860676813

Ranking national power of countries

In the territory power component, Russia (0.0144), China (0.0111), the United States of America (0.0105), Canada (0.0088), Brazil (0.00613), Australia (0.00535), England (0.00496), Iran (0.00461), India (0.00475), and Venezuela (0.00414) are the most important (see in Appendix, Figure A1). As the territory power map and pyramid of countries indicate, territory area can be an important indicator for a country in this dimension. Because a country with a large territory area often has resources such as food production, product diversity, metallic and non-metallic mineral resources, mineral resources, oil, gas etc. This high territory area can make a country rich because it provides the necessary facilities to increase the territory power of a country and the country's access to all the materials it needs.

In the economic component, the United States of America (0.0194), China (0.0107), Germany (0.0088), the United Kingdom (0.00804), Switzerland (0.0076), Japan (0.00704), Canada (0.00624), the Netherlands (0.00597), Belgium (0.00555), and Russia (0.00515) are ranked first to tenth, respectively (see in Appendix, Figure A2). Iran ranks 63rd with a weight of (–0.00799). This formula, considering negative factors and their algebraic sum with positive factors, can effectively represent the economic changes of countries either positively or negatively. As observed, it can be argued that half of the countries enjoy favourable economic power conditions, while the other half face less favourable conditions due to financial issues in regional and international arenas. Therefore, economic power is in the hands of developed countries, which utilize it for exerting power against other countries through economic sanctions, among other means. Figure A2 can also effectively display various forms of power disparities. For example, the difference between the United States and China is almost negligible, while Germany ranks next with a weighted average of 0.00105, indicating a significant gap in economic power between this country and the United States and China. In the subsequent ranks, the weight of this dimension shows considerable proximity among the designated countries. On the other hand, it can be observed that China, with a relatively small difference compared to other countries, ranks second in terms of economic power after the United States, indicating a future trend of economic power becoming bipolar on a global scale, not too far away.

In the scientific and technological component, the United States of America (0.0301), Germany (0.0167), the United Kingdom (0.0161), France (0.0157), Switzerland (0.0154), Sweden (0.0153), Japan (0.0147), Canada (0.0144), Denmark (0.0143), Republic of Korea (0.0142), and China (0.0137) are ranked first to tenth, respectively (see in Appendix, Figure A3). Iran also ranks 46th with a weight of (0.00167), higher than Turkey. As can be observed, there is less disparity among countries in terms of scientific power. That is, fewer countries have negative power compared to countries with lower economic power. This indicates that countries have relatively equal access to resources and power-generating factors in the scientific and

technological domain. However, it can be noted that the United States of America has the highest geopolitical weight in scientific-technological power, followed by other countries in ranks quite close to each other, which suggests a relatively balanced spatial distribution of scientific-technological power for the other countries in the subsequent ranks. As seen on the map, most of the top-ranked countries in terms of scientific power are located in European and North American regions, highlighting the importance these countries attach to scientific discourse and power in this dimension. On the other hand, these countries mostly engage in practical and applied aspects of science, while many developing countries, mostly ranked fourth and fifth in this dimension, do not prioritize the applied dimension of these sciences. For example, the number of joint articles prepared by developed European countries is often the result of their practical capabilities and facilities, while countries in the fourth and fifth ranks are less involved in this matter.

In the component of social power, France (0.00329), the Netherlands (0.00327), Belgium (0.00324), Germany (0.00320), Sweden (0.000315), Austria (0.00311), Denmark (0.00309), Finland (0.00295), Czech Republic (0.00287), and Italy (0.00274) rank first to tenth, respectively (see in Appendix, Figure A4). Iran is ranked 27th with a weight of (0.00151). As can be observed, many countries have similar weights in the field of social power. This can especially be seen in Scandinavian countries, indicating their attention to social policies aligned with their societies, which may indicate the formulation of similar social policies. However, only two countries, Nigeria and Venezuela, have obtained negative scores in social power, indicating the need for them to reconsider their population and social policies.

In the cultural component, Denmark (0.0000160), Switzerland (0.00150), Canada (0.00148), the United States of America (0.00141), Belgium (0.00140), England (0.001403), Norway (0.00137), France (0.00135), Australia (0.00129), and Finland (0.00128) rank first to tenth, respectively (see in Appendix, Figure A5). Iran is ranked 58th with a weight of (0.000129). In this dimension as well, many countries have weights close to each other, indicating the proximity of countries to each other, especially in Europe and the West. Developing countries such as Vietnam, Egypt, Morocco, Ghana, etc., have obtained negative scores in this dimension, meaning that these countries have weaknesses in this field, and their cultural power is much lower than the global average. As seen in the map and pyramid, European countries are at the top in this dimension as well.

In the political power dimension, Finland (0.0043), Sweden (0.0042), Norway (0.00414), Switzerland (0.00400), the Netherlands (0.00379), Denmark (0.00362), Canada (0.00359), New Zealand (0.00310), and Australia (0.00278) rank first to tenth, respectively, and Iran is ranked 64th with a weight of (–0.0105) (see in Appendix, Figure A6). Figure A6 indicates that successful countries in political power, which have the highest weights in this component as well, are Scandinavian and Western countries. The pyramid clearly shows that there is widespread discrimination in the

field of political power among countries, as the negative weight of political power in these countries is much higher than the positive-weighted countries. It can be argued that democracy and factors related to political power, including political management, freedom of expression, freedom of the press, etc., have failed in many countries. It cannot be said that countries have succeeded in the field of democracy and achieving their goals in such governments, as political power in these countries, which is meaningful and significant in relation to people and nations, has a very high negative burden. Therefore, as a result, it can be stated that the political power of countries has manifested itself in an imbalanced manner in relation to nations. Therefore, countries need to consider necessary and sufficient measures to improve the indicators related to this dimension of power, as otherwise, we may witness widespread instability in the not-so-distant future.

In the military component, the countries of the United States of America (0.0650), China (0.0487), Russia (0.0411), India (0.0255), Republic of Korea (0.0154), Israel (0.0152), England (0.0132), Japan (0.0119), Iran (0.0114), and Turkey (0.0109) are ranked first to tenth, respectively (see in Appendix, Figure A7). As observed, the three countries United States of America, Russia, and China have weights that are relatively close to each other, indicating the importance of military power for global superiority. In other ranks, we find out that countries have weights that are relatively close to each other, demonstrating the importance of military power in the global arena, which is essentially defensive in nature. Insecurity in the regional and global arena has led many countries to emphasize more on their external and transboundary dimensions rather than their internal and political security to counter external threats by strengthening their military infrastructure to some extent. This can be seen in the case of Iran, which, being located in the volatile Middle East region with neighbouring countries that also have political instability at the domestic and regional levels, has significantly emphasized strengthening its military power and is ranked fifth globally in terms of military power.

In the transboundary component, the countries of the United States of America (0.0199), England (0.0188), Canada (0.0118), China (0.0108), France (0.0955), Russia (0.0094), Norway (0.00599), Germany (0.00457), Italy (0.00440), and Turkey (0.00431) are ranked first to tenth, respectively, and Iran with a weight of (–0.00698) is ranked thirty-sixth (see in Appendix, Figure A8).

In the spatial component, the countries of the United States of America (0.0392), Russia (0.0329), China (0.0141), England (0.0099), Japan (0.00541), India (0.00463), Canada (0.00345), France (0.00463), and Australia (0.00199) are ranked first to tenth, respectively (see in Appendix, Figure A9). It can be argued that in this dimension, the United States of America is far ahead of other countries and is ranked first globally. Another point is that the Islamic Republic of Iran, like in the military power dimension, also has a good rank in this dimension compared to other dimensions, indicating its focus on progress and achieving space technologies in the region and the international arena.

In the nine dimensions of national power, the countries of the United States of America (0.1870), China (0.103), Russia (0.101), England (0.0756), Canada (0.0577), Germany (0.0507), France (0.0482), Japan (0.0469), Australia (0.0387), and Switzerland (0.0385) are ranked first to tenth, respectively, and Iran with a weight of (–0.0000411) is ranked forty-second (see in Appendix, Figure A10).

According to the results obtained, the United States of America is the world's first power. In the second rank, with a significant gap, are seven countries: China, Russia, England, Canada, Germany, France, and Japan, which are mainly considered as first and second-tier and advanced powers in the world. In the third tier of the pyramid, 15 relatively powerful and developed countries are located. In the fourth tier, 19 average countries, and in the fifth tier, 27 countries are considered third world and developing countries.

Table 3

Model validation against other models Sułek (2020)

Economic power			Military power		
Sułek		world data	Sułek		global firepower
China	USA	USA	USA	USA	USA
USA	China	China	China	China	Russia
India	Germany	Germany	India	Russia	China
Japan	UK	Japan	Russia	India	India
Brazil	Switzerland	India	Saudi Arabia	South Korea	South Korea
Germany	Japan	UK	France	UK	UK
Russia	Canada	France	Brazil	Japan	Japan
France	Netherlands	Italy	Japan	Iran	Turkey
UK	Belgium	Brazil	UK	Turkey	Pakistan

Conclusion

This study attempted to examine the variables that influence national power, based on their comprehensive and pervasive impact on power. A model was formulated and presented based on the performance of each influential component. The results indicated that the language of national power is changing on the global stage, and certain factors and indicators have been given the highest weight and importance, playing a prominent role in soft power and the intelligence of countries. This trend can be clearly observed in Western and European countries, many of which have made significant progress in social, cultural, and political power and have been able to transfer their values and desired norms to other countries, including developing countries, in the context of globalization and global projects. They have achieved this by exerting cultural and social influence and convincingly addressing the requests and desires of these countries. While many developing countries, including countries in the Western Asia region, are still involved in military power and arms race conflicts, other countries enhance their national power through soft power. Therefore,

countries like the Iran should consider strengthening their cultural diplomacy and increasing the acceptance and persuasion of others in the regional and international arenas. They should formulate policies that are appropriate for the current global conditions.

Considering the importance of measuring national power for countries and the geopolitical weight it represents at the national, regional, and international levels, this issue has become an attractive and noteworthy subject among scholars. Therefore, researchers have focused on measuring national power over the past decades using different methods and principles. Determining the level and weight of countries' power can regulate their relationships with others and determine regional and transregional interactions. Therefore, examining and measuring national power based on various factors and components is important for achieving national goals and interests. This article reports an attempt to evaluate the most influential variables on national power at the thematic, global, regional, and composite levels and design software to calculate the role of each of these variables in generating national power and rank countries. The software, designed to estimate the national power of countries, can add or remove countries and relevant indicators, and measure the national power of the desired countries in each component or indicator. The system or software has the capability to estimate and compare the national power of countries worldwide or in geopolitical regions based on the combination and outcome of the nine components of power. It can rank and sort countries or geopolitical regions based on their geopolitical weight or level of national power and ultimately provide the structure or hierarchy of global and regional national power (in other words, perform the categorization of the global or regional power system). Additionally, the system can classify countries worldwide based on the calculated weight for each of the nine components of power, both on a global scale and a regional scale, and extract their power structure. The software or system also has the ability to annually rank the power of countries from 0 to 1 on a global and regional scale with the entry of new data and present the updated power structure or hierarchy annually. However, it is necessary to mention that some composite indicators, such as national cohesion, political management of space, quality of service delivery, and national characteristics, which are formed by sub-indicators, should first be entered into the software based on the desired variables through summation of factors and then multiplied by the desired coefficient. In other words, in the software, only one number representing the concept of national cohesion should be entered. The existing diagrams in the software compare one country with other countries in different geopolitical and geographical regions. Furthermore, by placing the desired model in the software and calculating its various stages, it can be accurately displayed, and the output is presented in the form of a hierarchy and map in different regions and components.

Appendix

Figure A1

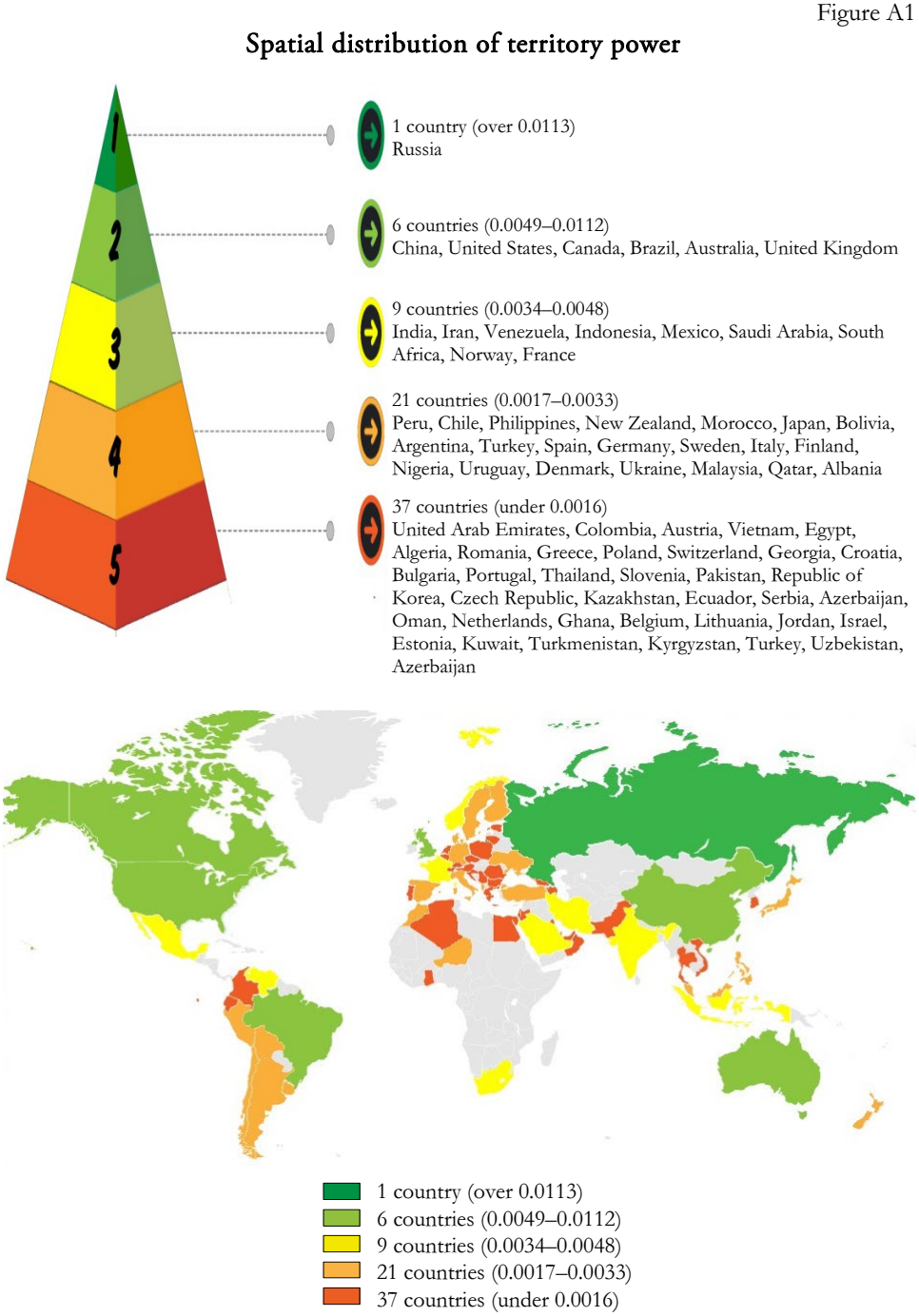


Figure A2

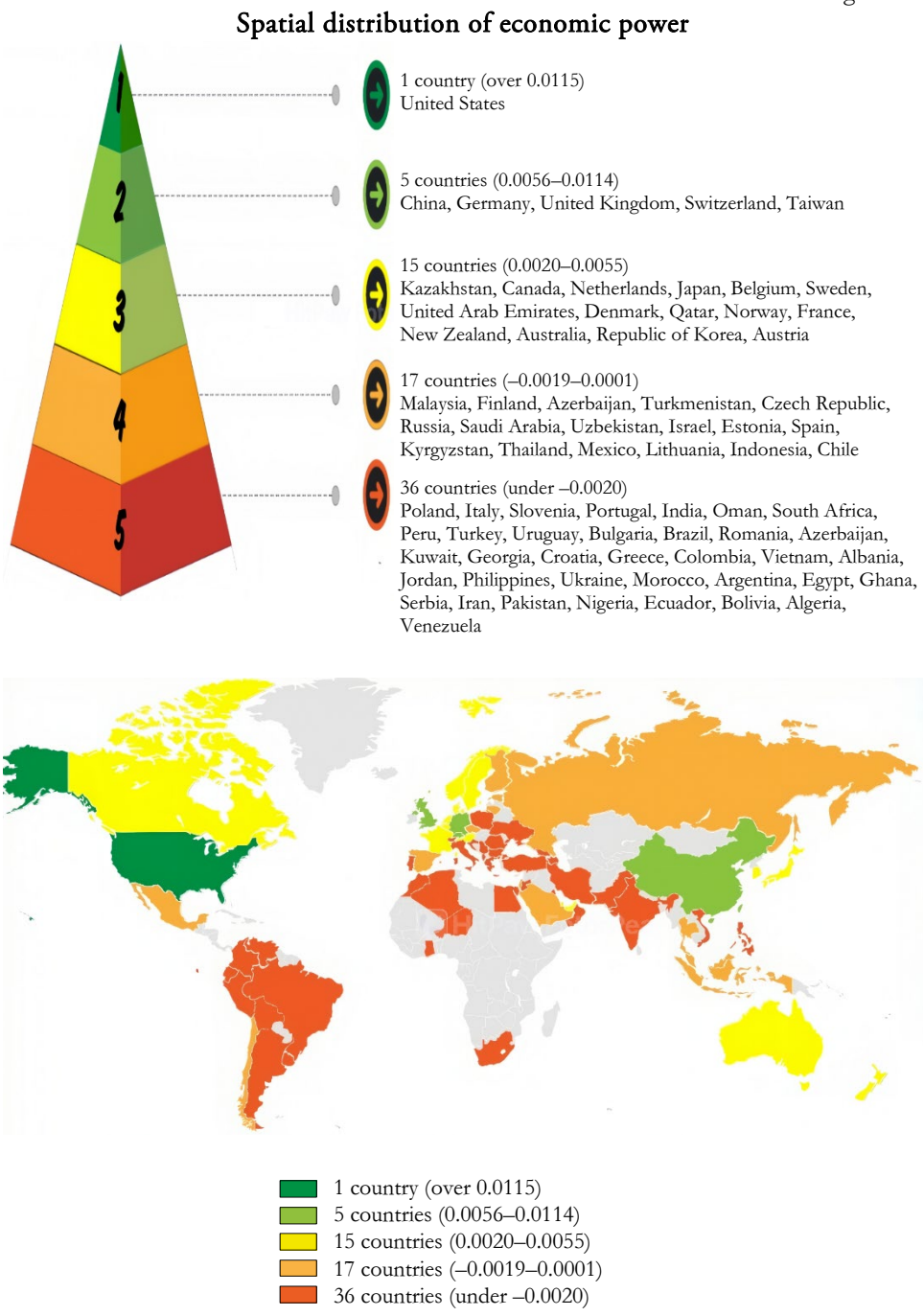
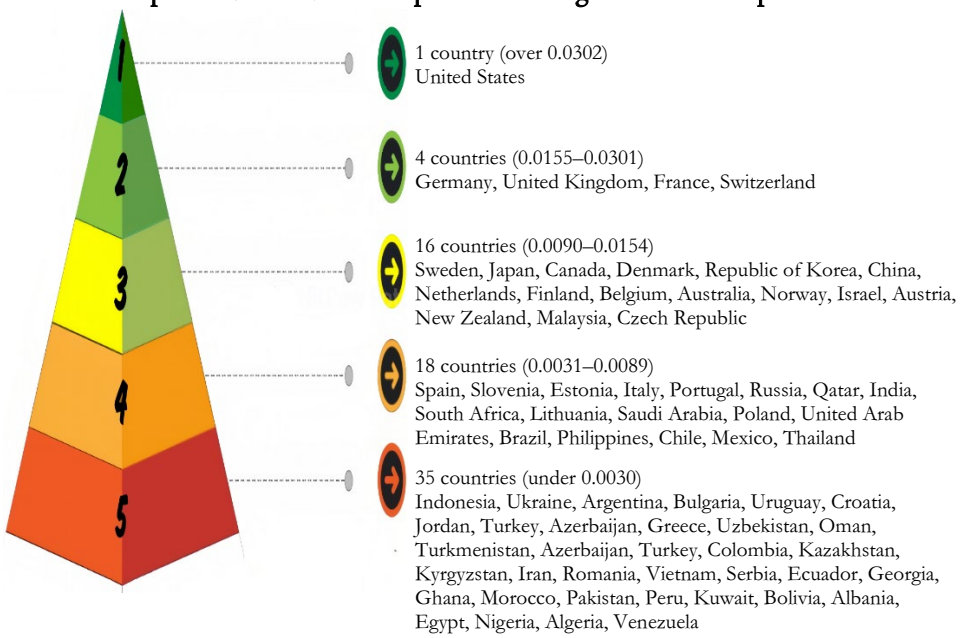
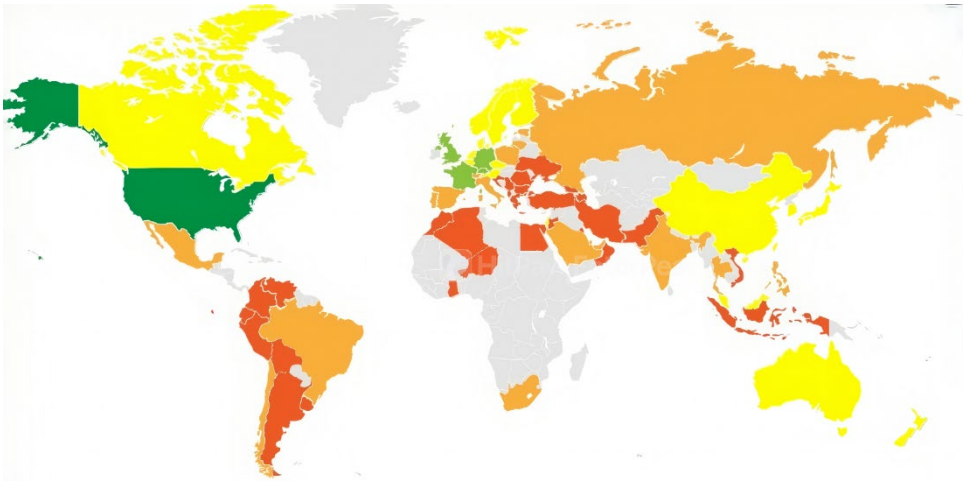

Spatial distribution of economic power
1
2
3
4
5
1 country (over 0.0115)
United States
5 countries (0.0056–0.0114)
China, Germany, United Kingdom, Switzerland, Taiwan
15 countries (0.0020–0.0055)
Kazakhstan, Canada, Netherlands, Japan, Belgium, Sweden, United Arab Emirates, Denmark, Qatar, Norway, France, New Zealand, Australia, Republic of Korea, Austria
17 countries (–0.0019–0.0001)
Malaysia, Finland, Azerbaijan, Turkmenistan, Czech Republic, Russia, Saudi Arabia, Uzbekistan, Israel, Estonia, Spain, Kyrgyzstan, Thailand, Mexico, Lithuania, Indonesia, Chile
36 countries (under –0.0020)
Poland, Italy, Slovenia, Portugal, India, Oman, South Africa, Peru, Turkey, Uruguay, Bulgaria, Brazil, Romania, Azerbaijan, Kuwait, Georgia, Croatia, Greece, Colombia, Vietnam, Albania, Jordan, Philippines, Ukraine, Morocco, Argentina, Egypt, Ghana, Serbia, Iran, Pakistan, Nigeria, Ecuador, Bolivia, Algeria, Venezuela
1 country (over 0.0115)
5 countries (0.0056–0.0114)
15 countries (0.0020–0.0055)
17 countries (–0.0019–0.0001)
36 countries (under –0.0020)

Figure A3

Spatial distribution map of technological-scientific power





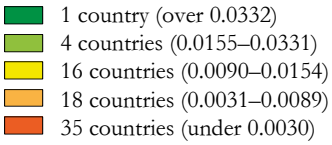
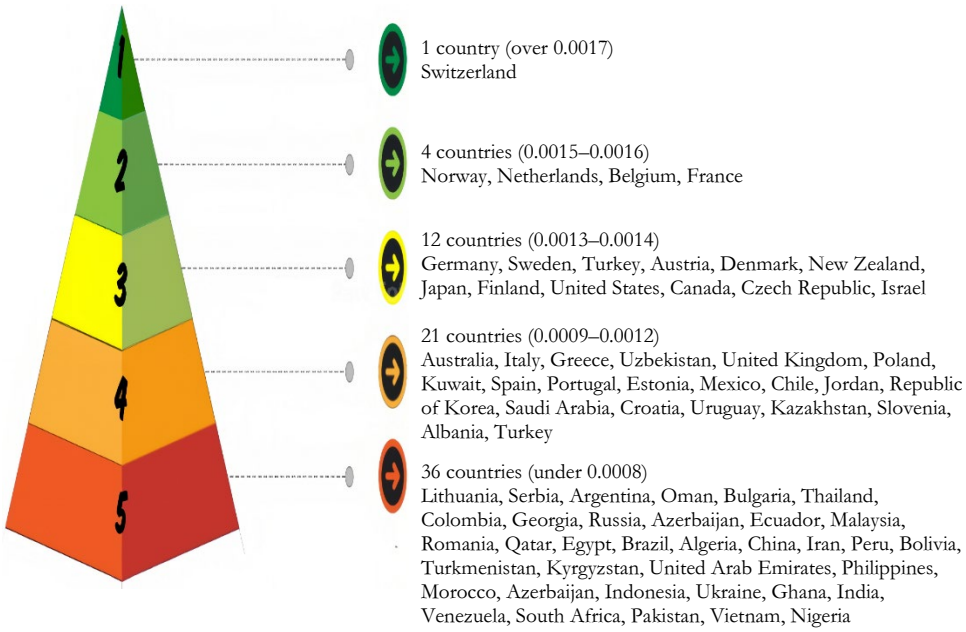
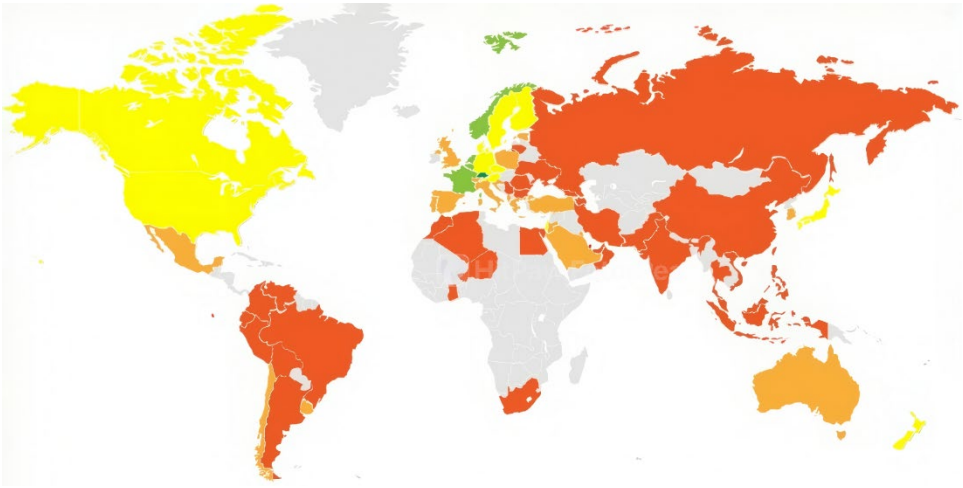


Figure A4

Spatial distribution map of social power





1 country (over 0.0017)
4 countries (0.0015–0.0016)
12 countries (0.0013–0.0014)
21 countries (0.0009–0.0012)
36 countries (under 0.0008)

Figure A5

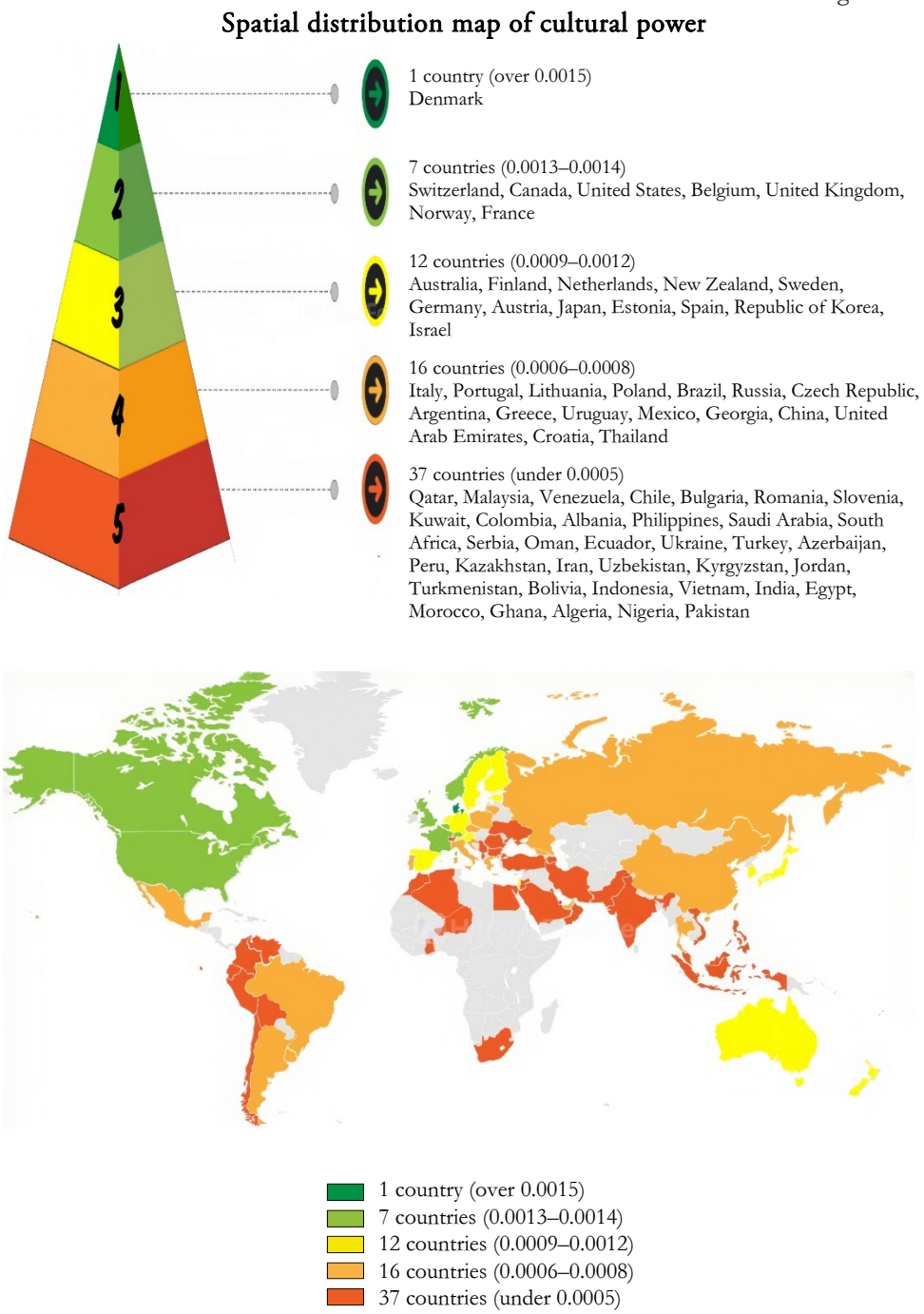

Spatial distribution map of cultural power
1
2
3
4
5
1 country (over 0.0015)
Denmark
7 countries (0.0013–0.0014)
Switzerland, Canada, United States, Belgium, United Kingdom, Norway, France
12 countries (0.0009–0.0012)
Australia, Finland, Netherlands, New Zealand, Sweden, Germany, Austria, Japan, Estonia, Spain, Republic of Korea, Israel
16 countries (0.0006–0.0008)
Italy, Portugal, Lithuania, Poland, Brazil, Russia, Czech Republic, Argentina, Greece, Uruguay, Mexico, Georgia, China, United Arab Emirates, Croatia, Thailand
37 countries (under 0.0005)
Qatar, Malaysia, Venezuela, Chile, Bulgaria, Romania, Slovenia, Kuwait, Colombia, Albania, Philippines, Saudi Arabia, South Africa, Serbia, Oman, Ecuador, Ukraine, Turkey, Azerbaijan, Peru, Kazakhstan, Iran, Uzbekistan, Kyrgyzstan, Jordan, Turkmenistan, Bolivia, Indonesia, Vietnam, India, Egypt, Morocco, Ghana, Algeria, Nigeria, Pakistan
1 country (over 0.0015)
7 countries (0.0013–0.0014)
12 countries (0.0009–0.0012)
16 countries (0.0006–0.0008)
37 countries (under 0.0005)

Figure A6

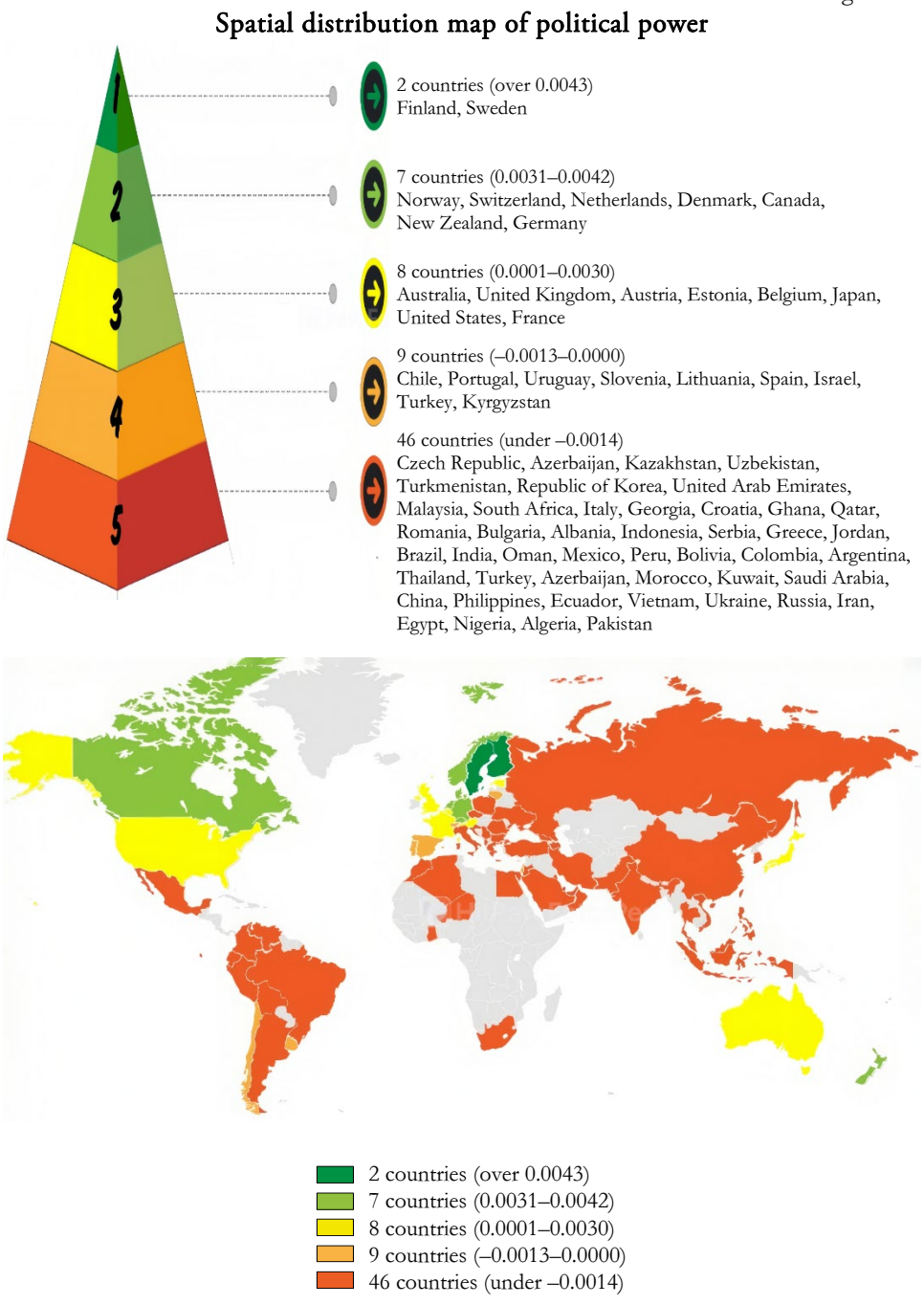

Spatial distribution map of political power
1
2
3
4
5
2 countries (over 0.0043)
Finland, Sweden
7 countries (0.0031–0.0042)
Norway, Switzerland, Netherlands, Denmark, Canada, New Zealand, Germany
8 countries (0.0001–0.0030)
Australia, United Kingdom, Austria, Estonia, Belgium, Japan, United States, France
9 countries (–0.0013–0.0000)
Chile, Portugal, Uruguay, Slovenia, Lithuania, Spain, Israel, Turkey, Kyrgyzstan
46 countries (under –0.0014)
Czech Republic, Azerbaijan, Kazakhstan, Uzbekistan, Turkmenistan, Republic of Korea, United Arab Emirates, Malaysia, South Africa, Italy, Georgia, Croatia, Ghana, Qatar, Romania, Bulgaria, Albania, Indonesia, Serbia, Greece, Jordan, Brazil, India, Oman, Mexico, Peru, Bolivia, Colombia, Argentina, Thailand, Turkey, Azerbaijan, Morocco, Kuwait, Saudi Arabia, China, Philippines, Ecuador, Vietnam, Ukraine, Russia, Iran, Egypt, Nigeria, Algeria, Pakistan
2 countries (over 0.0043)
7 countries (0.0031–0.0042)
8 countries (0.0001–0.0030)
9 countries (–0.0013–0.0000)
46 countries (under –0.0014)

Figure A7

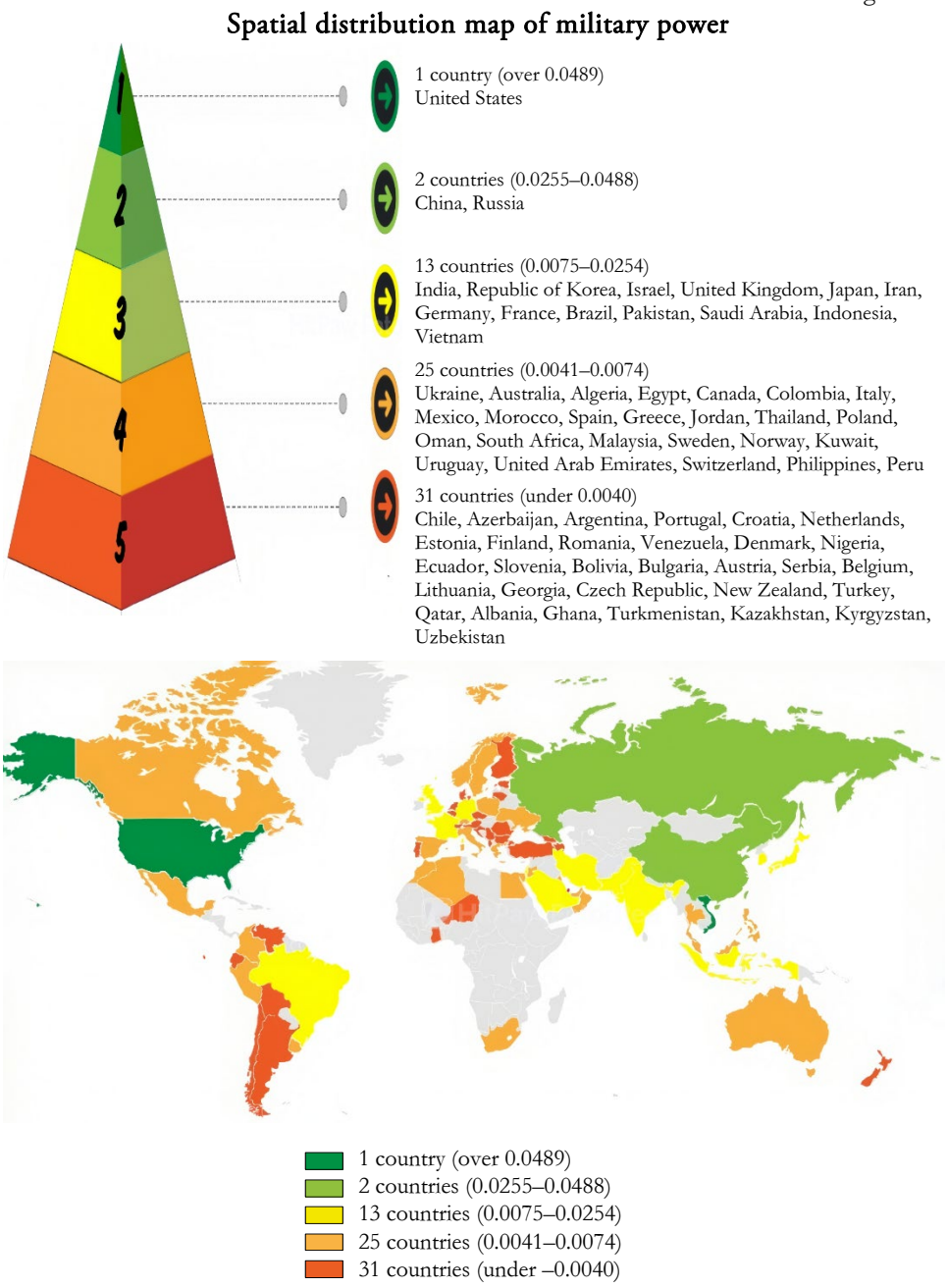
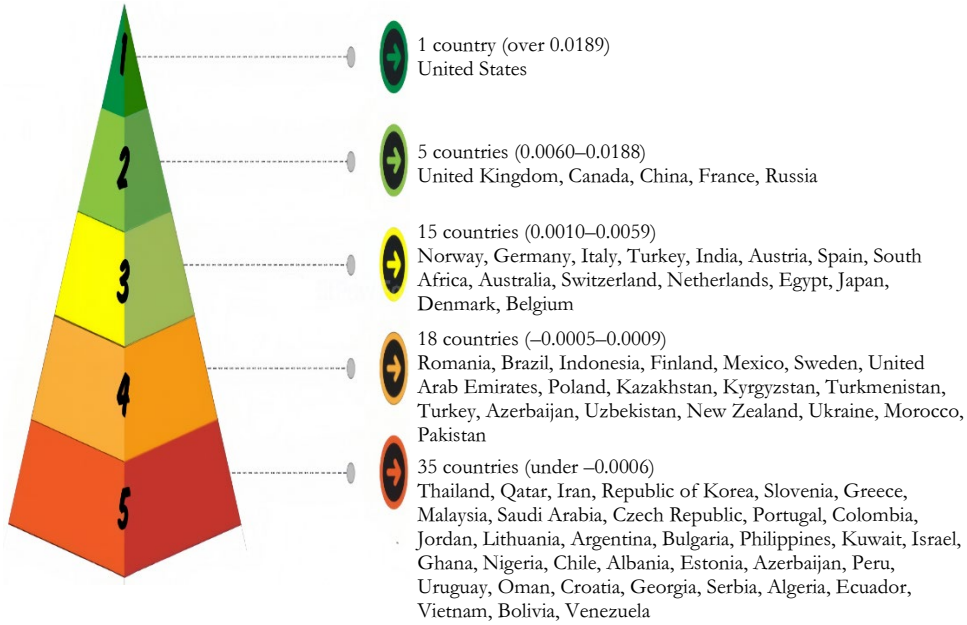
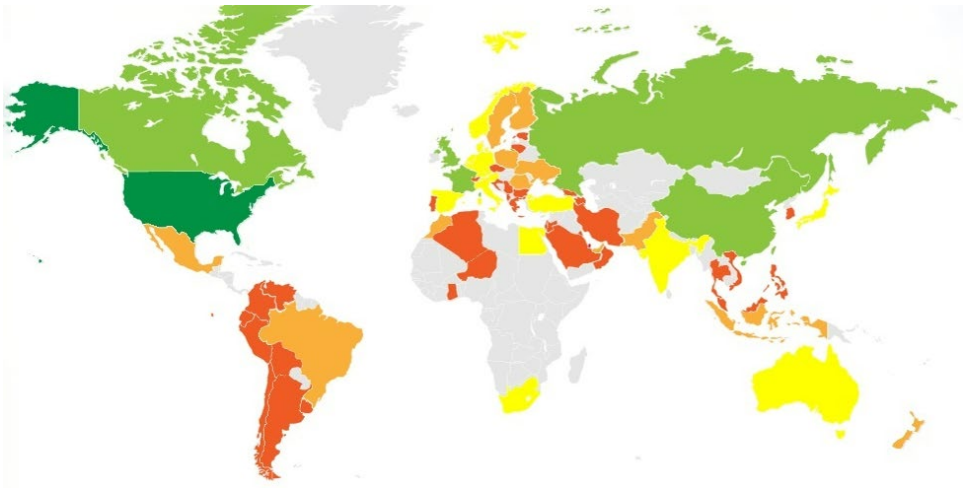

Spatial distribution map of military power
1
2
3
4
5
1 country (over 0.0489)
United States
2 countries (0.0255–0.0488)
China, Russia
13 countries (0.0075–0.0254)
India, Republic of Korea, Israel, United Kingdom, Japan, Iran, Germany, France, Brazil, Pakistan, Saudi Arabia, Indonesia, Vietnam
25 countries (0.0041–0.0074)
Ukraine, Australia, Algeria, Egypt, Canada, Colombia, Italy, Mexico, Morocco, Spain, Greece, Jordan, Thailand, Poland, Oman, South Africa, Malaysia, Sweden, Norway, Kuwait, Uruguay, United Arab Emirates, Switzerland, Philippines, Peru
31 countries (under 0.0040)
Chile, Azerbaijan, Argentina, Portugal, Croatia, Netherlands, Estonia, Finland, Romania, Venezuela, Denmark, Nigeria, Ecuador, Slovenia, Bolivia, Bulgaria, Austria, Serbia, Belgium, Lithuania, Georgia, Czech Republic, New Zealand, Turkey, Qatar, Albania, Ghana, Turkmenistan, Kazakhstan, Kyrgyzstan, Uzbekistan
1 country (over 0.0489)
2 countries (0.0255–0.0488)
13 countries (0.0075–0.0254)
25 countries (0.0041–0.0074)
31 countries (under –0.0040)

Figure A8

Spatial distribution map of transboundary power





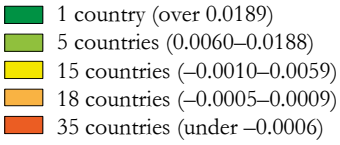
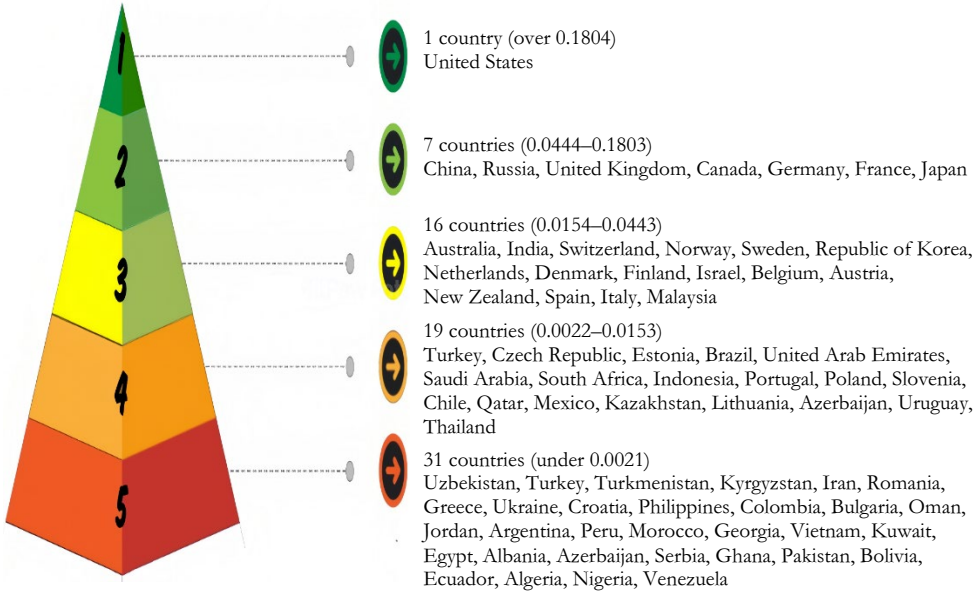


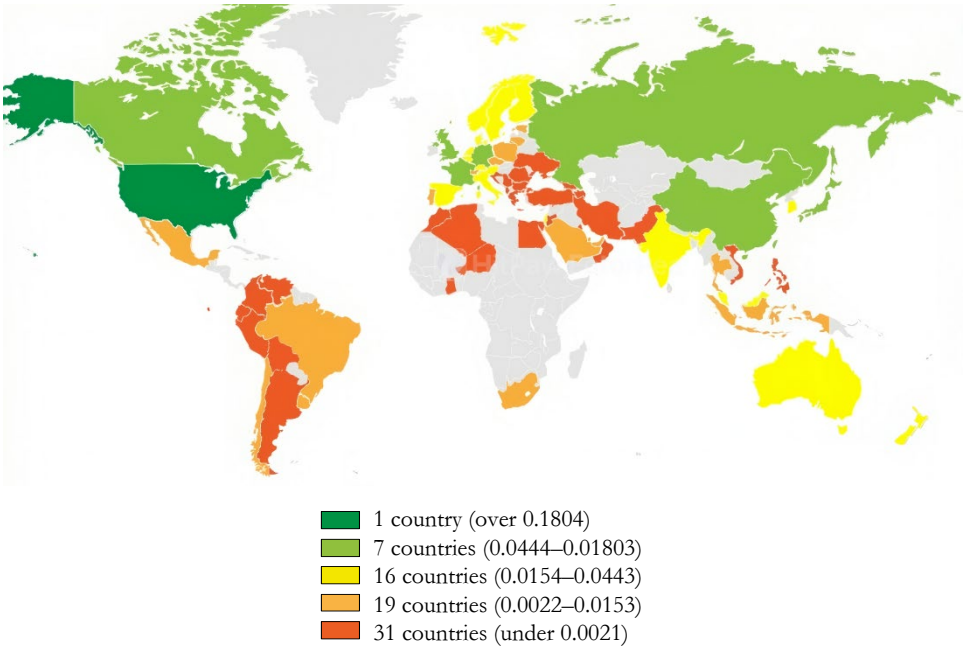
Figure A9

Spatial distribution map of spatial power

Figure A10

Spatial distribution map of overall power of the world's countries





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