

**SOCIAL NETWORK ANALYSIS AND
VISUALIZATION OF
GLOBAL SCIENCE AND TECHNOLOGY
GOVERNANCE STRUCTURE**



by

LE THI QUYNH LIEN

Supervisor

Professor MIKAMI YOSHIKI

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ABSTRACT

The term “global science and technology (S&T) governance” is used in this study to denote “collective efforts to regulate, provide and distribute science and technology resources, processes that go beyond the capacity of individual governments.” The rising interdependencies among members in the world that confronts a daunting array of trans-boundary S&T related threats have made the demand for global governance in world affairs has never been greater. However, scholars have pointed that while the cross-border challenges are likely to continue in coming decades, the current global governance architectures still short on capacity to cope with them. Partly, this is because the increasing interdependence among states has not been accompanied by sufficient adjustments in the global governance regime. Demand for effective global governance of S&T continues to outstrip supply, and the gap in the global governance regime is growing. To overcome these shortcomings, it is critical for policy planners, business leaders, scientists and engineers to understand the structure and effectiveness of the current global S&T governance regimes.

This study is an attempt to construct an analytical framework for understanding the structure and the effectiveness of the current global governance regimes, especially the attitudes and behavior of state-actors towards the multilateral agreements. The aim is to provide a detailed picture of how the world cooperates, especially in S&T, to address a vast area of global issues, from dual-use technology control, security, environment, to the issues of intellectual property, safety and health. For this purpose, more than one hundred of multilateral agreements deposited in United Nations system in different major issues for today’s world were collected. The social network analysis approach will be applied to provide the overall structure description of global joint-partnership among states in solving many global issues. Moreover, a set of quantitative indicators, the Global Leadership Index and the Global Support Index, was defined and calculated for each of 193 member states of the United Nations, to show their remarkable changes in policy attitude towards the global issues. Based on that, the study seeks to provide the useful information for policy planners, business leaders, scientists and engineers to draw lessons about how to achieve global S&T governance progress and how to strengthen the global partnership for the better usage of science and technology at national and global levels.

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Chapter 1.

INTRODUCTION

In this chapter, the motivation that leads to this research is firstly presented in section 1.1. The objectives and methodologies of this research are clearly described in section 1.2 and the outline of the thesis is briefly introduced in section 1.3.

1.1 Research Motivation

The international community now recognizes the urgent necessity of international cooperation in many global matters. The deepening economic interdependence, worsening environmental degradation, proliferating transnational threats and accelerating technological change, all the factors have raised the demand for international cooperation greater than ever (Patrick, 2014). To keep pace with these fast-moving threats, the world needs more effective multilateral responses from the states, as well as from the universal bodies such as the United Nations (UN). Global governance, one of the central orienting themes in the practice and study of world affairs these days, refers to the collective efforts by sovereign states, international organizations, and other non-states actors to address common challenges and seize opportunities that transcend national frontiers (Patrick, 2014). Simply put, global governance is concerned with problems that involve multiple countries. It creates the common space for national governments to work together through mutual legal assistance, including measures in the area of international law cooperation. The underlying mechanisms are based on the multilateral agreements or arrangements. Through these, states work together to establish common standards of behaviors in spheres such as trade and security, embedding norms and rules in international institutions charged with providing global good and mitigating global bads (Patrick, 2014). These regulatory regimes have helped facilitated international among states. A consensus is emerging around the international cooperation framework established

by the UN through several conventions and other multilateral instruments at the global level, which provide a strong basis for international cooperation.

In relation to science and technology (S&T), governance can be concerned with providing, distributing and regulating (European Commission, 2009). The most obvious and contentious form of S&T governance involves regulation, the class of activities and policies that support, distribute, and regulate scientific and technological processes and products (European Commission, 2009). For instance, states were working together to build a regulatory framework for the purpose of restrictions and/or reductions on the development, production, stockpiling, proliferation, and usage of the sensitive dual-use goods and technologies, including chemical, biological and nuclear technologies. Regarding to environmental issue, the United Nations Framework Convention on Climate Change (UNFCCC) provides a framework for transparency of the emission and the reduction of greenhouse gas concentrations in the atmosphere that would prevent dangerous interference with the climate system. This kind of cooperation to govern globally the scientific advancements is increasingly recognized by many governments and policy planners as a necessary and efficient tool for better response to global challenges. In general, the cooperation in global S&T governance is considered as the collaboration among multiple countries to pursue better management of scientific and technological activities, processes and knowledge for the sake of global happiness and sustainable development.

However, the transition to global sustainable development has not been successful yet (United Nations, 2013). Economic and social development has seen progress, but numerous challenges remain (United Nations, 2013). While global environmental problems have become more serious, the world peace and security is still being threatening by chemical and nuclear weapon proliferating. Partly, this is because the increasing interdependence among states has not been accompanied by sufficient adjustments in the global governance regime (United Nations, 2013). Demand for effective global governance continues to outstrip supply, and the gap in the global governance regime is growing (Patrick, 2014). Simply put, the current global governance architecture still shorts on capacity to coper with the fast-growing global challenges.

Therefore, to overcome these shortcomings, it is critical for policy planners to understand the architecture and performance effectiveness of the current global S&T governance regimes, especially on the attitudes and behavior of state-actors towards

the multilateral agreements. Although such overall analysis of global S&T governance structure should be particularly interesting to scholars, this is still a rarely examined issue. This absence of such empirical analysis suggests the necessary to carry out this research.

1.2 Research Objectives and Methodologies

This study is an attempt to construct an analytical framework for understanding the structure and the effectiveness of the current global S&T governance regimes, especially the attitudes and behavior of state-actors toward the multilateral agreements.

For the purpose of providing a close-up picture about the current system of global S&T governance regimes, about 130 multilateral agreements deposited in UN, the only truly universal and inclusive multilateral institution, were collected. Our database of international regimes is a resource for information on the agreements' ratification status of 193 member states, covering a range of major matters of cooperation in global S&T governance, from peace and security, environment, to the issues of technical competitiveness, safety and health. Each area is further composed of different related policy domains representing the key topics of global governance of S&T nowadays.

Regarding to the governance of global peace and security, we had paid our attention on a regulatory framework for the purpose of restrictions and/or reductions on the development, production, stockpiling, proliferation, and usage of the sensitive dual-use goods and technologies, including chemical, biological and nuclear weapons. In another aspect of the security domain, the policies for the prevention of terrorism and cybercrime are also investigated. In relation to the governance of global environment, the issues such as atmospheric protection, nature conservation, biodiversity and pollution control which are the main issues defined in the "Agenda 21" action of UN Conference on Environment and Development, are also cover in our collection. In addition, the regulatory framework to tackle different safety and health issues of the humankind, including: nuclear safety, occupational health and safety, food and drug safety, is another area-issue of concern in our analysis. Finally, two issues of standards and intellectual property for regulating the global market have also contributed one of the important policy domains to deepen our analysis.

To extract the useful information from this huge raw dataset, multiple frameworks of analysis are adopted. Firstly, we investigated the evolution of the norms and rules of regime over time by measuring the level of support of international community towards different key topics of global science and technology governance. Since international regimes reflect patterns of cooperation and discord among nations (Keohane, 1984), throughout this analysis, we can provide the overall picture of the continuity and development of the global governance throughout time.

Secondly, the social network analysis approach is applied to provide the overall structure description of the networks among states and among the international treaties, and the changes in these networks throughout different periods of time examined.

Next, a framework of quantitative indicators was proposed and calculated for each of 193 countries in the world, to show her policy attitude towards the issues of global S&T governance. For the state, the decision to ratify any treaties represents the interest in a certain S&T policy area, and then reflects the willingness on the part of the ratifying country to comply with international law and thus to cooperate with other partners in governing the world. Rather than only considering whether a state had ratified an international agreement or not, our analysis focuses on the underlying behavior of this action by taking account of the timeliness of the ratification act. Based on that, the variation in the behavior of states and groups of states towards different key topics of global S&T governance can be captured. Moreover, we go much deeper to analyse each of the state-actor's behavior to measure her willingness or reluctance in taking part in the global S&T governance system of regimes.

Further, we have applied our framework of analysis to verify one of the most pressing prepositions in political science field. This is the preposition about the existence of international cooperation in the current world in the absence of hegemonic leadership, which is called in short, *Cooperation-without-Hegemony*. Many striking discussions about a new world order where no power or group of powers can sustainably set an international agenda (Bremmer, 2012). It is described as the existing situation of the world where every country is exceptional in its own way and no country can exercise global leadership. This leads to a state of world affairs where tools for global policymaking, principally state-to-state negotiations over treaties and international institutions, have either failed to make breakthroughs or have had only limited success (Hale et al, 2013). Without a dominant power, it is much more difficult

for multinational forums to reach a final consensus or they may even fail (Rachman, 2011). However, there is currently no systematic framework to verify the transformation towards cooperation without hegemony paradigm of the international relations on an empirical basis. The study is an attempt to construct a quantitative framework that can observe global leadership change over time and that is more systematic than the one that currently exists. The results then are used to highlight what is stated about the new world era—an era of cooperation without hegemony.

Overall, the study seeks to provide the useful information for policy planners to draw the lesson about how to achieve global governance progress and how to strengthen the global partnership for the sustainable development at national and global levels.

1.3 Outline of the Thesis

Based on the above proposed purposes, the thesis is organized in seven chapters as follows:

Chapter 1: This chapter introduces the motivation, objectives and methodologies of the research. The outline of the thesis is also briefly described in this chapter.

Chapter 2: This chapter initially introduces the preliminaries of *Global Governance* concept and its relation with the *International Regime*, which are the essential backgrounds for this study. The increasing demand of global governance is also discussed. The chapter also introduces our collected database for information on the ratification status of over one hundred major international conventions deposited in UN system.

Chapter 3: In this chapter, the evolution of global S&T governance in the form of multilateral conventions is reviewed using the Global Support Index as a visualization aid. The comparable results of the Global Support Index in different perspectives suggest useful information about the gap between the demand for and the supply of global governance.

Chapter 4: In this chapter, the social network analysis approach will be applied to describe the changes over time of global governance structure in two different aspects: state-by-state network and treaty-by-treaty network. Based on that, we will provide the visible visualization of the global governance structure where the relative

positions among the actors and among the treaties are represented in a two-dimensional graphical layout.

Chapter 5: The set of measurements is proposed to reflect different aspects in the way states cooperate to each other in governing the S&T processes globally. In one hand, the variation in the behavior of states and groups of state towards different key S&T topics of global S&T governance is captured. On the other hand, the lengths of time needed to expand and consolidate cooperation in different issue-areas of global S&T governance are also investigated. Moreover, we analyse much deeper each of the state-actor's behavior to measure her willingness or reluctance in taking part in the global S&T governance system of regimes.

Chapter 6: This chapter is the application of our framework of analysis to the political science field. By using our proposed Global Leadership Index, we have successfully provided the empirical testing for the transformation of the world politics towards the *Cooperation without Hegemony* paradigm.

Chapter 7: This chapter presents the overall conclusions of this research work and describes the future developments of the research.

Chapter 2.

GLOBAL GOVERNANCE AND THE CREATION OF INTERNATIONAL REGIME

This chapter provides the preliminaries of *Global Governance* concept and its relation with the *International Regime*, which are the essential backgrounds for this study. Section 2.1 describes the increasing demand of global governance when it comes to the global matters, such as trade and security domains. Global governance has become the central discussion of leading scholars and practitioners concerned with the processes of international cooperation and multilateralism (Thakur, nd). Section 2.2 presents the sets of governing arrangements that include networks of rules, norms, and procedures, called in short, international regimes, which are seen as the most concrete instances and important source of global governance. Section 2.3 introduces our collected database which is a significantly large resource for information on the ratification status of over one hundred major international conventions deposited in UN system, covering a range of major subject matters of current global governance infrastructure.

2.1 The Need of Global Governance

There is no government for the world (Weiss and Thakur, 2010). Yet, on any given day, mail is delivered across borders; people travel from one country to another; goods and services are freighted across land, air, sea, and cyberspace; and a whole range of other cross-border activities take place in reasonable expectation of safety and security for the people, groups, firms, and governments involved (Weiss and Thakur, 2010). This immediately raises a question: How is the world governed even in the absence of a

world government? The answer, lies in a concept that has gained greater acceptance over the last decade and a half— global governance (Weiss and Thakur, 2010). From the ranks of the unknown to one of the central orienting themes in the practice and study of international affairs of the post-Cold War period (Barnett and Duvall, 2005), scholars have used “global governance” to denote “the management of global processes in the absence of global government” (Adil Najam) or “collective efforts to identify, understand, or address worldwide problems that go beyond the capacity of individual governments to solve” (Weiss and Thakur, 2010).

Indeed, the intensifying connections between states and peoples last two decades, better known as globalization, are now frequently presumed to create the need for governance and rule-making at the global level (Barnett and Duvall, 2005). According to the Commission on Global Governance established in 1992, as for most others, global governance meant “global institutional arrangements” (The Commission on Global Governance, 1995). More specifically, global governance can be defined as the sum of laws, norms, policies, and institutions that define, constitute, and mediate trans-border relations between states, cultures, citizens, intergovernmental and nongovernmental organizations, and the market (Weiss and Thakur, 2010). It embraces the totality of institutions, policies, rules, practices, norms, procedures, and initiatives by which states and their citizens try to bring more predictability, stability, and order to their responses to transnational challenges (Weiss and Thakur, 2010).

Our increasingly interdependent world confronts a daunting array of threats that transcend national boundaries, such as climate change and environmental degradation, nuclear proliferation, and terrorism. Most countries have acknowledged that national policy measures essentially cannot cope with such international issues because their impact may not be within a particular state’s jurisdiction. As national governments alone cannot ensure adequate and effective solutions to face what former UN Secretary-General Kofi Annan called “problems without passports,” international cooperation and collective action at global level are required to solve shared global concerns and to promote sustainable development of the world. The rising interdependencies among the members of international society have made the demand for global governance in world affairs has never been greater (Young, 1997).

2.2 International Regime as Source of Global Governance

The most concrete instances of cooperation and collective decision-making at the global level are international regimes. Keohane and Nye have stated that “regimes are sets of governing arrangements that include networks of rules, norms, and procedures that regularize behavior and control its effects” (Keohane and Nye, 1989). This conception is consistent with Krasner definition that international regimes are “implicit or explicit principles, norms, rules and decision-making procedures around which actors’ expectations converge in a given area of international relations” (Krasner, 1982, p.186). International regimes, therefore, are seen as important source of global governance.

An ever more interconnected world demands more cooperation among nations which leads the number of tools for global policymaking, principally state-to-state cooperation over treaties and international institutions negotiated under the UN systems. To its initial goals of protecting human rights, safeguarding peace, establishing a framework for international trade and promoting economic and social progress, international conventions have been added to tackle the new generation of global matters, from intellectual property protection and labor laws to issues associated with peaceful uses of nuclear energy, armaments and proliferation, combat against terrorism and cybercrime. As of December 1, 2000, there were 520 major multilateral instruments deposited with the Office of the UN Secretary-General, covering a range of subject matters such as human rights, disarmament, commodities, refugees, the environment, and the law of the sea (Barker, 2004). The number of treaties deposited with the Secretary-General grows steadily. However, these represent only a fraction of the over 40,000 international agreements currently registered with the UN (Barker, 2004).

A multilateral treaty is a principal source of international law that is defined as legally binding agreement which is open for ratification by member states. Over the past centuries, a number of additional terms that refer to this international law instrument have been developed. It may also be known as a convention, agreement, protocol, covenant, contract, statute, or exchange of letters among other terms. No particular nomenclature exists for such international instruments, thus the title has normally no overriding legal effects. Although the term treaty is the generic term used to refer to all formal written agreements between states, conventions are most commonly used to refer to a large multilateral agreement on a topic that is generally of

considerable importance (Barker, 2004). Despite the difference in title, these documents all have common features as formally written instruments entered into by sovereign states through a process of negotiation, signature, and ratification, by which states establish rights and obligations among themselves. A government that has ratified the convention is expected to apply its provisions through legislation or other appropriate means, as indicated in the text of the convention (Alli, 2008).

2.3 Database of International Regimes

Our database of international regimes is a resource for information on the ratification status of over one hundred major international conventions, covering a range of subject matters. Basically, the database provides “*when, who, what*” information about conventions (i.e. who ratified which convention and when).

The first version of the collection was created in 1999 and covered the treaties that are mainly related to the issues such as the management of dual technology to govern the global peace and security issues, the management of hazardous substances that harm to the environment, intellectual property protection and technical standards to regulate the global trading system, or the matters of transportation and telecommunication (Mikami, 2000). The database had indexed by Japan National Diet Library (NDL) and became accessible on-line since 2001 through NDL’s Japan Database Navigation Service (Dnavi) (National Diet Library, nd). As new treaties and agreements are continually being deposited with the Secretary-General of the United Nations, since then, several updating efforts were routinely made to keep the database up-to-date with such new content. The current version covers around 130 multilateral treaties. The coverage of conventions is greatly improved especially in the specific concern of safety and health issues, including nuclear safety, food and drug safety, occupational health and safety regulations of International Labor Organization. The records about these treaties are mainly based on physical collection of treaties and agreements from various resources, amongst which are the UN Treaty Collection, the annual reports from well-known international organizations, such as Organization for the Prohibition of Chemical Weapons (OPCW), International Atomic Energy Agency (IAEA) or World Trade Organization (WTO) among others.

Moreover, to select which conventions should be included in the database is one of the main concerns of the study. This task is far from easy, considering that there are more than 500 multilateral treaties that have been deposited with the UN Secretary-

General and many other treaties that are deposited with governments or other entities. Therefore, this study first referred to Mathias Koenig-Archibugi's map on the organizational infrastructure of global governance (Koenig-Archibugi, 2002). It includes a number of formal international and transnational organizations operating at a global level and is categorized into four areas, security, human welfare, environment, and economy. Based on that, we extend the scope of the study by not only focusing on the instruments developed by UN specialized agencies, programs and funds, but also including other international agreements that fall under the auspices of the UN. Through the assessment of their importance and contribution in forming international regimes, we have collected in total 126 multilateral conventions deposited in the UN system. Moreover, the domain of subjects has been also widened to cover six areas representing six major global issues for today's world: Human Rights (H), Peace and Security (P), Trade, Commerce and Communication (C), Environment (E), Intellectual Property (I), and Labor (L). Each area includes different related sub-subject matters. For instance, arms control and disarmament, non-nuclear zones, non-nuclear proliferation, cybercrime, and terrorism, all fall under the Peace and Security category. The following table shows all the conventions covered in our database, listed by their abbreviated forms. Each convention is briefly introduced in the next chapter.

Table 2.1: List of Multilateral Conventions Covered by the Study

Domain	Sub-Category	Conventions in acronyms or shortened names
Human Rights (H)	Human Rights	Slavery, Genocide, ICERD, ICESCR, ICCPR, ICCPR Protocol 1, War Crimes, ICSPCA, CEDAW, CAT, Apartheid in Sports, CRC, ICCPR Protocol 2, MWC, CRPD, Disappearance
Peace and Security (P)	Arms Control and Disarmament	Hague 1899, Hague 1907, Geneva, PTBT, BWC, CCW, CWC, CTBT, APM
	Non-Nuclear Zones	Tlatelolco, Rarotonga, Bangkok, Pelindaba, CANWFZ
	Non-Nuclear Proliferation	NPT, IAEA
	Cybercrime and Terrorism	Aircraft, Unlawful Seizure, Civil Aviation, Diplomatic Agents, Hostages, Airport Protocol, Maritime, Fixed Platform, Plastic Explosives, Terrorist Bombings, Terrorist Financing, Nuclear Terrorism, Nuclear Materials, Cybercrime
	Export Control	AG, MTCR, WA

Trade, Commerce & Communication (C)	Trade and Commerce	IMF, WB, GATT, WTO
	Transportation and Communication	ITU, UPU, IMO, ICAO
	Measurement and Technical Standards	Metre, ISO, IEC, TBT
	Food and Drug Safety	FAO, WHO, IPPC, CODEX
Environment (E)	Environment	ICRW, WH, CITES, LC72, Ramsar, Air Pollution, LOS, CMS, Vienna, Montreal, Basel, CBD, FCCC, Kyoto, PIC, POPs
	Nuclear Safety	CEENA, CACNARE, CNS, JCS
Intellectual Property (I)	Intellectual Property	Paris, Berne, Madrid, Hague, UCC, Rome, UPOV, WIPO, Phonograms, PCT, TRIPS, TLT, WPPT, WCT
Labor (L)	Basic Labor Rights	C29, C87, C98, C100, C105, C111, C138, C182
	Occupational Health and Safety	C13, C45, C62, C115, C119, C120, C127, C136, C139, C148, C155, C161, C162, C167, C170, C174, C176, C184, C187

Note: The full listing of conventions is given in Appendix 1

Chapter 3.

THE EVOLUTION OF GLOBAL SCIENCE AND TECHNOLOGY GOVERNANCE REGIMES

Since international regimes reflect patterns of cooperation and discord among nations (Keohane, 1984), by investigating the evolution of the norms and rules of regime over time, we can explore the continuity and development of the global governance throughout the twentieth century towards the twenty-first century. In this chapter, the evolution of the global S&T governance in the form of multilateral conventions is reviewed using the Global Support Index as a visualization aid. We first describe the concept of Global Science and Technology Governance within our scope of study in section 3.1. The construction of the Global Support Index to measure the support of international community towards different key topics of global science and technology governance is then followed in section 3.2. Section 3.3 will show the comparable results of this quantitative index in different perspectives while also briefly introducing the formation and goal of each convention. Through the analysis of changes in treaty participation across a broad time pattern, the noteworthy different results suggest useful information about the gap between the demand for and the supply of global governance can be extracted.

3.1 Global Science and Technology (S&T) Governance

During much of the nineteenth century, science activity was concentrated in a small set of countries and it progressed with very little attention to issues of governance. Different scientific communities operated independently and produced new knowledge in physics, chemistry, geology and biology. These achievements led the human-beings to new understandings of the world and contributed to the health and

wealth of nations (European Commission, 2009). When it turned to the twentieth century, especially through the two periods of the World War I and World War II, the public has recognized that the degree to which science and technology could be utilized for destructive purposes is dramatic. Technological development had led to chemical, biological and nuclear weapons with the terribly devastating effects, killing unbelievable numbers of people, and destroying the nature environment. In response, the governance of science and technology gradually become a global, public issue.

Moreover, during the same period, along with the globalization process, environmental scientists were becoming increasingly concerned about level of new chemical flows, industrial wastes and hazardous materials into the natural environment. It stimulated the emergence of the environmental movements to protect the environment (European Commission, 2009). The regulations at the global level to protect the environment, as well as the joint actions for the environmental restoration and improvement purpose become the major areas of global S&T governance.

Turning to the 1970s, a series of high technological disasters such as airline crashes, oils spills, chemical plant explosion in Bhopal, India, or the nuclear accident in Chernobyl, once again raised the alarm to the whole world about the application and manifestation of scientific and technological knowledge and how the humans can access and manage these kinds of risk (European Commission, 2009).

From the 1990s until now, concerns intensified about genetic engineering in food, animal and potentially human (European Commission, 2009). The prospects of biodiversity destruction argued the need for science and technology to be tempered by ethics and politics (Wilson, 1998).

It can be seen clearly that, S&T have become increasingly and genuinely global, forcing policymakers to expand their horizons of management and control the flows of S&T activities and knowledge within and between states. Advances in S&T have accelerated the growth of the international law as an effective force in directing, organizing, regulating and verifying the S&T processes at the global level. It has introduced new needs and challenges for global governance. Therefore, the history of global governance is also the story of adaption to new technology (Patrick, 2014).

For S&T, governance can be seen as concerned with providing, distributing, and regulating (European Commission, 2009). For instance, governance provides funds to support some kinds of science over other kinds, and distributes the results of science

to some constituencies at the expense of others (European Commission, 2009). Yet the most obvious and contentious form of governance involves regulation, the class of activities concerned with preventing, allowing, steering and confirming a flow of S&T events (European Commission, 2009). This framework of policies that support, distribute, and regulate scientific processes and products make up systems of governance (European Commission, 2009). Moreover, governance is concerned as *'global'* in the meaning that it is concerned with problems crossing the national boundaries. In general, global S&T governance is considered as the collaboration among multiple countries to pursue better management of science and technology for the sake of global happiness and sustainable development.

The mechanisms to govern the S&T activities such as providing, distributing, and regulating are increasingly materialized in the form of the international treaties. We pick up here some examples of treaties that work under different governance mechanism.

Table 3.1: Different Mechanisms of Global S&T Governance

Treaty	Goal	Governance Mechanism
Treaty on the Non-Proliferation of Nuclear Weapons (NPT)	To prevent the spread of nuclear materials and technology for the offensive military applications and promote cooperation in the peaceful uses of nuclear energy	<u>Regulate</u> the transborder flow of weapon-grade fissile materials and weapon making technologies and equipment
United Nations Framework Convention on Climate Change (UNFCCC)	To stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system	<u>Provide</u> a framework for transparency of the emission and the reduction of global bad (GHGs) <u>Distribute</u> resources for GHGs reduction among countries through Clean Development Mechanism (CDM) and/or other measures
Basel Convention on the control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel)	To diminish the risk of harms caused by hazardous wastes and materials	<u>Regulate</u> the transborder flow of hazardous wastes and toxic materials between nations <u>Provide</u> a framework for transparency of the transborder flow of hazardous wastes and toxic materials

Convention on Biological Diversity (CDB)	To conserve the sustainable use of biological diversity that covers all ecosystems, species, and genetic resources	<p><u>Regulate</u> appropriate assessment to genetic resources</p> <p><u>Provide</u> a framework for the fair and equitable sharing of benefits arising from the use of genetic resources</p>
Convention on Nuclear Safety (CNS)	To governs safety rules at nuclear power plants	<u>Regulate</u> the safety rules and standards at all civil facilities related to nuclear energy, including the issues offsite selection; design and construction; operation and safety verification; and emergency preparedness
International Plant Protection Convention (IPPC)	To prevent and to control the introduction and spread of harmful pests (phytosanitary measures) of plants and plant products through international trade	<p><u>Regulate</u> the safe movements of plants and plant products</p> <p><u>Provide</u> the framework for preventing the entry and spread of new pests of plants into a country</p> <p><u>Distribute</u> information and capacity for the implementation of the IPPC</p>
International Electrotechnical Commission (IEC)	To coordinate the development and promulgation of international standards for electrical, electronic and related technologies	<u>Regulate</u> from 300 to 500 international standards each year, covering a wide range of technologies from power generation, transmission and distribution to home appliances and office equipment
Berne Convention for the Protection of Literary and Artistic Works (Berne)	To protect, in as effective and uniform a manner as possible, the rights of authors in their literary and artistic works	<p><u>Regulate</u> the copyright of works of authors at least 50 years after the author's death</p> <p><u>Provide</u> a system of equal treatment that internationalized copyright (the copyright of works of authors from other country members of the Berne Union) in the same way as it recognizes the copyright of its own nationals</p>

To sum up, it can be seen that global governance in S&T seeks to provide, regulate, and distribute science by many pathways, including establishing rules and enforcing standards for people and organizations, attaching certain attributes, such as property rights, to scientific knowledge and the products of innovation, or restricting what are considered the misapplications and misuses of new science and technology (European Commission, 2009). The good implementation of governance opens up options and opportunities for the social use of new knowledge, rather than just closing options down through regulation (European Commission, 2009). Civil society is not simply interested in limiting scientific activity, but in steering the production and use of knowledge to appropriate ends, be it in relation to healthcare, education, the environment, or any number of sectors within and across nations (European Commission, 2009).

3.2 Institutional Infrastructure of Global S&T Governance

This section aims at providing an institutional infrastructure of global S&T governance. It includes a number of formal international organizations and agreements operating at a global level and is categorized into four major global issue-areas of the global S&T governance nowadays. These include: Security, Environment, Technical Competitiveness, Safety and Health. Each is further divided in different related policy domains representing the key topics of global governance of S&T.

Regarding to the governance of global peace and security, we had paid our attention on a regulatory framework for the purpose of restrictions and/or reductions on the development, production, stockpiling, proliferation, and usage of the sensitive dual-use goods and technologies, including chemical, biological and nuclear weapons. In another aspect of the security domain, during the second half of the twentieth century, the world has faced the threat of a “war on terrorism” and cybercrime. The global governance for the prevention of terrorism and cybercrime has become one of the most critical policy domains.

In relation to the governance of global environment, the issues such as atmospheric protection, nature conservation, bio-diversity and pollution control are among the major issues that has received the high priority in the “Agenda 21” action of UN Conference on Environment and Development.

To mitigate the undesirable social consequences accompanied with technological advances, there is a regulatory framework in the form of international treaties to tackle different safety and health issues of the humankind. Within the scope of our study, we focus on three different aspects of global governance of safety and health, including: nuclear safety, occupational health and safety, food and drug safety.

To ensure the compatibility, inoperability and fairness of the global markets, many global standards and intellectual property rights are developed. Therefore, two issues of standards and intellectual property have become increasingly an important policy domain for governing the technical competitiveness globally.

Table 3.2 summarizes the key topics of global S&T governance nowadays, while figure 3.1 shows the institutional infrastructure of global governance of S&T in the forms of multilateral treaties. The core pink colored circle represents the four global values covered in this study. The second round marked in green color deeper divides the global values in different key policy domains in the international S&T cooperation. The outer round in yellow color includes more than one hundred of formal multilateral agreements and regulatory regimes with UN-centred perspective. By that way, our collection of UN multilateral treaties can be categorized in different groups representing different policy domains of the global S&T governance. The full name of these treaties can be found in Appendix 1.

Table 3.2: Key Topics of Global S&T Governance

Global Value	Policy Domains	
<i>Security</i>	Control and Management of Dual-use Technology	Chemical and Biological Technology
		Nuclear Technology
		Export Control
	Prevention of Terrorism and Cybercrime	
<i>Environment</i>	Atmospheric Protection	
	Nature Conservation	
	Bio-Diversity	
	Pollution Control	
<i>Safety and Health</i>	Nuclear Safety	
	Occupational Health and Safety	
	Food and Drug Safety	
<i>Technical Competitiveness</i>	Standards	
	Intellectual Property Protection	

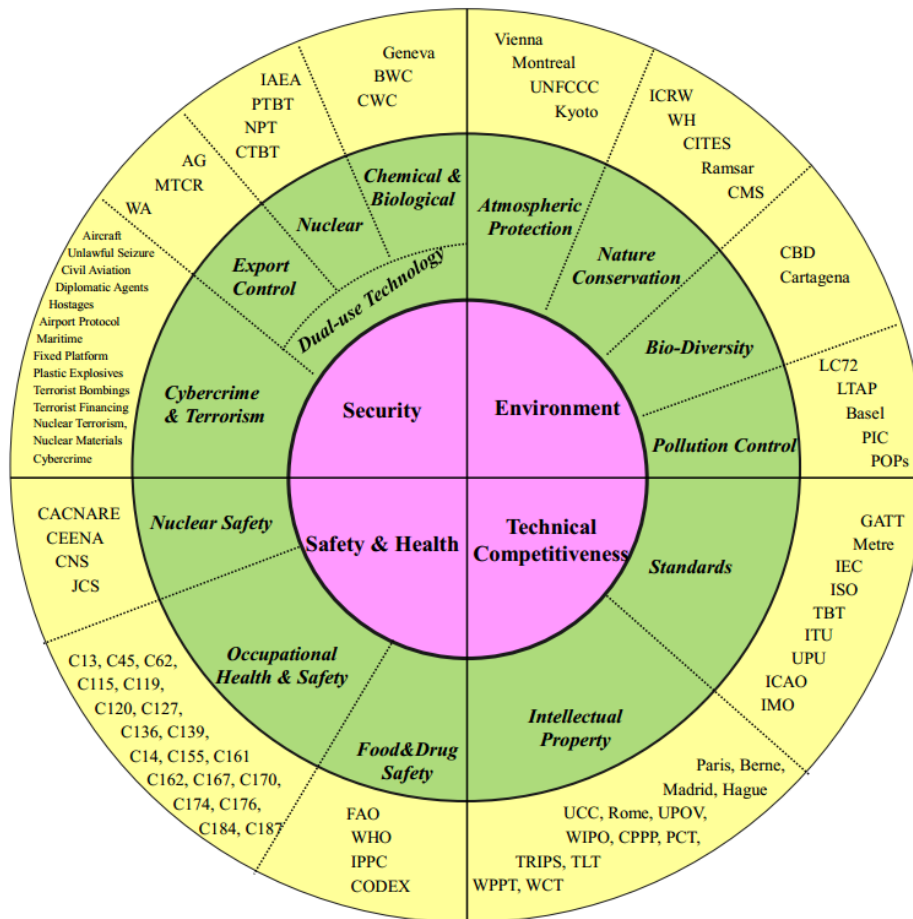


Figure 3.1: Institutional Infrastructure of Global S&T Governance

3.3 Measurement of Global Support for Global S&T Governance Regimes

For our research, we have constructed a Global Support Index (GSI) to measure the degree of support by the international community for an international agreement. GSI is an indicator that covers participation by nearly 200 states for international agreements. In particular, we developed this global support metric to consider the three different aspects that provide different views about the increasing engagement of states in global S&T governance regimes, including: the ratified country coverage (RCC), the ratified population coverage (RPC) and the global gross domestic product coverage (GDPC). By showing the degree to which the international agreement is supported or has spread globally through a time-series base in (1) number of state members coverage, (2) world population coverage, and (3) global gross domestic product coverage, a more detailed and up-close picture of how the world supports different international agreements according to different policy domains regulating global S&T processes is provided.

The following sections will explain more in more detail about our method for creating the Global Support Index (GSI) in three different aspects of measurement: by state members coverage, by world population coverage and by global gross domestic product coverage.

3.3.1 By State Members Coverage

The ratified country coverage (RCC) is our first attention when measuring the degree of support by the international community for an international S&T agreement. RCC was obtained by counting how many states have ratified the given convention to become its party members. The results show the increasing number of state members engaged in S&T agreement in a time-series base from the year of 1960 until now.

3.3.2 By World Population Coverage

The ratified population coverage (RPC) is another corner of view for measuring the degree of support by the international community for an international S&T agreement. RPC represents the international commitment to the convention by the percentage of the world population. To derive RPC, we collected the yearly population data of all states in the world from the World Bank Statistics collection.

3.3.3 By Gross Domestic Product Coverage

The global gross domestic product coverage (GDPC) is another aspect to observe the change in the level of international community support for an international S&T agreement. GDPC is measured by calculating the ratio of the total gross domestic product of all member states that have ratified a given convention at a given year to the total global gross domestic product.

3.4 Evolution of Global Governance for Security

The following sections of this chapter show the comparable results of the Global Support Index, by RCC, RPC and GDPC, while also briefly introducing the formation and goal of each convention. Through the analysis of changes in treaty participation by number of state members across a broad time pattern, there is clearly a surge of ratification from the mid-twentieth century onwards. Moreover, the noteworthy

difference among RCC, RPC and GDPC suggests useful information about the variation of ratification can be extracted.

In general, the upward trend in the representation of emerging and developing countries in multilateral institutions and other S&T norm and standard setting bodies can be observed more clearly. From being marginalized or even excluded from global decision-making processes, they appear to be more active in supporting the global governance regimes. A stronger partnership at the global level among states and multilateral organisations that work more closely with each other to face the growing threats of many global issues can be observed through our analysis.

The following section shows the results of our analysis using the Global Support Index regime by regime. We first come with the policy domain related to dual-use technology control.

3.4.1 Dual-use Technology Control

The twentieth century was the most disastrous in the history of humankind due to the World Wars I and II. Toward the end of the century, approximately 90 percent of casualties in war were civilians, as opposed to just 10 percent at the beginning of the twentieth century (Fast, 2004). Technological development has led to nuclear, biological, and chemical weapons with potentially devastating effects, killing unbelievable numbers of people, and destroying the natural environment.

It raised the alarm to the whole world about the necessity of a safeguard framework to protect civilian lives in times of war. Assigned to be the organization that aims to promote peace, stability, and well-being, the UN has responded to these challenges by strengthening the regimes to control the export, transit and brokering of dual-use technology. The term dual-use refers to any technology that has both vital legitimate uses and potent military applications (Evan and Hays, 2006). Beside peaceful civilian purposes such as the specific uses of biological and chemical substances within government funded research laboratories, or the uses of nuclear energy for the production of electricity, these technologies came along with the possibility of offensive military applications and may contribute to the manufacture and proliferation of weapons of mass destruction (WMD). Therefore the consideration about undesirable dangerous consequences which could make harm to human beings from acquiring and spreading of these technologies become a key instrument in the

governance of global peace and security. A regulatory framework of international treaties has been created for the purpose of restrictions and/or reductions on the development, production, stockpiling, proliferation, and usage of these sensitive dual-use goods and technologies, including chemical, biological and nuclear weapons.

The Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare signed in Geneva on 17 June 1925, usually referred to as the Geneva Protocol, is a treaty prohibiting the first use of chemical and biological weapons. It strictly regulates the use of chemical and biological weapons, but did not mention anything about production, storage, or transfer of them. As the results, the creation and stockpiling of chemical and biological weapons have been continuously deployed in some countries despite the existence of the treaty. Later, two conventions, the 1972 Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (BWC) and the 1993 Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC) were created to cover these aspects. Significant challenges to controlling the bad side-effects of these dual-use technologies still remain, however. The UN's effort to develop these conventions has faltered because of the dual-use technology dilemma (Evan and Hays, 2006). Some countries resist cooperation from a concern that many legitimate uses of the technologies are still needed, such as the applications for purely medical purpose; thus this convention was not ratified by many states for decades. In spite of this fact, BWC has been currently ratified by 165 states and CWC nowadays received the multilateral consensus from 188 states in the world.

Since nuclear weapons entered the realm of world politics during World War II, issues related to the control of nuclear materials, technology, and knowledge have formed one of the most important dimensions of international security. After the atomic bombing of Hiroshima revealed the existence of nuclear weapons to the general public, a mass nonviolent protest forced the creation of the first nuclear arms control agreement, the Partial Test-Ban Treaty (PTBT) in which nuclear tests in the atmosphere, in outer space, and under water were banned, but not underground. A major step toward this goal came with the signing of the key agreement, the Non-Proliferation Treaty in 1968 (NPT). A total of 190 parties have joined the treaty, with five states being recognized as nuclear-weapon states: the United States, Russia, the United Kingdom, France, and China. Under the regulation of NPT, non-nuclear weapon

states were prohibited from possessing, manufacturing, or acquiring nuclear weapons or other nuclear explosive devices.

The subsequent decades witnessed little progress in nuclear disarmament legislation. It was not until the end of the Cold War in 1991 that intensive efforts were made to adopt the 1996 Comprehensive Test-Ban Treaty (CTBT) by which states agree to ban all nuclear explosions in all environments, for military or civilian purposes.

The global Nuclear Non-Proliferation Treaty and other treaties against the spread of nuclear weapons are the responsibility of the International Atomic Energy Agency (IAEA) as the nuclear inspectorate regulated under the Safeguard Agreement. Under this agreement, IAEA can verify that a state is meeting its international commitments to not use nuclear programs for nuclear-weapons purposes. Within the world's nuclear non-proliferation regime, the IAEA's safeguards system functions as a confidence-building measure, an early warning mechanism, and a trigger that sets in motion other responses by the international community if and when the need arises (IAEA, nd).

At the forefront of managing strategic goods and dual-use technology to prevent the threats from the proliferation of weapons of mass destruction, export controls, more than ever, become a critical security-related trade instrument. Most industrial countries thus have controls on the export, transit and brokering of certain types of designated defense material and dual use items that are subject to legislation. These efforts are carried out by concluding international agreements and exercising multilateral cooperation related to export control. There are several international arrangements among countries which seek to harmonize lists of dual-use (and military) technologies to control. These include the Nuclear Suppliers Group (NSG) which focuses on stemming the proliferation of nuclear weapons, the Australia Group (AG) which looks at chemical and biological technologies, the Missile Technology Control Regime (MTCR), which covers delivery systems for weapons of mass destruction, and the Wassenaar Arrangement (WA), which covers conventional arms and dual-use technologies.

Figures 3.2, 3.3 and 3.4 provide the visualization of the global support level for the most important treaties related to global security issue. It can be seen clearly that some treaties seem to attract more particular attention from international community than others and then quickly reached to the high degree of global consensus and commitment from majority number of states.

Dual-use Technology Control

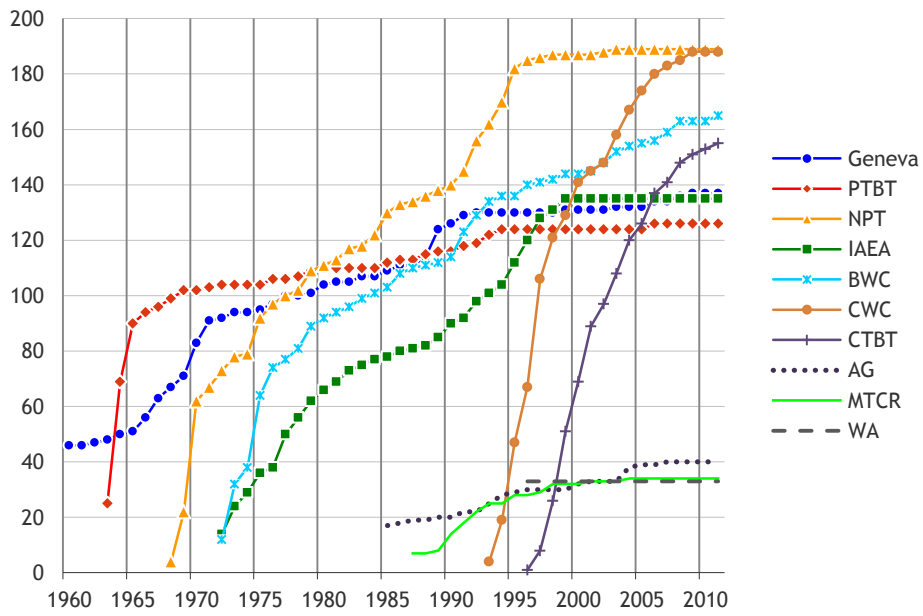


Figure 3.2: GSI Measured by RCC (Dual-use Technology Control)

Dual-use Technology Control

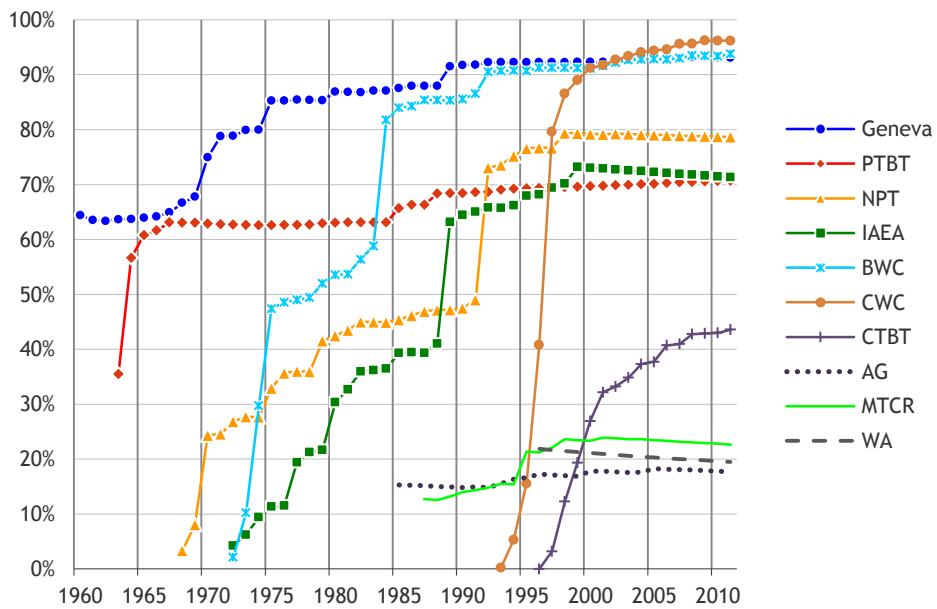


Figure 3.3: GSI Measured by RPC (Dual-use Technology Control)

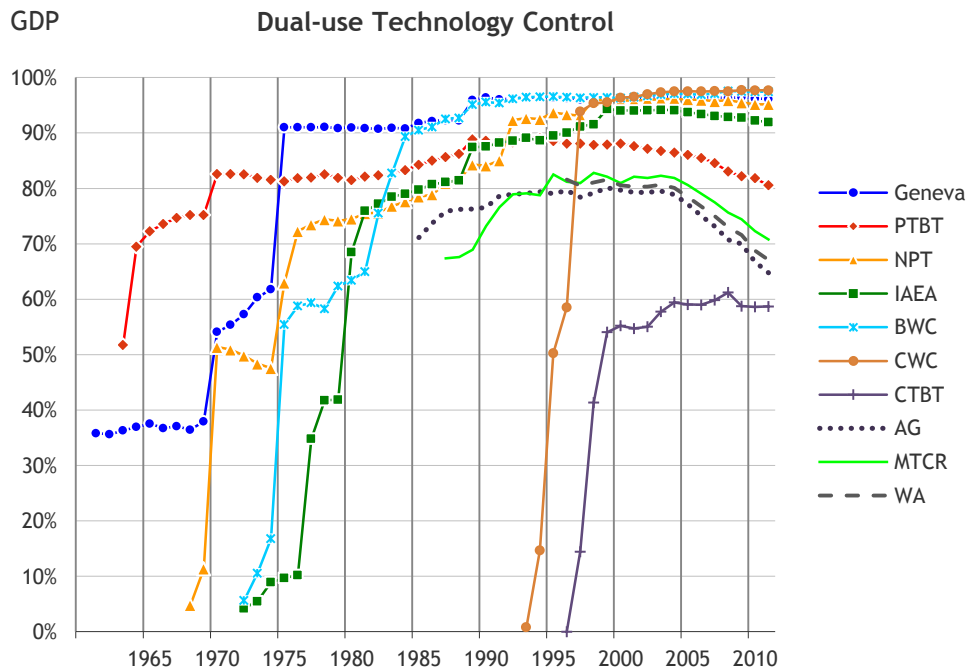


Figure 3.4: GSI Measured by GDPC (Dual-use Technology Control)

3.4.2 Prevention of Cybercrime and Terrorism

Since the concept of “international security” is no longer confined to traditional issues of war and peace, but now also covers topics such as terrorism and criminal law. Terrorism has been on the international agenda since 1934, when the League of Nations took the first major step toward outlawing the scourge by discussing a draft convention for the prevention and punishment of terrorism. Although the Convention was eventually adopted in 1937, it never came into force until the UN (United Nations, 2014).

During the second half of the twentieth century many countries in Europe, Latin America, Africa, and Asia confronted movements of the most diverse kinds that had in common a willingness to resort to the use of violence against innocent civilians to obtain their goals (O’Donnell, 2006). In response, the establishment of effective international regimes to combat criminal activity of terrorism and cyber penetration has taken on a new urgency. Currently there are thirteen international treaties against terrorism, and one treaty adopted for cybercrime prevention.

The Convention on Offences and Certain Other Acts Committed on Board Aircraft, adopted in Tokyo in 1963, is considered to be the first international treaty against

terrorism (O'Donnell, 2006). Later five more were adopted during the 1970s: the 1970 Convention for the Suppression of Unlawful Seizure of Aircraft, the 1971 Convention for the Suppression of Unlawful Acts against the Safety of Civil Aviation, the 1973 Convention on the Prevention and Punishment of Crimes against Internationally Protected Persons, including Diplomatic Agents, the 1979 International Convention against the Taking of Hostages and the 1979 Convention on the Physical Protection of Nuclear Material. Three treaties were adopted in 1988: the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, the 1988 Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on the Continental Shelf, and the Protocol for the Suppression of Unlawful Acts of Violence at Airports Serving International Civil Aviation. The 1990s saw the adoption of the 1991 Convention on the Marking of Plastic Explosives for the Purpose of Detection, the 1997 International Convention for the Suppression of Terrorist Bombings, and the 1999 International Convention for the Suppression of Financing of Terrorism. On 13 April 2005, the UN General Assembly adopted the International Convention for the Suppression of Acts of Nuclear Terrorism. These treaties define crimes against civil aviation, shipping or continental platforms, crimes involving the use, possession, or threatened use of "bombs" or nuclear materials, and crimes concerning the financing of terrorism.

Over the past decade, cybercrime also has posed a serious threat to national and international security. Cybercrime is one of the fastest growing areas of crime (Interpol, nd). The global spread of the Internet has enabled criminals to carry out illegal activity throughout the world via cyberspace. The security vulnerability systems include not only information systems and the computer systems of government and major companies but also national critical infrastructures, such as power plants or electrical grids. The Convention on Cybercrime in 2014 is the only binding international instrument on this issue until now. It serves as a guideline for any country developing comprehensive national legislation against cybercrime and as a framework for international cooperation between state parties to this treaty (Council of Europe, nd).

Cybercrime and Terrorism

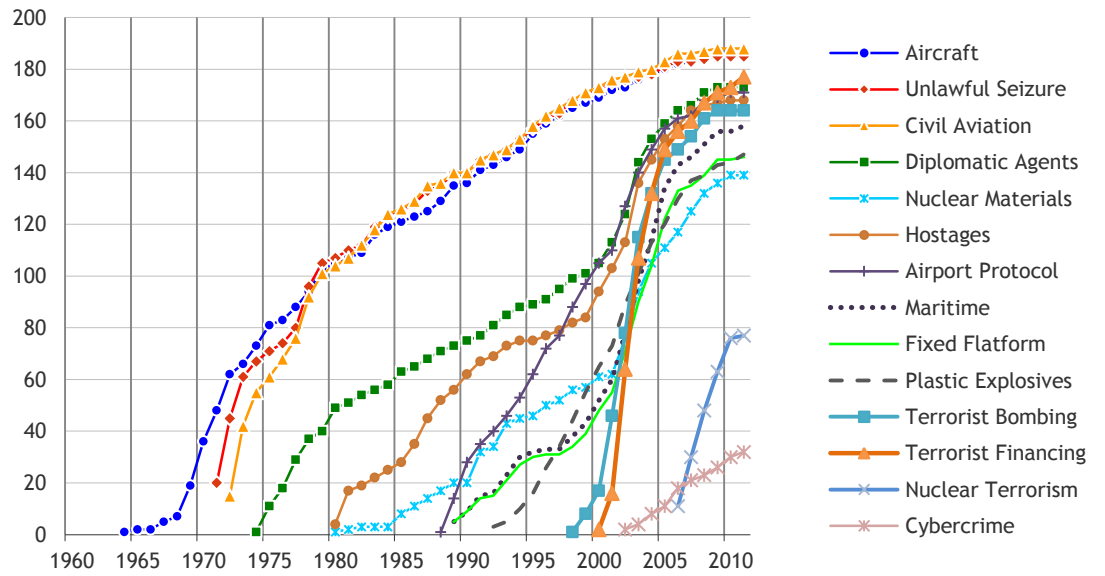


Figure 3.5: GSI Measured by RCC (Prevention of Cybercrime and Terrorism)

Cybercrime and Terrorism

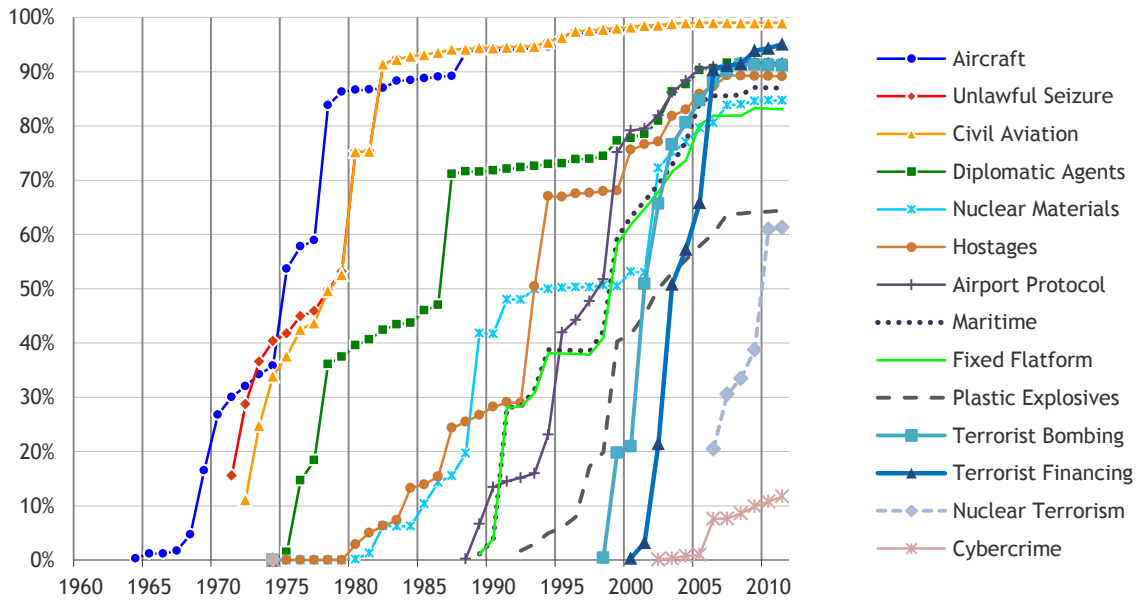


Figure 3.6: GSI Measured by RPC (Prevention of Cybercrime and Terrorism)

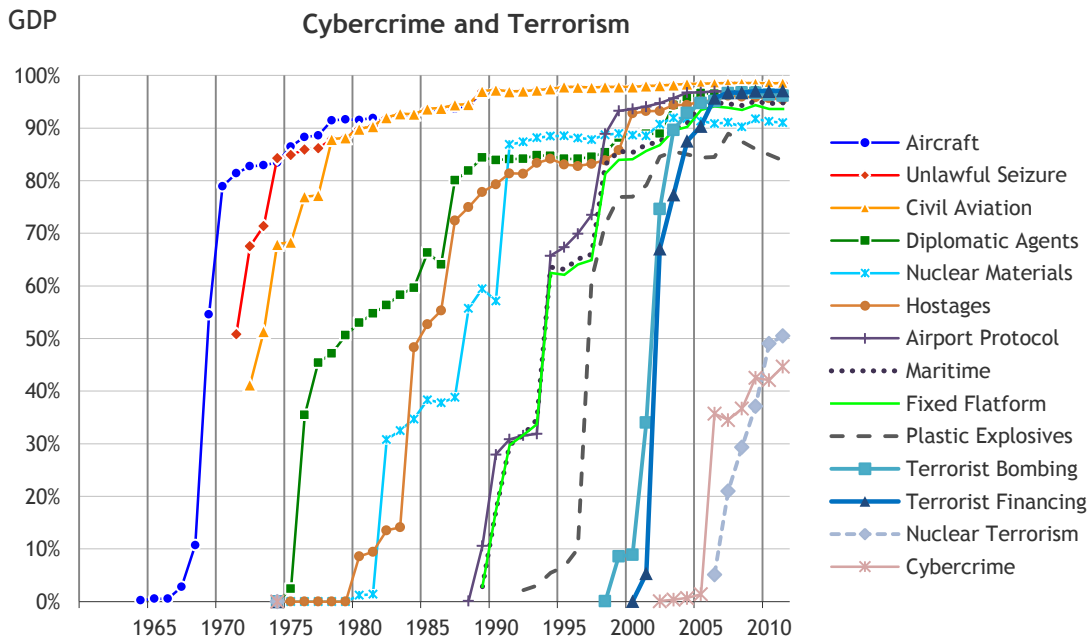


Figure 3.7: GSI Measured by GDPC (Prevention of Cybercrime and Terrorism)

3.5 Evolution of Global Governance for Environment

Global environment issues are the most recent concerns of world leaders. The post-World War II era has truly seen a steady increase in awareness of environmental problems, along with an increase in the severity and incidence of those problems (Schwabach, 2004). Global environmental problems, such as ozone depletion, climate change, and loss of biodiversity across borders, endanger the entire globe and also pose a long-term obstacle for all of humanity.

The mid-twentieth century, coupled with the globalization era, experienced a serious degradation of the global environment. The world recognized the importance of working together to solve this transboundary issue. This is strongly illustrated through the historical conference in Stockholm in 1972 that attracted representatives from 114 countries. The Stockholm Conference transformed micro- and macro-perceptions of environmental issues, firmly placed it on the international political agenda, and raised it in prominence, distinguishing the environment as a universal concern. It provided the catalyst that continues to shape the international convention related to environmental protection until today (Varfis, 2004).

The second major milestone in international action on environmental issues was reached in June 1992. More than a hundred heads of state gathered in Rio de Janeiro

for the UN Conference on Environment and Development (UNCED), popularly known as the “Earth Summit” where the “Agenda 21” action plan was proposed (French, 2004). Governments, international organizations, and non-governmental organizations (NGOs) again met to find a common response to transboundary environmental issues, such as climate change and loss of biodiversity.

The priority for “Agenda 21” action emphasizes on the conservation and management of resources for development which includes different issue-areas, amongst which are: 1) protection of the atmosphere; 2) nature conservation and protection of terrestrial resources and all kinds of seas; 3) conservation of biological diversity and environmentally sound management of biotechnology; 4) promotion of the safe management of toxic wastes to prevent air and water pollution. These environment movements provided the catalyst that shape and strengthen the system of collective international environmental agreements (IEAs) until today.

The action towards protecting the atmosphere represents one of the most important groups of multilateral conventions and includes: The 1985 Vienna Convention for the Protection of the Ozone Layer (Vienna), the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal), the 1992 Framework Convention on Climate Change (FCCC), and the 1997 Kyoto Protocol (Kyoto).

To deal with nature conservation and protection of terrestrial resources and all kinds of seas, a list of IEAs have been adopted to form another important regulatory framework for environmental protection. Among them, the International Convention for the Regulation of Whaling (ICRW) has the longest history among all. It was signed in 1946 and entered in force two years later. From being an international convention with a small number of members, it has now expanded with the participation of 86 nations to regulate commercial whaling and conservation of the remaining whale populations. Other IEAs, including the 1971 Ramsar Convention on the Conservation of Wetlands (Ramsar), the 1972 World Heritage Convention concerning the Protection of the World Cultural and Natural Heritage (WH), the 1973 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), the 1979 Convention on the Conservation of Migratory Species of Wild Animals (CMS), all are linked to the regulatory area of nature conservation.

Environmentally sound management of toxic wastes for preventing air and water pollution is another target of IEAs. These include: the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LC72), the

1979 Convention on Long-range Transboundary Air Pollution (LTAP), the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel), the 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC) and the 2001 Stockholm Convention on Persistent Organic Pollutants (POPs).

Another critical issue, despite mounting efforts over the past 20 years, the loss of the world's biological diversity, mainly from habitat destruction, over-harvesting, pollution and the inappropriate introduction of foreign plants and animals, has continued (UNCED, nd). To address this issue, the 1992 Convention on Biological Diversity (CBD) was finalized and adopted in Montreal in 2000. It provides a comprehensive and holistic approach to the conservation of biological diversity, the sustainable use of natural resources and the fair and equitable sharing of benefits deriving from the use of genetic resources (Zedan, 2005). Biosafety is one of the main topics addressed by the convention. As twin aspects of biotechnology, besides great potential for food, agriculture and health care, this modern technology can also pose the potential threats to human health and the environment. With a view to the sustainable management and use of biological resources, the 2000 Cartagena Protocol on Biosafety seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology (Secretariat of CBD, 2000).

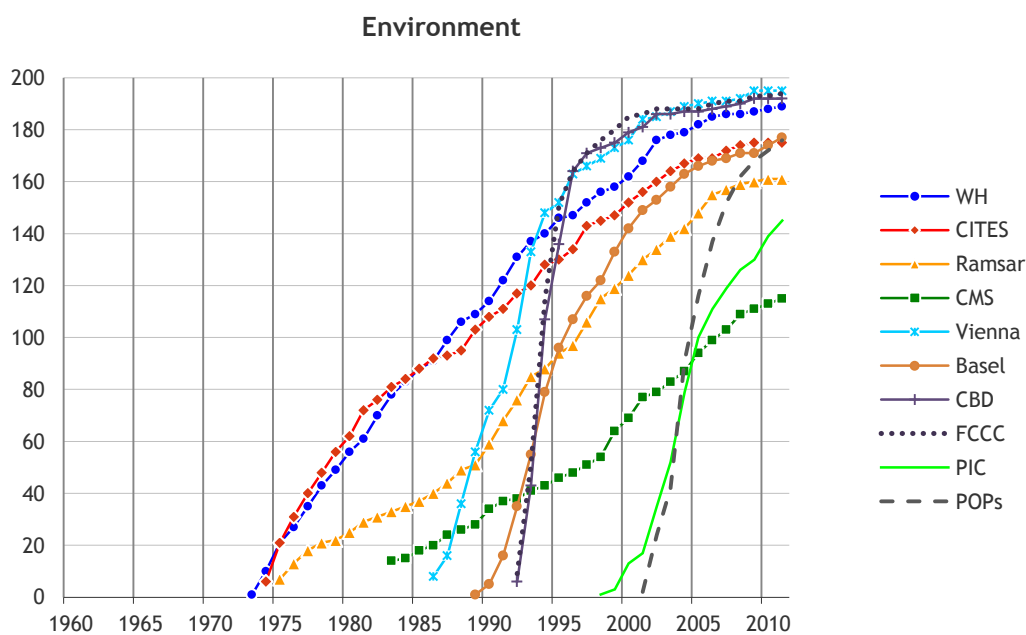


Figure 3.8: GSI Measured by RCC (Environment)

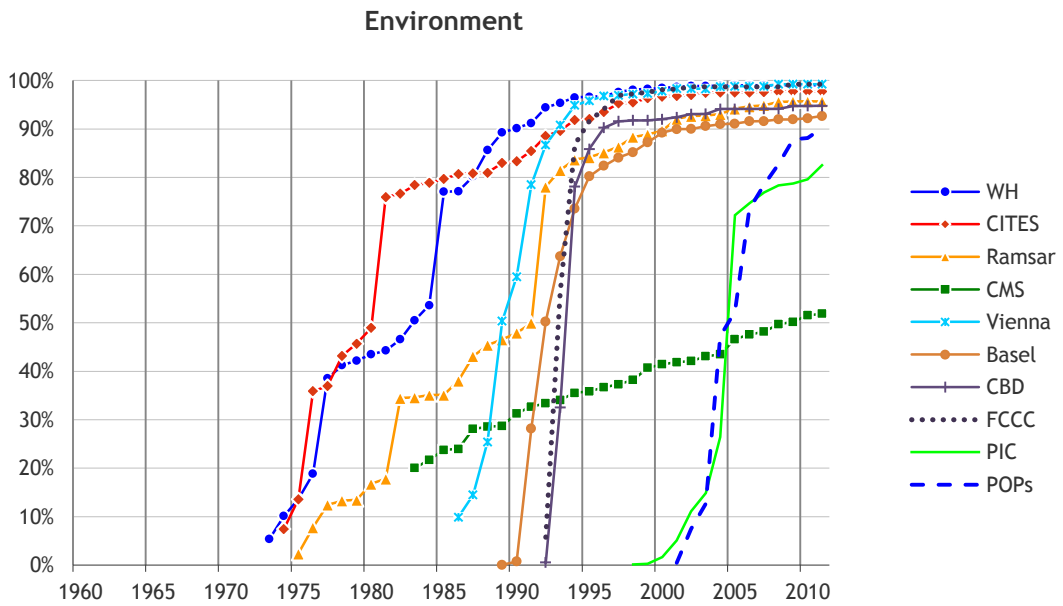


Figure 3.9: GSI Measured by RPC (Environment)

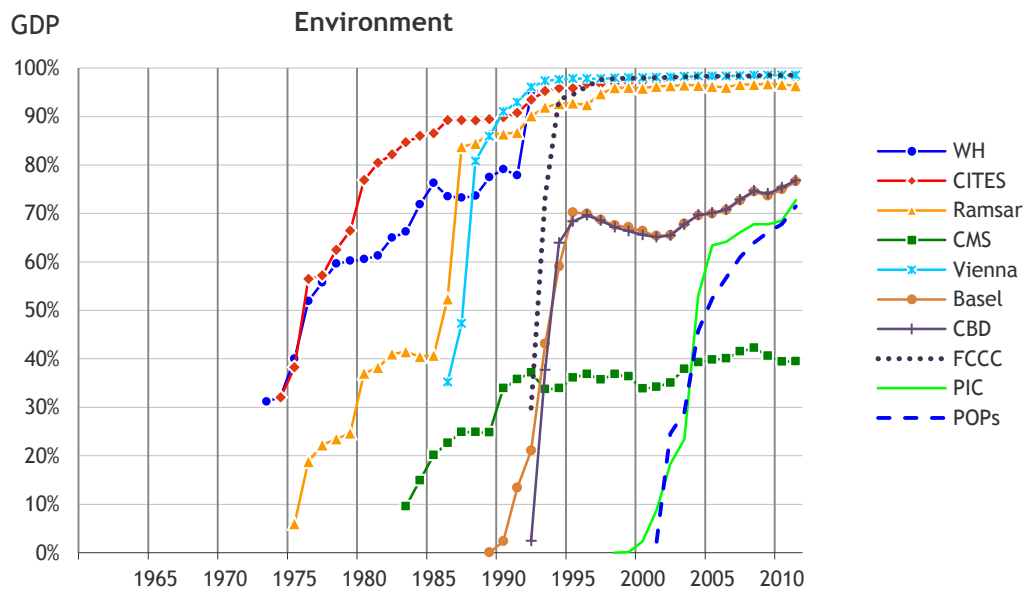


Figure 3.10: GSI Measured by GDPC (Environment)

Figure 3.8, 3.9 and 3.10 show the measure of global joint-commitment for the most important treaties of “Agenda 21” environment protection action plan. It is illustrated clearly that since the early 1970s, global environmental problems have raised awareness among states throughout the world and been implemented at extraordinary levels of international cooperation. By introducing different perspectives, the worldwide spreading of ratification is now being supplemented more clearly.

3.6 Evolution of Global Governance for Safety and Health

Most of the increased productivity and social wealth in the world over the recent decades can be traced largely to the advances in technology. However, along with great benefits it can bring to mankind, technological advances are frequently accompanied by undesirable social consequences, such as health or safety hazards. It is a characteristic trend nowadays that, the magnitude of the consequences of each individual incident, whether it be air, train or shipping disaster, a chemical or nuclear plant, is growing considerably (IAEA Bullentin, 1987). For preventing these kinds of tragic accident, the governments as overseers and protectors of the public interest must play a very direct role in controlling such undesirable effects, via planning, controls and regulations. Last decades of the twentieth century has seen the multinational cooperation in finding a regulatory framework in the form of international treaties to tackle different safety issues of the humankind.

3.6.1 Nuclear Safety

The Chernobyl disaster in 1986 brought attention to the importance of safety culture and the impact of managerial and human factors on the outcome of safety performance (Flin et al, 2000). As the response, the international legal framework for nuclear energy safety was developed relatively recently.

Promotion of nuclear safety is achieved mainly through adoption of legally binding agreements focusing on two basic aspects of nuclear energy: 1) prevention of accidents and 2) communication and management of their effects. Currently, there are five key international conventions are in force regulating these aspects and the IAEA is the depositary of these legal agreements. Adopted in 1986, the Conventions on Early Notification of Nuclear Accident (CEENA) and Convention on Cooperation and Assistance in Cases of Radiological Emergencies (CACNARE) deal with responses to communication and management of nuclear accidents or radiological emergencies. Later, the other critical conventions are issued cover the aspects of prevention of accidents. The Convention on Nuclear Safety (CNS) which was adopted in 1994 is an incentive-based instrument that commits states operating nuclear power plants to establish and maintain a regulatory framework to govern the safety of nuclear installations. Entered into in 2001, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (JCS) is the first international instrument to focus on minimizing the effects of hazardous radiological

materials and developing best practices to promote an effective nuclear safety culture. Another critical convention which deals with international legally binding undertaking in the area of physical protection of peaceful use nuclear materials is the Convention on the Physical Protection of Nuclear Material (CPPNM). It establishes measures related to the prevention, detection and punishment of offenses relating to nuclear material.

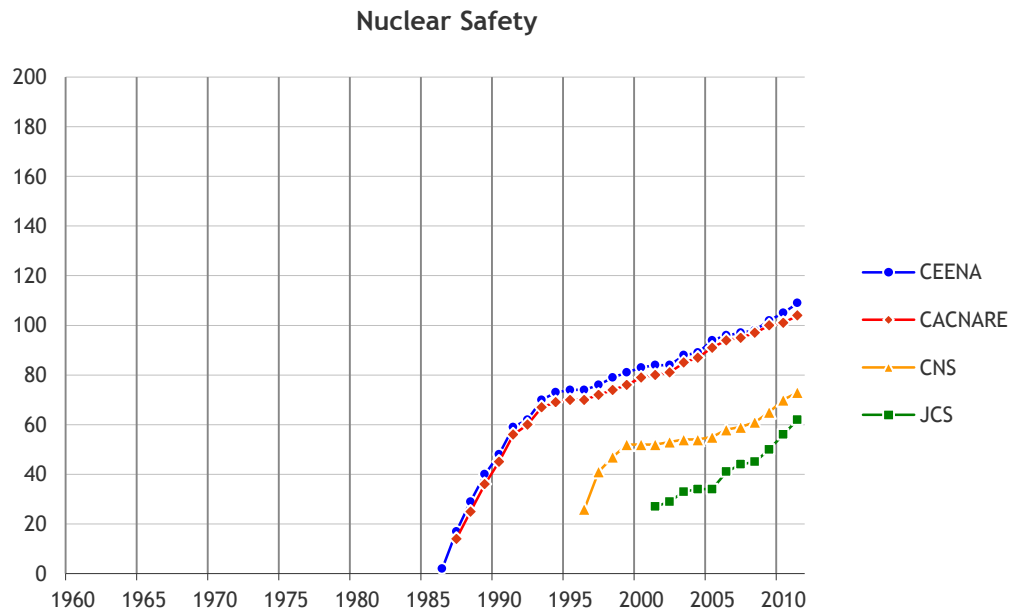


Figure 3.11: GSI Measured by RCC (Nuclear Safety)

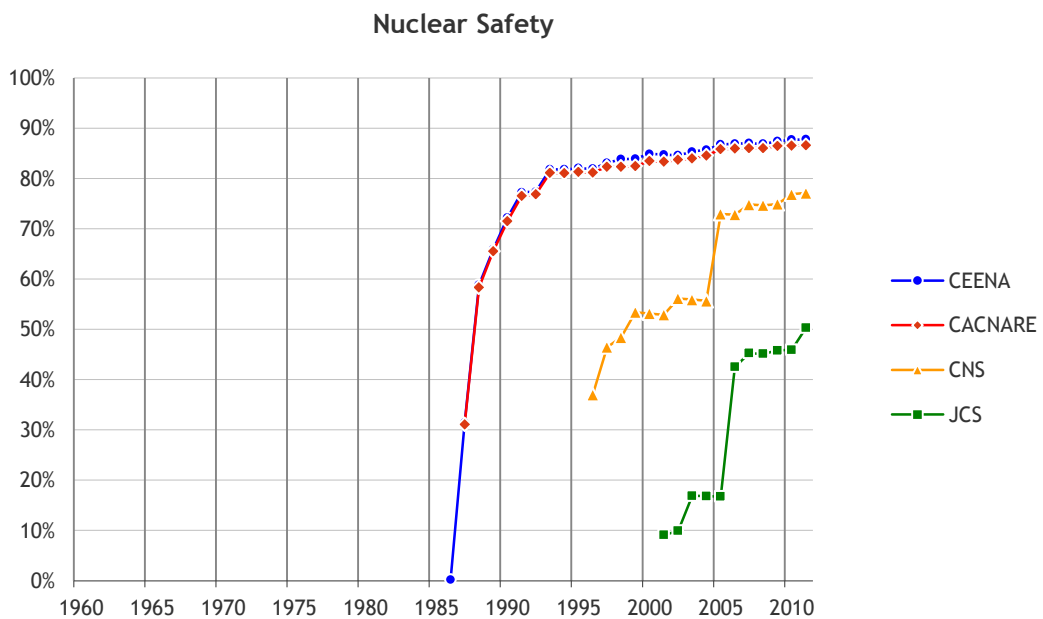


Figure 3.12: GSI Measured by RPC (Nuclear Safety)

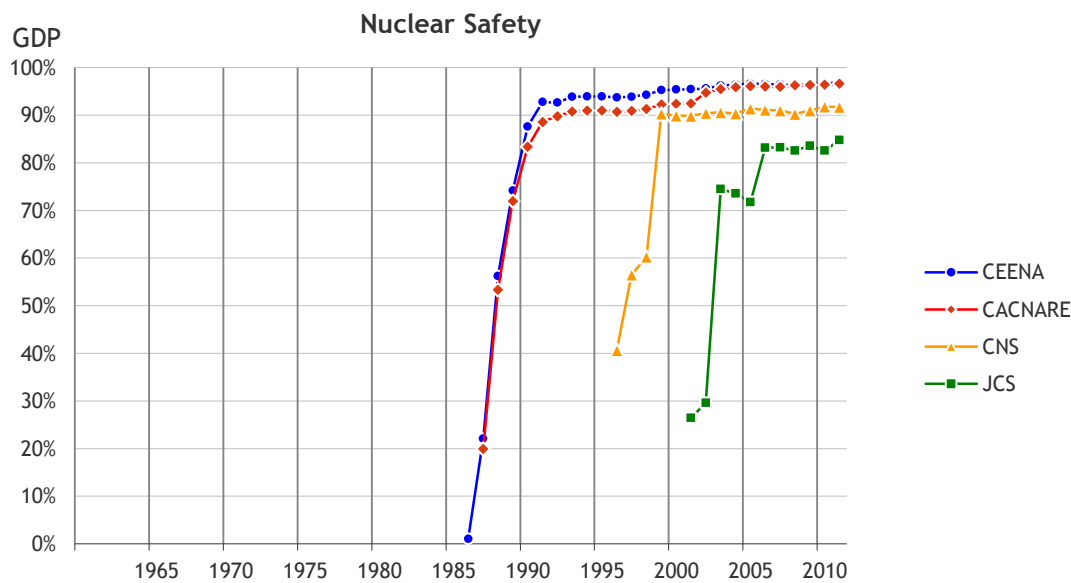


Figure 3.13: GSI Measured by GDPC (Nuclear Safety)

3.6.2 Occupational Health and Safety

Over the years, another safety issue that has received an increasing attention from the international community is occupational health and safety (OHS) which encompasses the social, mental and physical well-being of workers in the workplace environment (ILO, nd). Yet, most countries and industries still scarcely recognize occupational health and safety practices as a crucial determinant of national development. To enhance the protection of the worker against sickness, disease and injury arising from employment and to achieve the strong preventive safety cultures are among the main tasks assigned to the International Labor Organization (ILO) through its set of international OSH conventions. The conventions embody principles that define the rights of workers in this field as well as allocating duties and responsibilities to the competent authorities, to employers and to workers (Alli, 2008). Based on scope or purpose, the OSH conventions can be categorized into these following groups.

The first one is fundamental principles to guide policies for OSH promotion, action, and management contained in three international labor conventions (Occupational Health Services Convention in 1985 [C161], Promotional Framework for Occupational Safety and Health Convention in 2006 [C187], Occupational Safety and Health Convention in 1981 [C155]). These provide for the adoption of a national occupational safety and health policy, as well as describing the actions to be taken by governments and within enterprises to promote occupational safety and health and improve the working environment (Alli, 2008).

The second OSH convention group comprises a set of general protection measures, for example, guarding of machinery (Guarding of Machinery Convention in 1963 [C119]), or limiting the weight of loads to be transported by a single worker (Maximum Weight Convention in 1967 [C127]).

The third group regulates the protection in specific branches of economic activity, such as the building industry (Safety Provisions Building Convention in 1937 [C62], Safety and Health in Construction Convention in 1988 [C167]), commerce and dock work (Hygiene [Commerce and Offices] Convention in 1964 [C120]), mining (Safety and Health in Mines Convention in 1995 [C176]), or agriculture (Safety and Health in Agriculture Convention in 2001 [C184]). The protection of specific type of workers having specific occupational health needs, such as women (Underground Work [Women] Convention in 1935 [C45]) also forms another aspect of OSH conventions.

Another approach for OSH is the protection against specific risks and substances such as ionizing radiation, benzene, asbestos (White Lead [Painting] Convention in 1921 [C13], Radiation Protection Convention in 1960 [C115], Benzene Convention in 1971 [C136], Asbestos Convention in 1986 [C162]), prevention of occupational cancer (Occupational Cancer Convention in 1974 [C139]), control of air pollution, noise and vibration in the working environment (Working Environment [Air Pollution, Noise and Vibration] Convention in 1977 [C148]), measures to insure safety in the use of chemicals (Chemicals Convention in 1990 [C170]), including major industrial accidents (Prevention of Major Industrial Accidents Convention in 1988 [C155]).

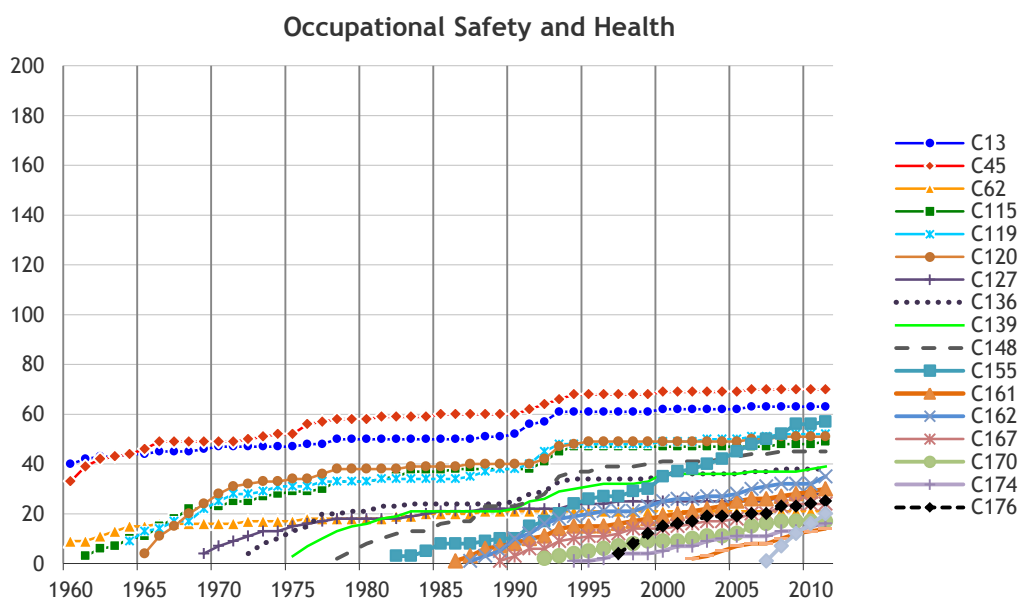


Figure 3.14: GSI Measured by RCC (Occupational Health and Safety)

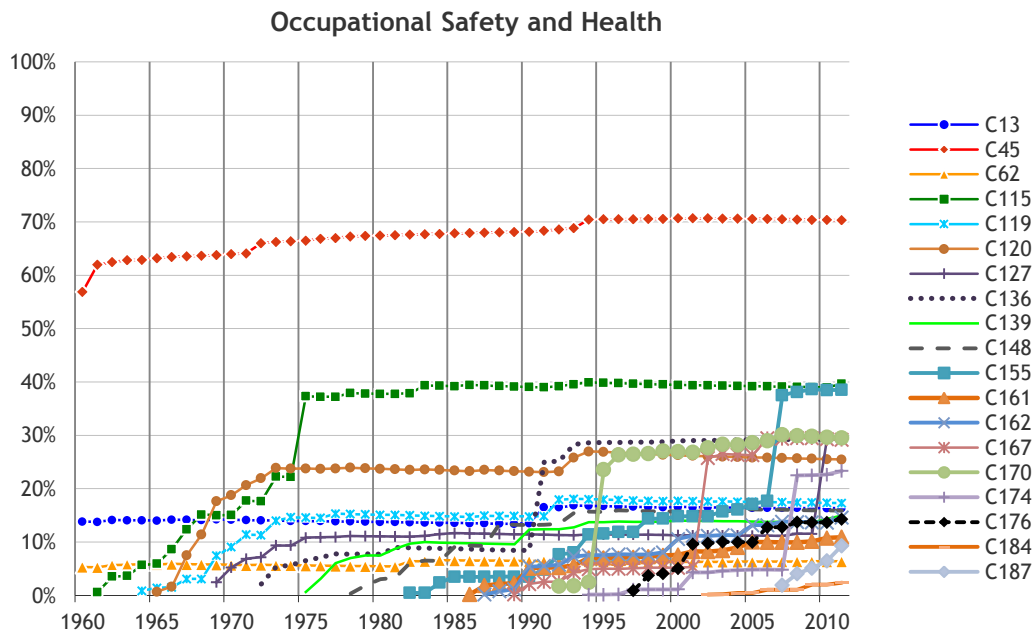


Figure 3.15: GSI Measured by RPC (Occupational Health and Safety)

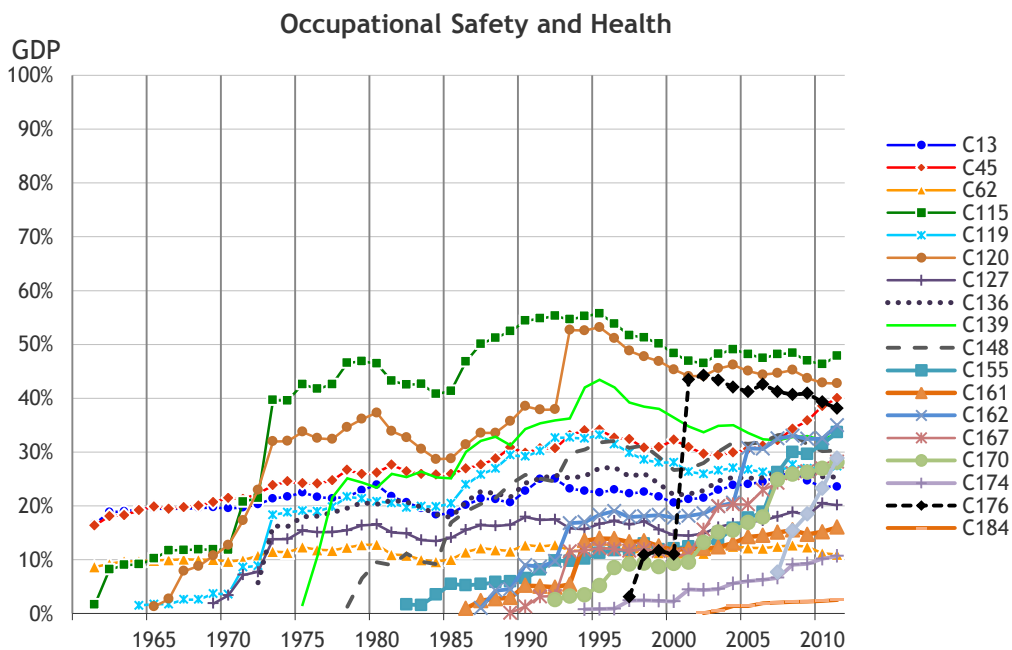


Figure 3.16: GSI Measured by GDPC (Occupational Health and Safety)

The slow increase in the number of states committed to OHS related conventions can be observed through RCC in Figure 3.14, while the RPC in Figure 3.15 shows a very marginal change in the world population weight benefit from these regulations.

3.6.3 Food and Drug Safety

Recently, a series of bad rumour involving contaminated baby formula milk, toxic fruits and vegetables demonstrated the threat that unsafe food and drug imports pose to public health and international trade. The expanding importation and exportation of food products among countries has raised the importance of global food safety-related regulatory systems. Ensuring safety in the global trade in food and drugs has introduced many challenges to UN System, especially to specialized agencies such as Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO). The International Plant Protection Convention (IPPC) is an international plant health agreement, established in 1952 by FAO that aims to prevent the introduction and spread of pests to protect not only cultivated plants but also natural flora and plant products. The Convention makes provision for the application of measures by governments to protect their plant resources from harmful pests (phytosanitary measures) which may be introduced through international trade (WTO, nd). Another critical joint FAO/WHO Food Standards Programme that works towards setting international food standards is the Codex Alimentarius Commission, established in 1963. Its target is to develop harmonized international food standards, guidelines and codes of practice to protect the health of the consumers and ensure fair practices in the food trade (Tritscher et all, 2010). Figure 3.17, 3.18 and 3.19 is the measure of global commitment degree for the selected treaties regulating the food and drug safety.

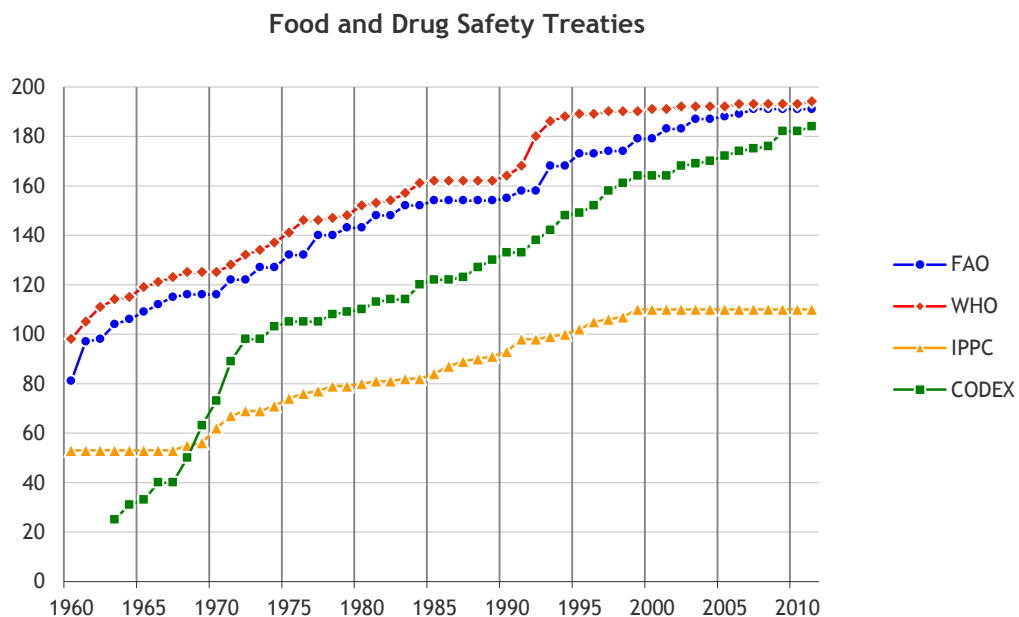


Figure 3.17: GSI Measured by RCC (Food and Drug Safety)

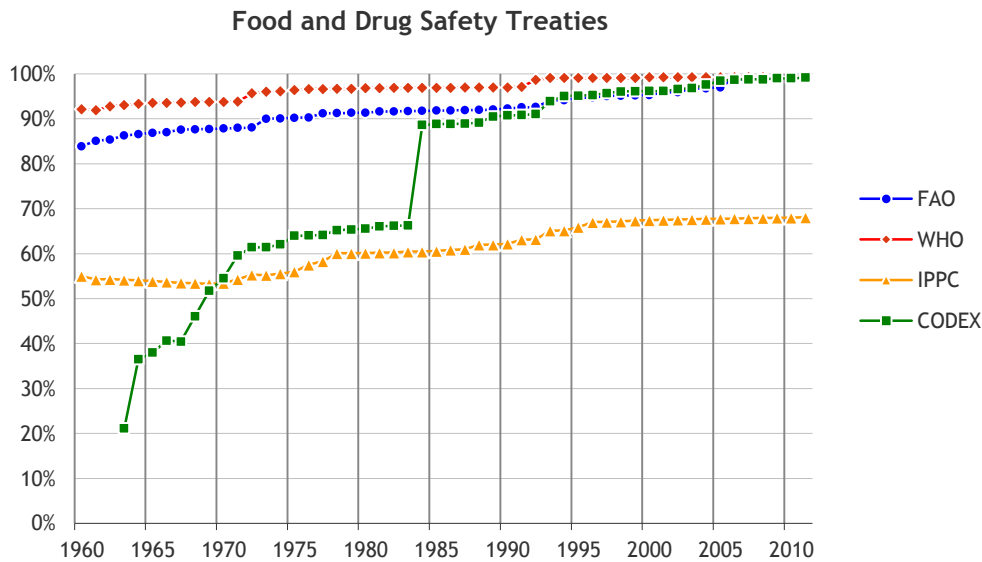


Figure 3.18: GSI Measured by RPC (Food and Drug Safety)

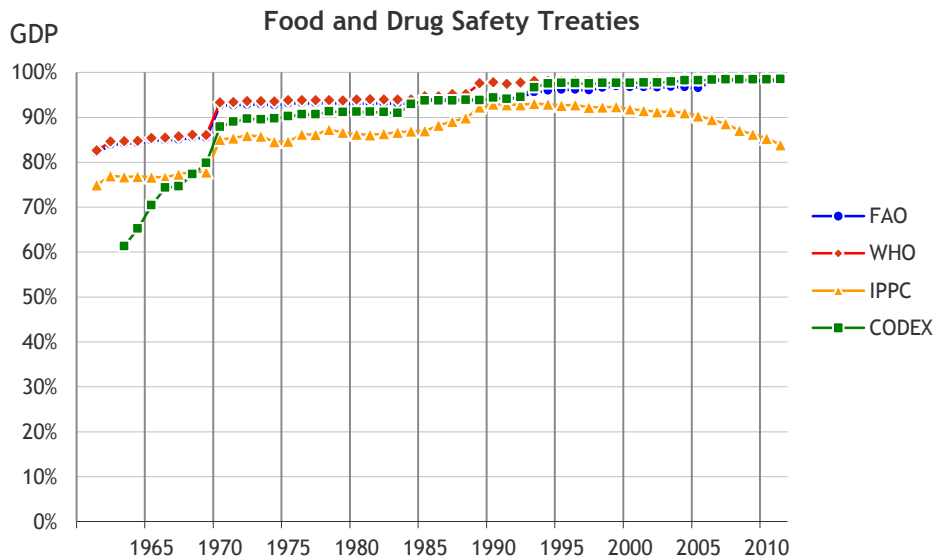


Figure 3.19: GSI Measured by GDPC (Food and Drug Safety)

3.7 Evolution of Global Governance for Technological Competitiveness

3.7.1 Standards

The growth of cross-border trade of products and service is a driving force behind the creation of a global system of tariffs and technical standards. Tariffs, technical and safety standards have become one of the main area for coordination.

Among all, tariffs had been the central and uppermost concerns of all members. An uncountable number of tariff unions and tariff agreements have been formulated throughout history. It can be traced back centuries. But all of them have been regional in terms of geographical scope, and it is not until the General Agreement on Tariffs and Trade (GATT) emerged after World War II that the world had a truly global tariff. A global coordination mechanism seems to have appeared in other aspects of international trade, such as measurement standards and quarantine procedures.

Standards facilitate international trade, by ensuring the compatibility and interoperability in different markets. Standards also have an important role to play in supporting the competitiveness of each country in global market, by helping to improve the products and services. They help to harmonize technical specifications of products and services making industry more efficient and breaking down barriers to international trade (ISO, nd).

Many existing global standards are developed and regularly revised and updated to ensure that they remain fit for purpose as new materials, technologies and processes become available (European Commission, nd). The first ever globally uniform measurement convention was established in 1875 based on the Metric System. As a central organ to implement the Convention, the International Bureau of Weights and Measures (French acronym BIPM is commonly used to denote this organ) was established in Paris at the same time to ensure world-wide uniformity of measurements and their traceability to the International System of Units (SI).

Other well-known standards setting organizations, the International Telecommunications Union (ITU), the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO) stand as three principal standards bodies involved in the development and adoption of international standards. Being one of the oldest international organizations, ITU is a specialized agency of the United Nations which is specifically responsible for coordinating standards for shared global use of the telecommunication infrastructure and for assisting in the development and coordination of worldwide technical standards. IEC is a non-governmental organization that plays as the principal body coordinating the development and promulgation of international standards for electrical, electronic and related technologies. It publishes 300 to 500 international standards each year, covering a wide range of technologies from power generation, transmission and distribution to home appliances and office equipment (European Commission, nd). ISO

is the principal body coordinating the development and promulgation of formal international standards. ISO standards are developed in almost all industry sectors, with the exception of electrotechnical and telecommunications standards (developed by IEC and ITU respectively) (European Commission, nd).

Trans-border trade often brought in unexpected, unwelcomed guests. Pests, cholera, and several communicable diseases, brought by traders had upset people repeatedly. In order to prevent the spread of diseases, various formulas of quarantine systems were devised and practiced at many ports around the world. The word “quarantine” originates from the Venetian dialect form of the Italian quaranta giorni, meaning “forty days.” One practice was an imposed 40-day period of isolation for ships and people wishing to enter the city of Dubrovnik in Dalmatia (currently Croatia). As a form of an international convention, the first multilateral International Sanitary Convention was concluded at Venice in 1897, which focused on the plague (Obijiofor, 1969). The functions of sanitary conventions were later integrated into the mandates of the World Health Organization (WHO).

Thus, the removal of tariffs and technical barriers of various forms are the central issues in the promotion of commerce, even from the early days of global commerce, and the value of these eliminations is growing increasingly today.

For the commercial aspects of international development, there are numerous international organizations involved in the regulation of international trade that have been developed. The Bretton Woods Conference in 1944 is recorded as an important milestone by the creation of the International Bank for Reconstruction and Development (IBRD), which is part of today’s World Bank (WB) and International Monetary Fund (IMF). Then came GATT, which was signed at an international conference in Geneva in October 1947.

The World Trade Organization (WTO), GATT’s successor body, serves to exemplify the methods and practical measures adopted by an organized global trading system to regulate international trade in support of national aspirations for international development (Sucharitkul, 2004). GATT’s aim was to expand international trade and raise world welfare by promoting non-discrimination among member nations and by adhering to a policy of national treatment (Tiefenbrun, 2004). It provided a regulatory framework for world trade (Tiefenbrun, 2004). However, GATT was not followed consistently by each of its member nations until the WTO was formed in 1995 (Tiefenbrun, 2004).

The WTO has more than 130 members, accounting for over 90 percent of world trade. The WTO represents a legal framework for the organization of international trade, consisting of a binding set of technical regulations and product standards governing the Agreement on Technical Barriers to Trade (TBT). In recognition that differing regulations and standards among countries makes trade difficult for producers and exporters, the TBT exists to promote the development of regulations, standards, testing and certification procedures that countries use to regulate markets, while also providing members with the right to protect their consumers, preserve their natural resources, and protect domestic industries.

A connected world always requires coordination efforts to establish and maintain connectivity. This is true for all stages of communication from postal mail to the Internet and for all venues of transportation from ocean going ships, railway to airlines.

In the area of postal communication, experts organized an international congress in Berne, Switzerland, in 1874 to discuss how to facilitate a global postal system by regarding the whole world as a single postal territory. This meeting marked the birth of another international organization, the Universal Postal Union (UPU) in 1874. Through UPU, postal authorities agree on the rules for what and how items should be mailed, and they compensate each other for handling each other's mail (Alleyne, 2004).

For another area of global communication, the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO) constitute the current participants in the law-making process for international transport by air, sea, and other international waterways (Alleyne, 2004). To respond to the need for international standards to regulate shipping that can be adopted and accepted by all countries, the IMO was formally created in 1948. Meanwhile, the ICAO was established in 1944 to promote a safe and orderly development of international civil aviation throughout the world. Until now, it serves as a forum for cooperation among its 190 member states. Its function is to create standards and regulations necessary for aviation safety, security, efficiency, and regularity, as well as for aviation environmental protection.

Standards

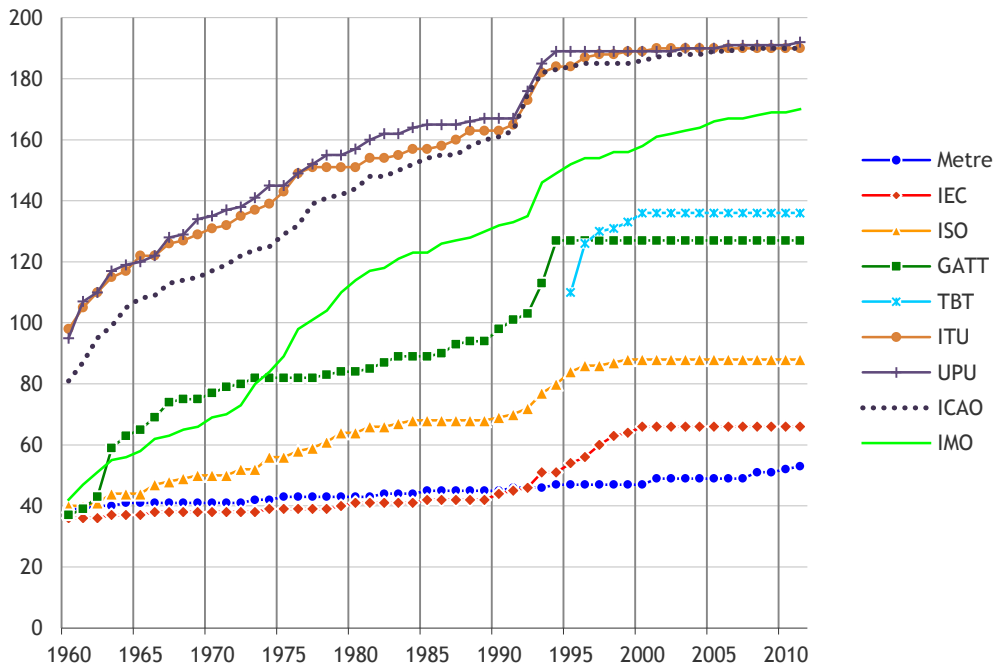


Figure 3.20: GSI Measured by RCC (Standards)

Standards

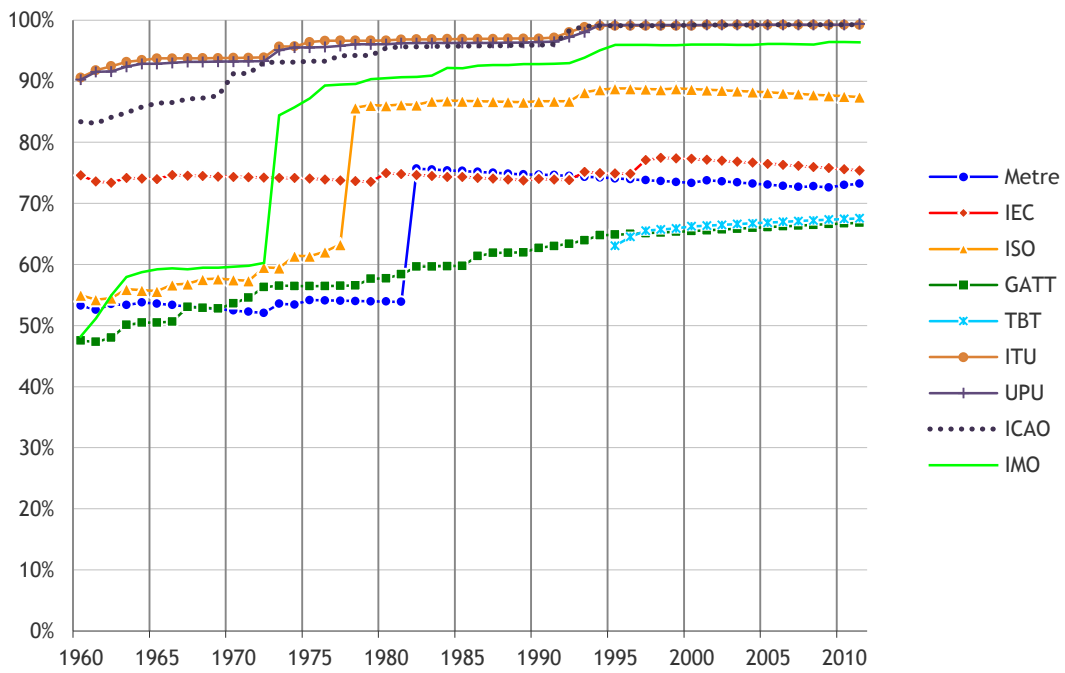


Figure 3.21: GSI Measured by RPC (Standards)

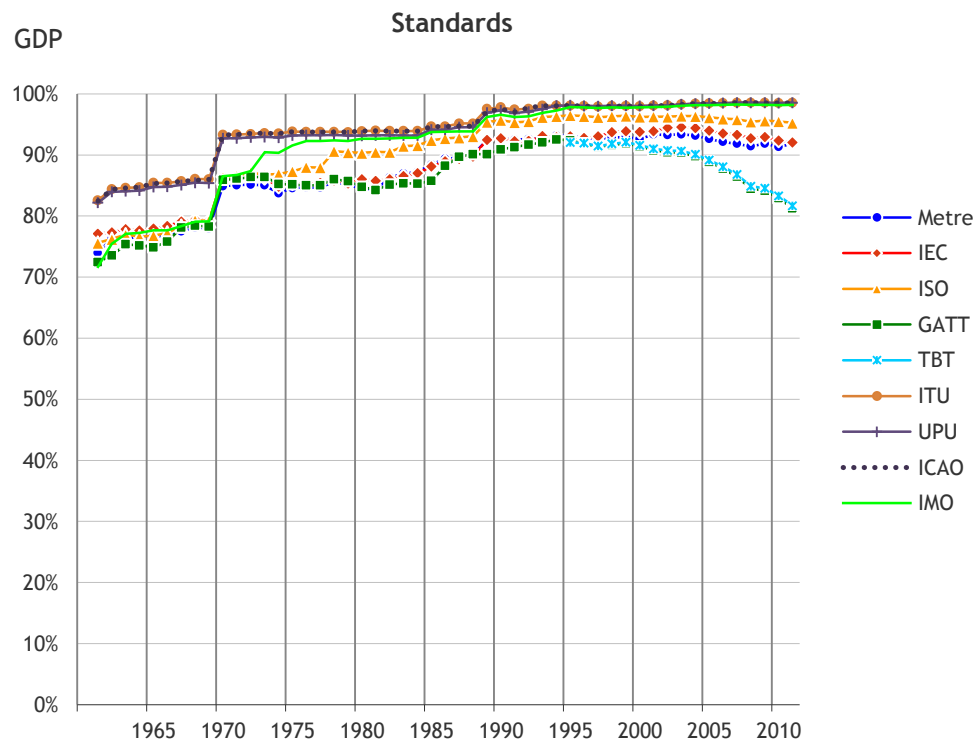


Figure 3.22: GSI Measured by GDPC (Standards)

Figure 3.20, 3.21 and 3.22 represent the development progress of the most important standards for the development of the world's trade, commerce and communication.

3.7.2 Intellectual Property Protection

In the late twentieth century, economists and critical theorists recognized that in many developed countries, long dominant industrial economies based on the manufacturing, distribution, and consumption of tangible goods were being eclipsed in size and social impact by an emerging economic system based on the creation, commodification, exploitation, and control of intangible (or information-based) goods (Coombe, 2012). This shift raised the importance of intellectual property (IP) in an increasingly globalized information economy. When valuable technology is transferred through trade, it is therefore likely to be copied or imitated. Therefore, intellectual property rights which regulate legal protection for investors from outside use or implementation without consent, has increasingly become an important issue in multilateral trade negotiations. They provide encouragement for developing and exploiting subsequent innovations by granting successful inventors temporary

monopoly power over their innovations. By this mechanism, intellectual property rights can foster creativity in high technology, thus strengthening its protection has been a priority for many nations and has increasingly been the focus of attention of policymakers (Bird and Jain, 2008). There is an extensive international system for defining, protecting, and enforcing intellectual property rights, comprising both multilateral treaty schemes and international organizations (Marsh, 2014). Intellectual property treaties regulate the protection and management of copyright, trademark, patent rights and related areas such as trade secrets, geographical indications, and rights of publicity. They also conserve the originality of industrial designs, plant varieties, databases, and integrated circuit topography. In mainstream policy discourses, IP policy is advanced as a means to provide incentives for creativity and innovation, and to secure economic rewards for investment in research and development while providing a socially optimal level of creative and technological goods (Coombe, 2012). That explains why the last two decades have attracted heightened attention and concern of the IP community.

The most important international governmental organizations to promote the protection for intellectual property is the World Intellectual Property Organization (WIPO)—a specialized UN agency, established in 1967 in Geneva, Switzerland. WIPO currently has 187 member states and manages 25 international treaties. However, the origins of WIPO can be traced back to one of the first intellectual property treaties, the 1883 Paris Convention for the Protection of Industrial Property (Paris), which established the Union for the Protection of Industrial Property, the so-called Paris Union. Other key conventions in this arena include the 1886 Berne Convention for the Protection of Literary and Artistic Works (Berne), the 1891 Madrid Agreement Concerning the International Registration of Marks (Madrid), the 1925 Hague Agreement Concerning the International Deposit of Industrial Designs (Hague), and the Universal Copyright Convention (UCC). UCC, adopted in 1952 and entered into force in 1955, introduced the idea that culture (literary, scientific, and artistic works) embodies universal values that require uniform protection and accordingly a shared responsibility to be assumed by the international community. UCC is an alternative for those countries that disagreed with aspects of the Berne Convention, but still wished to participate in some form of multilateral copyright protection.

Whereas previous copyright law had been written to regulate the circulation of printed materials, there was no equivalent protection for sound recordings. In the 1930s, the use of magnetic tape for recording made the reproduction of sounds and

images easier and cheaper than ever before. In response to these new technologies, the Rome Convention for the Protection of Performers, Producers of Phonograms, and Broadcasting Organizations (Rome) was accepted in 1961. The convention expands the coverage of copyright protection from the author of a work to the creators and owners of specific physical instance of intellectual property, such as audiocassettes or DVDs. Later, in 1971, the Convention for the Protection of Producers of Phonograms against Unauthorized Duplication of Their Phonograms (Phonograms) was created as a new international treaty that was designed to give music producers, separate from composers and performers, additional powers to combat copyright infringement. This gave them standing to prosecute makers of unauthorized copies of their tapes or records in other countries (Baskerville, 2006).

Extending the regulations for the protection of industrial property in the Paris Convention, the Patent Cooperation Treaty (PCT) came into effect in 1978 and facilitates filing for patent protection for the same invention in member countries by providing centralized filing and standardized application procedures (Moschini, 2004).

The 1994 Agreement on Trade Related Intellectual Property Issues (TRIPS) administered by WTO achieved further progress in this field by creating a framework of uniform standards of protection for a wide range of intellectual property on a near-universal basis. The agreement covers seven areas of intellectual property. They are (1) copyright and related rights (rights of performers, producers of sound recordings, and broadcasting organizations), (2) trademarks, (3) geographical indications including appellations of origin, (4) industrial designs, (5) patents, including the protection of new varieties of plants, (6) layout-designs of integrated circuits, and (7) undisclosed information including trade secrets. In each of these areas, the agreement establishes minimum standards of protection, provisions relating to the domestic enforcement of IP rights, and provisions concerning international dispute settlement (Safadi, 2004).

Other instruments in the field of protecting copyrights, include the well-known International Convention for the Protection of New Varieties of Plants (UPOV), WIPO Performances and Phonograms Treaty 1996 (WPPT) and WIPO Copyright Treaty 1996 (WCT).

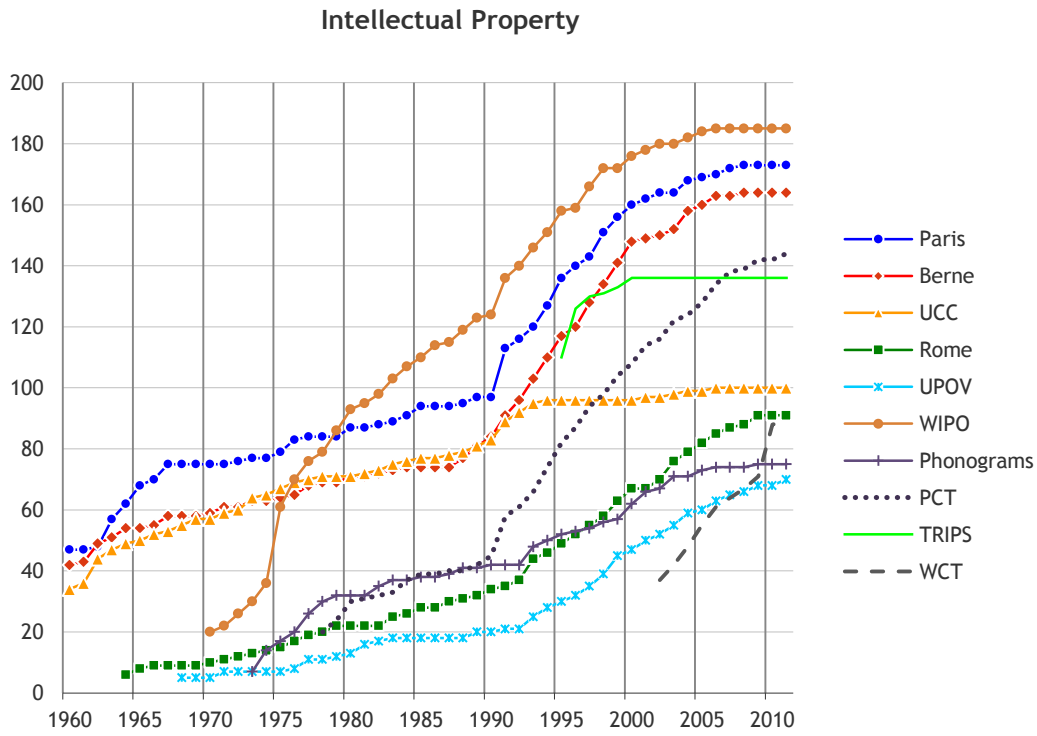


Figure 3.23: GSI Measured by RCC (Intellectual Property)

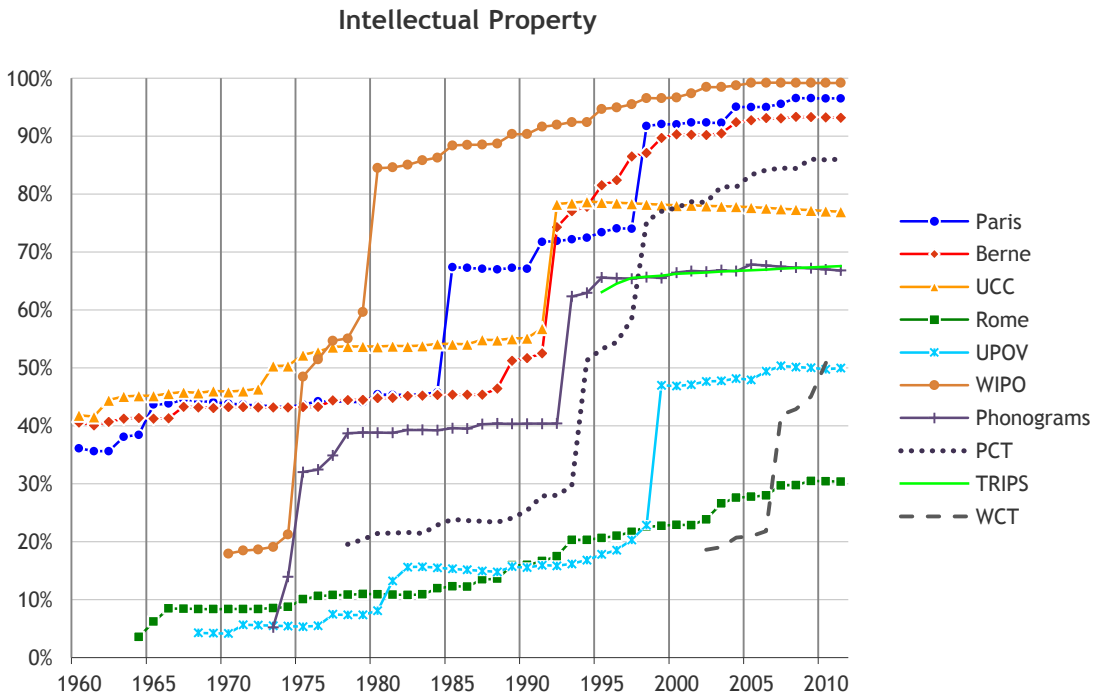


Figure 3.24: GSI Measured by RPC (Intellectual Property)

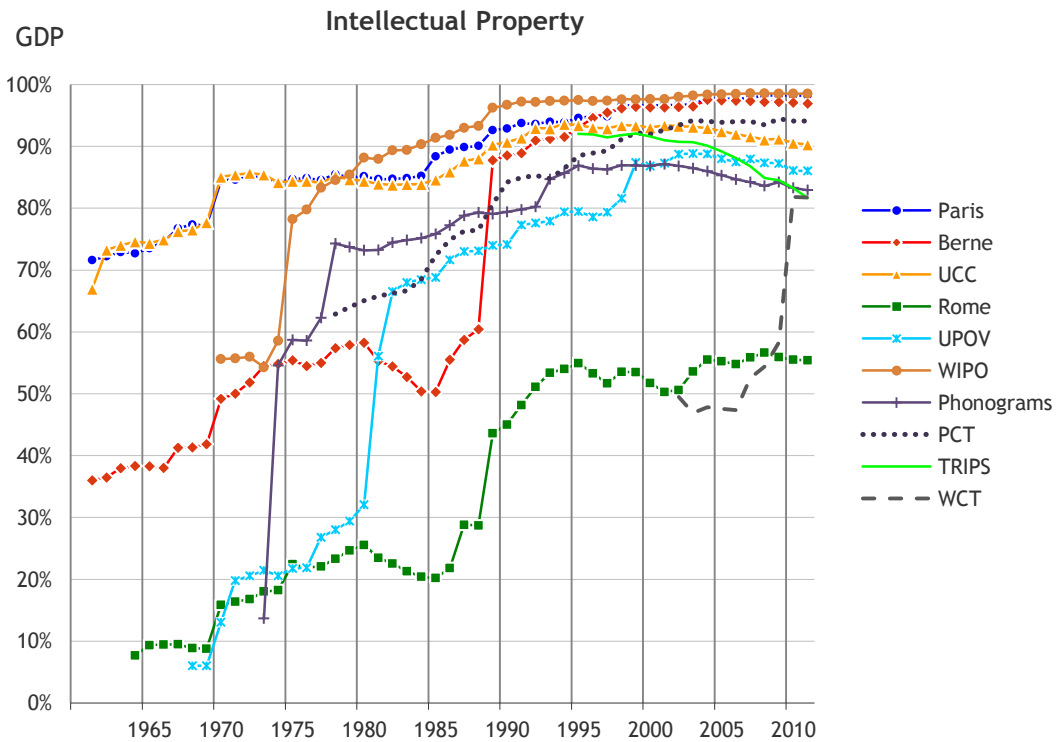


Figure 3.25: GSI Measured by GDPC (Intellectual Property)

Figure 3.23, 3.24 and 3.25 are used to depict the evolution of intellectual property rights since the late nineteenth century.

Chapter 4.

SOCIAL NETWORK ANALYSIS OF GLOBAL SCIENCE AND TECHNOLOGY GOVERNANCE STRUCTURE

In this chapter, the social network analysis approach will be applied to describe the changes over time of global governance structure in two different aspects: state-by-state network and treaty-by-treaty network. The historical and theoretical background of Social Network Analysis approach is first described in the Section 4.1. Some terminology and technical procedures that we adopted for our network modelling are described in Section 4.2 and Section 4.3 respectively. Section 4.4 will provide the visible visualization of the global governance structure where the relative positions among the actors (state-and-state and regime-and-regime) are represented in a two-dimensional graphical layout.

4.1 Historical and Theoretical Background of Social Network Approach

The notion of social network and the methods of social network analysis have attracted considerable interest and curiosity from the social and behavioral science community in recent decades (Wasserman and Faust, 1994). However, the ideas of network analysis that focuses on the mathematical structures used to model pairwise relations between objects are found in the writings of scholars many years before in the field of graph theory. The paper written by Leonhard Euler on the *Seven Bridges of Königsberg* and published in 1736 is regarded as the first paper in the history of graph theory (Biggs, Lloyd and Wilson, 1986). The *Seven Bridges of Königsberg* became a

historically notable problem in mathematics that laid the foundations of graph theory and prefigured the idea of topology (Shields, 2012). Contributing to the field of graph theory, the problem raised by William R. Hamilton, *Cycle in Platonic Graphs*, was at the origin of another branch of graph theory. The Hamiltonian path problem and the Hamiltonian cycle problem are problems of determining whether a Hamiltonian path (a path in an undirected or directed graph that visits each vertex exactly once) or a Hamiltonian cycle exists in a given graph (Wikipedia-a). Later, graph theory was also applied in the field of physics. The first example of such a use comes from the work of the physicist Gustav Kirchhoff, who published in 1845 his Kirchhoff's circuit laws for calculating the voltage and current in electric circuits. The ideas of graph analysis is also applied in chemistry and introduced by Sylvester in a problem called *Enumeration of Chemical Isomers*. Another famous and stimulating problem in graph theory is the *Four Color Problem*. This problem, first posed by Auguste DeMorgan and Francis Guthrie in 1852, raised that question that it is true that any map drawn in the plane may have its regions colored with four colors, in such a way that any two regions having a common border have different colors (Wikipedia-b).

However, it is not until the year of 1930s that social network analysis gained its main development to become a different field working independently. Jacob Moreno is one of the scientists that took initiative for working on this field by his developed idea of sociometry. He started asking people who their friends were and explored the ways in which their relations with others served as both limitations and opportunities for action and for their psychological behaviour (Borgatti, 1997). He believed that large scale social phenomena, such as the economy and state, were sustained and reproduced over time by the small scale configurations formed by people's patterns of friendship, dislike and other relations (Borgatti, 1997). By this method, Moreno invented the sociogram - a diagram of points and lines used to represent relations among persons (Borgatti, 1997). Before Moreno's work, ideas like the "*social fabric*" or "*social network*" were just vague ideas (Borgatti, 1997). By using sociograms, Moreno can identify social leaders and isolates, to uncover asymmetry and reciprocity in friendship choices, and to map chains of indirect connection (Borgatti, 1997). This idea has received an increasing of the interest on relationships among social entities, and on the patterns and implications of these relationships. Later, the ideas of the random graphs by Paul Erdos and Alfred Renyi and small-world network by Duncan Watts, as well as other researches on network perspective have proved widely applied in a range of social and behavioral science disciplines.

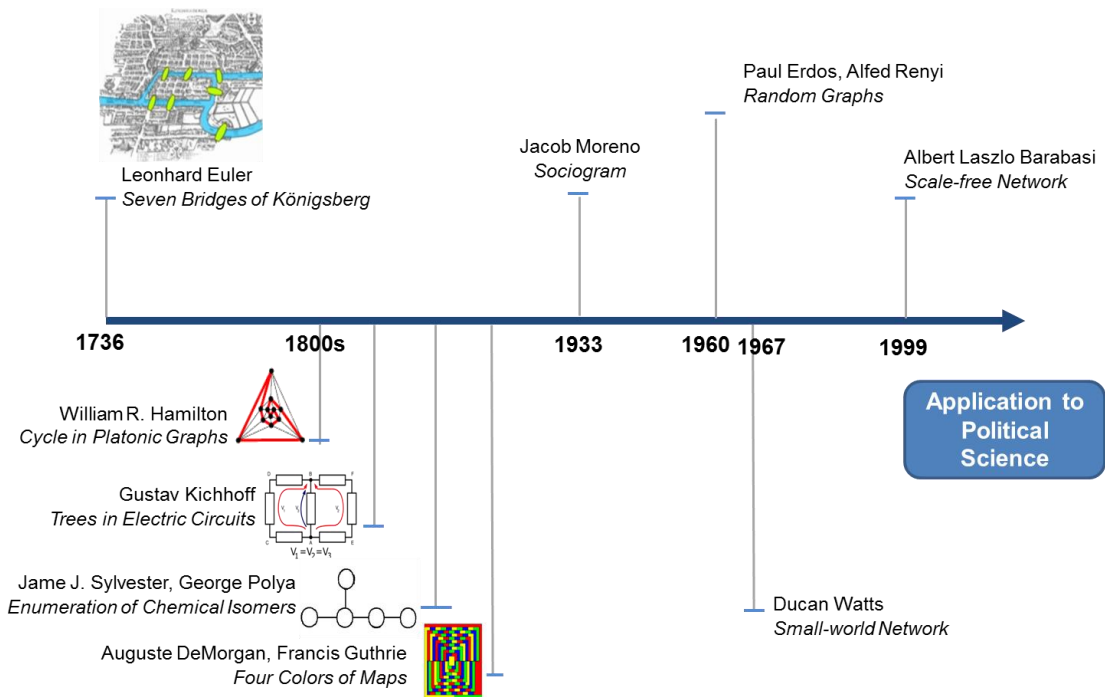


Figure 4.1: Historical Timeline of Social Network Approach Development

Nowadays, social network analysis has emerged as a key technique in modern sociology. It has also gained significant applications in anthropology, biology, communication studies, economics, geography, history, information science, organizational studies, political science, social psychology, development studies, among others (Wikipedia-c). The social network perspective focused on relationship among social entities; examples include communications among members of a group, economic transactions between corporations, and trade or treaties among nations (Wasserman and Faust, 1994). Network analysis addresses the associations among actors rather than the attributes of particular actor. It is grounded in three principles: actors and their behaviors are mutually dependent, not autonomous; ties between actors can be channels for transmission of both material (for example, weapons, money, or disease) and nonmaterial products (for example, information, beliefs, and norms); and persistent patterns of association among actors create structures that can define, enable, or restrict the behavior of actors (Wasserman and Faust, 1994). Many researchers have realized that the network perspective allows new leverage for answering standard social and behavioral science research questions by giving precise formal definition to aspects of the political, economic, or social structural environment (Wasserman and Faust, 1994).

Recently, social network analysis approach has recently gained in popularity in international relations in general and studies on governance of many global issues in

particular (Hafner-Burton, Kahler, and Montgomery 2009). Especially, a rapidly growing sociological literature demonstrates that many policies of modern states, such as educational expansion, environmental protection, and human rights, are shaped by embeddedness in the world polity (Beckfield, 2006). Also in his paper, Beckfield have presented a brief literature of the involvement in international organizations shapes policy in the domains of human rights (Hafner-Burton and Tsutsui 2005), democracy (Wejnert, 2005), environmental protection (Frank 1997; 1999; Schofer and Hironaka 2005), women's suffrage (Ramirez, Soysal, and Shanahan 1997), education (Bradley and Ramirez 1996; Meyer, Ramirez and Soysal 1992; Schafer 1999; Schofer and Meyer 2005), and population (Barrett and Frank 1999; Barrett and Tsui 1999). Much of these results were achieved from systematic empirical research inspired by conceptualizing a network of states, societies, and international organizations.

4.2 Network Data and Modelling

The purpose of this chapter is to use the techniques of social network analysis to describe the relationship among the entities that shape the global governance structure. As defined in the precious chapters, global governance is a collection of multifaceted, formal and informal institutions, codes and norms, motivated or enforced by international organizations or coalitions, that regulate and facilitate economic, cultural, social and political activity, and other trans-border relations between states. Therefore, by taking the social network approach, our target is to exploit the relations between states, as the main institutional actors of the global governance, based on their network positions and their behaviors in interacting with other countries in creating the system of international regimes, principally in the form of international treaties, towards various issues of global science and technology management.

Since a network consist of nodes and edges, two decisions need to be made: *What constitutes a node and what forms an edge?* For representing the act of a country ratifying a given treaty, a bipartite graph G (Figure 4.2) is built up as following:

$$G = (U, V, E)$$

Where U represents a set of countries and V represents a set of treaties. E is the set of edges created by the ratification acts of the countries. It is defined that if a country is ratified a given treaty, there exists an edge from a county to that treaty.

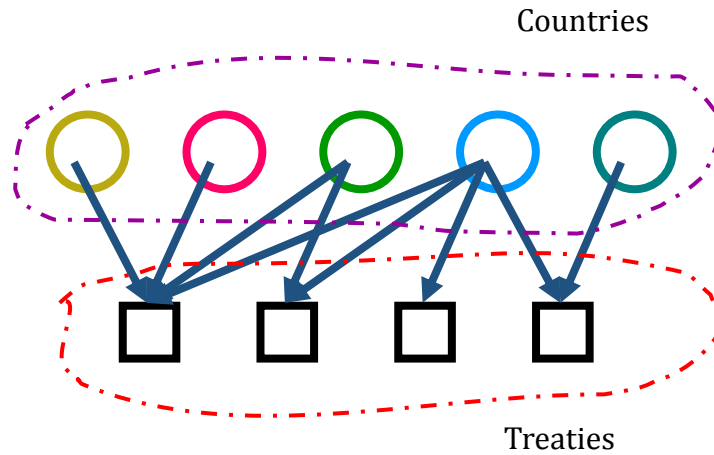


Figure 4.2: Bipartite Graph (Bimodel Graph of Country-Treaty Relation)

The bipartite graph represents the relational data between a country and an international treaty, thus is also called as bimodel graph of country-treaty relationship. This kind of relationship can be mathematically noted as a 193 x 126 (193 states and 126 treaties) binary matrix where an entry in cell x_{ij} indicated whether the ratification of state i for the treaty j exists or not. More precisely, the value of 1 indicates that state i had already ratified the treaty j , while 0 means that the act of ratification has not yet been carried out (Table 4.1).

Table 4.1: Matrix of Country-Treaty Relation

$i \rightarrow$ $j \downarrow$		1 st Treaty	2 nd Treaty	126 th Treaty
1	Afghanistan	0	0	...	1
2	Albania	1	1	...	0
...
193	Zimbabwe	1	1	...	0

From this two-mode bipartite graph, the state-by-state square matrix representing the co-membership between a pair of countries can be generated. This is the matrix that every cell x_{ij} shows the numbers of international treaties that state i

and state j hold common membership in. Figure 4.3 is the example of the network gained after converting the bipartite graph representing the relation country-treaty into the unimodel graph that only shows the relation among countries. By that way, the visualization of how states form social networks through membership in international regimes can be provided. Mutual memberships create ties between states, and the strength of these ties increases with additional joint memberships. In other words, the number of shared memberships measures the strength of a tie between two states. These ties define states' relative positions in social hierarchies in the international system. While many social network studies of international relations only determine whether a tie exists or not between two nodes, in this study, the strength of a tie representing information on the co-membership can be used to perform a more in-depth analysis of the structure of a network.

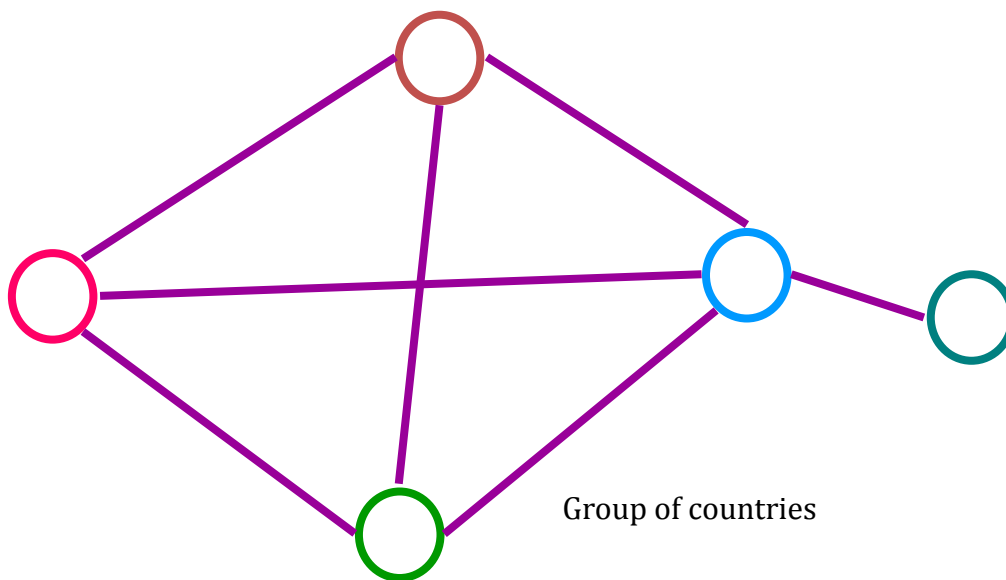


Figure 4.3: Unimodel Graph (Country-by-Country)

Table 4.2: Matrix of Country-Country Relation

	Afghanistan	Albania	Zimbabwe
Afghanistan	0			
Albania		0		
....			0	
Zimbabwe				0

Likewise, a treaty-by-treaty square, valued overlap matrix can also be generated, where cell x_{ij} indicated the number of states that are members of both treaty i and j (Table 4.2).

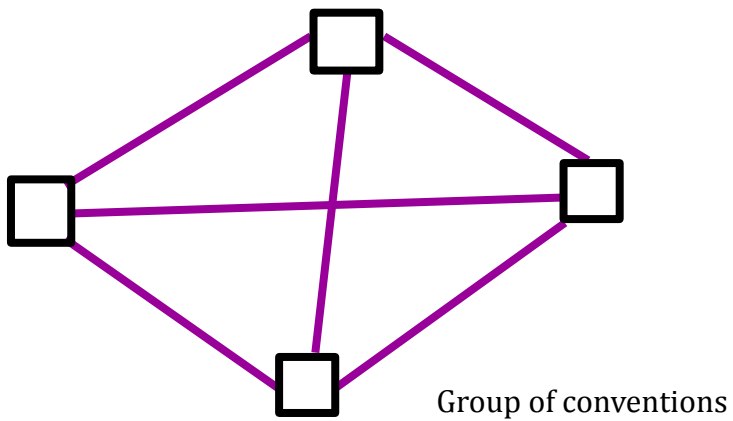


Figure 4.4: Unimodel Graph (Treaty-by-treaty)

Table 4.3: Matrix of Treaty-Treaty Relation

	Treaty A	Treaty B	Treaty Z
Treaty A	0			
Treaty B		0		
....			0	
Treaty Z				0

4.3 Network Visualization

One of the most important aspects of Social Network Analysis is to provide the visible visualization of how complex the structure of the investigated organization is. The main task in network visualization is to determine the positions of the actors/vertices in a (typically two-dimensional) graphical layout. Multidimensional scaling is one of several data analysis techniques that aim to reveal the structure formed by a given dataset by plotting points in one or two dimensions (Bartholomew, 2002). The results provided by the multidimensional scaling is a set of estimated distances among pairs of entities, which can be expressed as coordinates in one-, two-, or higher-dimensional space (Wasserman and Faust, 1994). These coordinates then will be used to display the equivalences and the relative distances among actors within the overall structure of the investigated organization. The underlying mechanism is that multidimensional scaling technique seeks to represent similarities (or dissimilarities) among a set of entities in low-dimensional space so that entities that are more similar to each other are closer in the space, and entities that are less similar to each other are farther apart in the space (Wasserman and Faust, 1994). For this kind of visualization output, the usual input to multidimensional scaling is a one-mode symmetric matrix consisting of pairwise measures of similarity, dissimilarity, or proximity (Wasserman and Faust, 1994). To study equivalences among actors in a network, the Pearson product moment correlation matrix, or the matrix of Euclidean distances are often used (Wasserman and Faust, 1994).

In this study, for the visualization of the network, we apply multidimensional scaling technique with the Pearson product-moment correlation coefficients to generate the distance among pairs of entities (state-state or treaty-treaty). We used UCINET (Borgatti et al, 2002) to carry out the multidimensional scaling procedure with the Pearson correlation matrix (Figure 4.5), as input. The final visualization in two different types of network, state-by-state network and treaty-by-treaty network, is provided by Netdraw tool (Borgatti et al, 2002). The next sections will show the results of visualization obtained through the procedure of Social Network Analysis.

	Afghanistan	Albania	Algeria	Andorra	Angola	AntiguaandBarbuda	Argentina	Armenia	Australia	Austria	Azerbaijan	Bahamas	Bahrain	Banglades	Barbados	Belarus
Afghanistan	1															
Albania	0.801133926	1														
Algeria	0.842063822	0.9065	1													
Andorra	0.539973137	0.838133	0.735804	1												
Angola	0.788978393	0.881052	0.90463	0.786768	1											
AntiguaandBarbuda	0.896010302	0.887883	0.895091	0.806917	0.862576	1										
Argentina	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1									
Armenia	0.893460849	0.894307	0.933155	0.71813	0.817878	0.89925	0.946567	1								
Australia	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1							
Austria	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1	1						
Azerbaijan	0.686615584	0.839637	0.918202	0.763235	0.77809	0.796735	0.884824	0.891655	0.894824	0.894824	1					
Bahamas	0.919942932	0.847082	0.809212	0.794788	0.727507	0.938925	0.915289	0.905482	0.915289	0.915289	0.741018	1				
Bahrain	0.832567623	0.96072	0.934563	0.722312	0.911604	0.832425	0.914667	0.916842	0.914667	0.914667	0.845036	0.786129	1			
Bangladesh	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1	1	0.894824	0.915289	0.914667	1		
Barbados	0.924110127	0.892968	0.857484	0.716369	0.803847	0.923204	0.911908	0.858378	0.911908	0.911908	0.735532	0.945341	0.845343	0.911908	1	
Belarus	0.853008089	0.891959	0.919151	0.71872	0.797229	0.878448	0.968496	0.976469	0.968496	0.968496	0.94055	0.875902	0.90493	0.968496	0.836044	1
Belgium	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1	1	0.894824	0.915289	0.914667	1	0.911908	0.968496
Belize	0.848686778	0.858913	0.813809	0.783819	0.725062	0.88634	0.882177	0.861694	0.882177	0.882177	0.768193	0.958164	0.786858	0.882177	0.958945	0.839838
Benin	0.8335029	0.963217	0.88586	0.78734	0.840895	0.90947	0.984902	0.915018	0.984902	0.984902	0.865346	0.872994	0.926589	0.984902	0.870391	0.944793
Bhutan	1	0.801134	0.842054	0.539973	0.788978	0.89601	0.880081	0.893461	0.880081	0.880081	0.686616	0.919943	0.832568	0.880081	0.92411	0.853008
Bolivia	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1	1	0.894824	0.915289	0.914667	1	0.911908	0.968496
BosniaandHerzegov	0.858382508	0.935813	0.909017	0.818907	0.801987	0.939752	0.970785	0.97112	0.970785	0.970785	0.881731	0.944824	0.892201	0.970785	0.898158	0.95718
Botswana	0.836462694	0.932017	0.821746	0.778116	0.749373	0.886347	0.936671	0.915033	0.936671	0.936671	0.780132	0.926582	0.874703	0.936671	0.872715	0.900168
Brazil	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1	1	0.894824	0.915289	0.914667	1	0.911908	0.968496
BruneiDarussalam	0.816153216	0.901724	0.947207	0.746786	0.821352	0.835853	0.911457	0.966778	0.911457	0.911457	0.930294	0.840378	0.929809	0.911457	0.843068	0.951216
Bulgaria	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1	1	0.894824	0.915289	0.914667	1	0.911908	0.968496
BurkinaFaso	0.801133926	1	0.9065	0.838133	0.881052	0.887883	0.946776	0.894307	0.946776	0.946776	0.839637	0.847082	0.96072	0.946776	0.892968	0.891959
Burundi	0.568707273	0.848323	0.870355	0.823459	0.824345	0.714299	0.786365	0.835345	0.786365	0.786365	0.900365	0.627191	0.867716	0.786365	0.619182	0.83343
Cambodia	0.854858728	0.936718	0.903259	0.80529	0.850295	0.927456	0.972126	0.89604	0.972126	0.972126	0.882354	0.901511	0.891834	0.972126	0.940762	0.927162
Cameroon	0.808333156	0.89696	0.921797	0.642034	0.883845	0.802319	0.856695	0.839936	0.856695	0.856695	0.791039	0.725483	0.938809	0.856695	0.808888	0.824329
Canada	0.880080978	0.946776	0.921789	0.767871	0.831507	0.940647	1	0.946567	1	1	0.894824	0.915289	0.914667	1	0.911908	0.968496
Cape Verde	0.93593408	0.891508	0.863396	0.679389	0.902221	0.905125	0.906538	0.91176	0.906538	0.906538	0.730287	0.873114	0.922433	0.906538	0.873583	0.880899
CentralAfricanRepu	0.965005203	0.81757	0.784708	0.54102	0.812505	0.854093	0.850596	0.849314	0.850596	0.850596	0.613145	0.869178	0.853868	0.850596	0.87611	0.808541
Chad	0.716532876	0.856028	0.772977	0.825228	0.803324	0.917508	0.861331	0.829723	0.861331	0.861331	0.756873	0.862338	0.760841	0.861331	0.777321	0.815682
Chile	0.906611763	0.913888	0.939787	0.683531	0.844966	0.907559	0.982133	0.964516	0.982133	0.982133	0.901939	0.880166	0.934017	0.982133	0.880695	0.982514

Figure 4.5: Pearson Correlation Coefficients among States

4.4 Visualization of Global S&T Governance Structure

We have traced the changes over time in the structure of global governance in two aspects: the changes in the shape of the state-by-state network and the changes in the shape of treaty-by-treaty network over the history. We focus our observation on these changes through two critical milestones of the world history that marked the biggest transformations of the international system. These are the years of 1945 and 1989 that marked the end of the World War II and the Cold War respectively. Based on that, we took three snapshots of the state-by-state and treaty-by-treaty networks divided by these two critical years to provide the visualization of the global governance in three periods: until-the-end-of-World War II (until 1945), until-the-end-of-Cold-War (until 1989), and the current situation until now.

4.4.1 Network of International Regimes

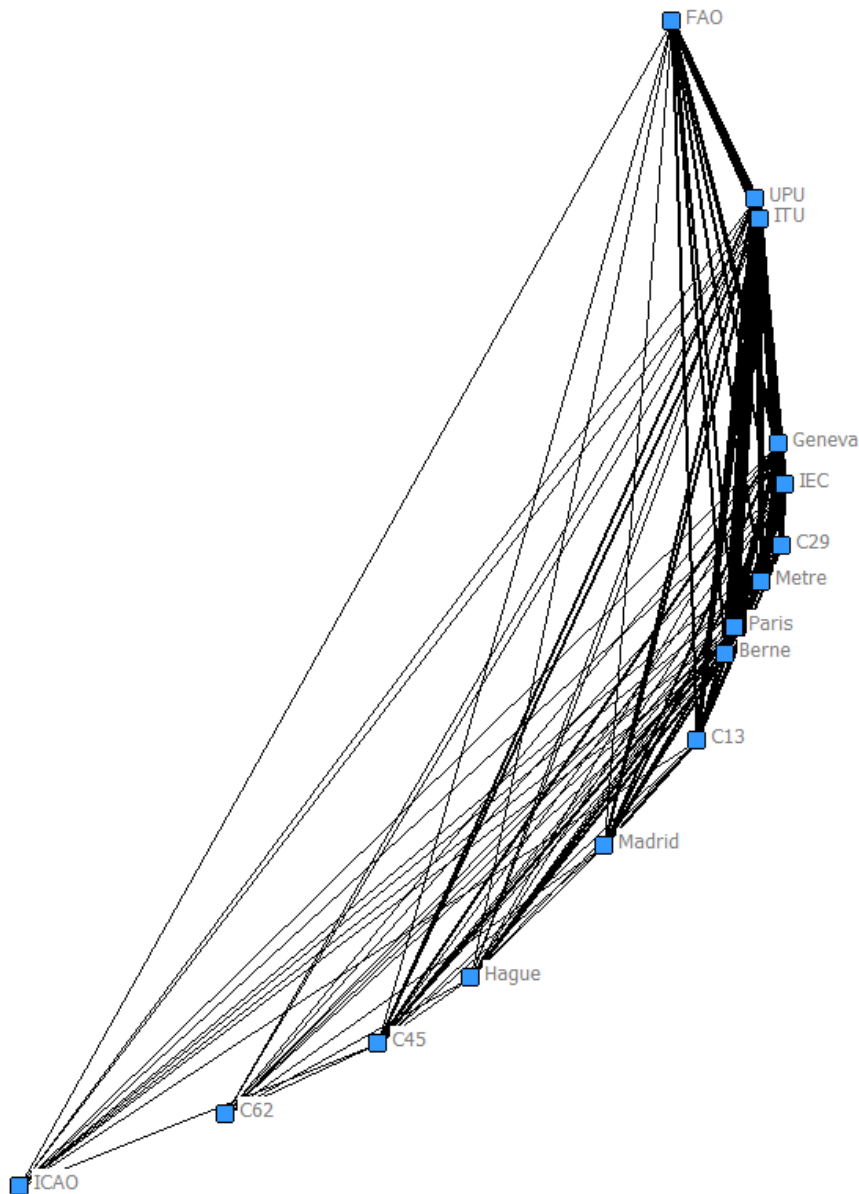


Figure 4.6: Network of International Regimes (until the Year of 1945)

The network of international regime the years until 1945 is quite simple. It was formed by the oldest international organizations that still exist until now, such as ITU, UPU, IEC, FAO and ICAO. It also composed of the first international agreements that are the origins of the World Intellectual Property Organization (WIPO) today, such as the 1883 Paris Convention for the Protection of Industrial Property (Paris), the 1886 Berne Convention for the Protection of Literary and Artistic Works (Berne), the 1891 Madrid Agreement Concerning the International Registration of Marks (Madrid) and the 1925 Hague Agreement Concerning the International Deposit of Industrial Designs

(Hague). The issue of labor safety was also regulated in the form of global norm such as the Underground Work Convention (C45) and the Safety Provisions Convention (C62). The close position of the pairs of vertices, such as (UPU and ITU) or (Paris and Berne) in the two-dimensional graphical layout suggests the similarity in the nature of these institutions and agreements.

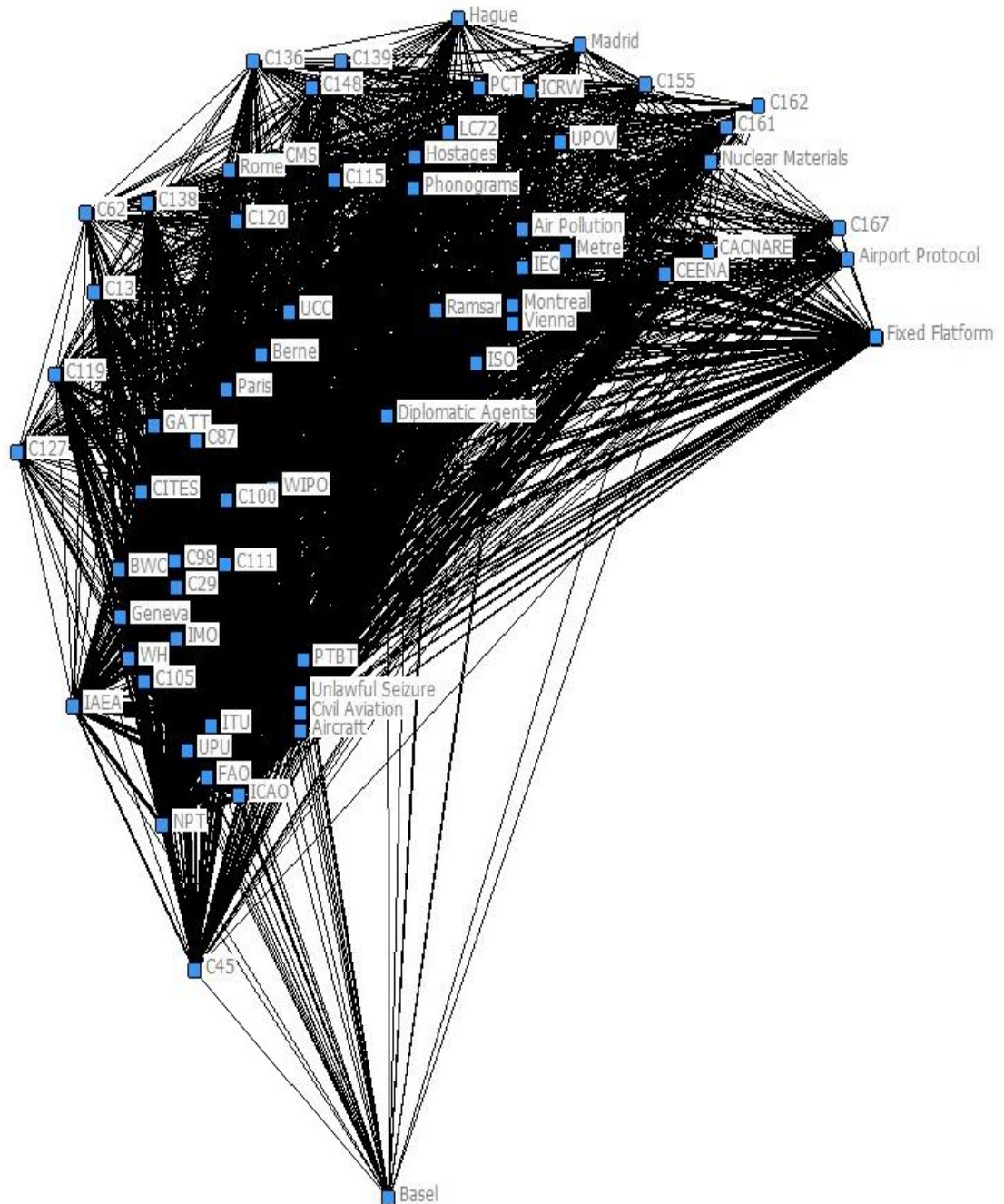


Figure 4.7: Network of International Regimes (until the Year of 1989)

Throughout the time, the network of international regime are expanded and developed in the number of adopted multilateral agreements, as well as the density of membership sharing. As the thickness of the lines represents the number of shared memberships between two states, it can be observed that the network are increasingly densified and centralized in the shape. The international institutions and agreement received high contribution from enormous number of states (e.g. international environmental agreements...) are located in the center, while the others that are less being concerned (e.g. labor safety...) are placed in the peripheral position of the shape. Moreover, it can be observed the clusters of agreements are formed. It reflects the similarity of the global governance issues embedded in these agreements.

4.4.2 Network of State Partnerships

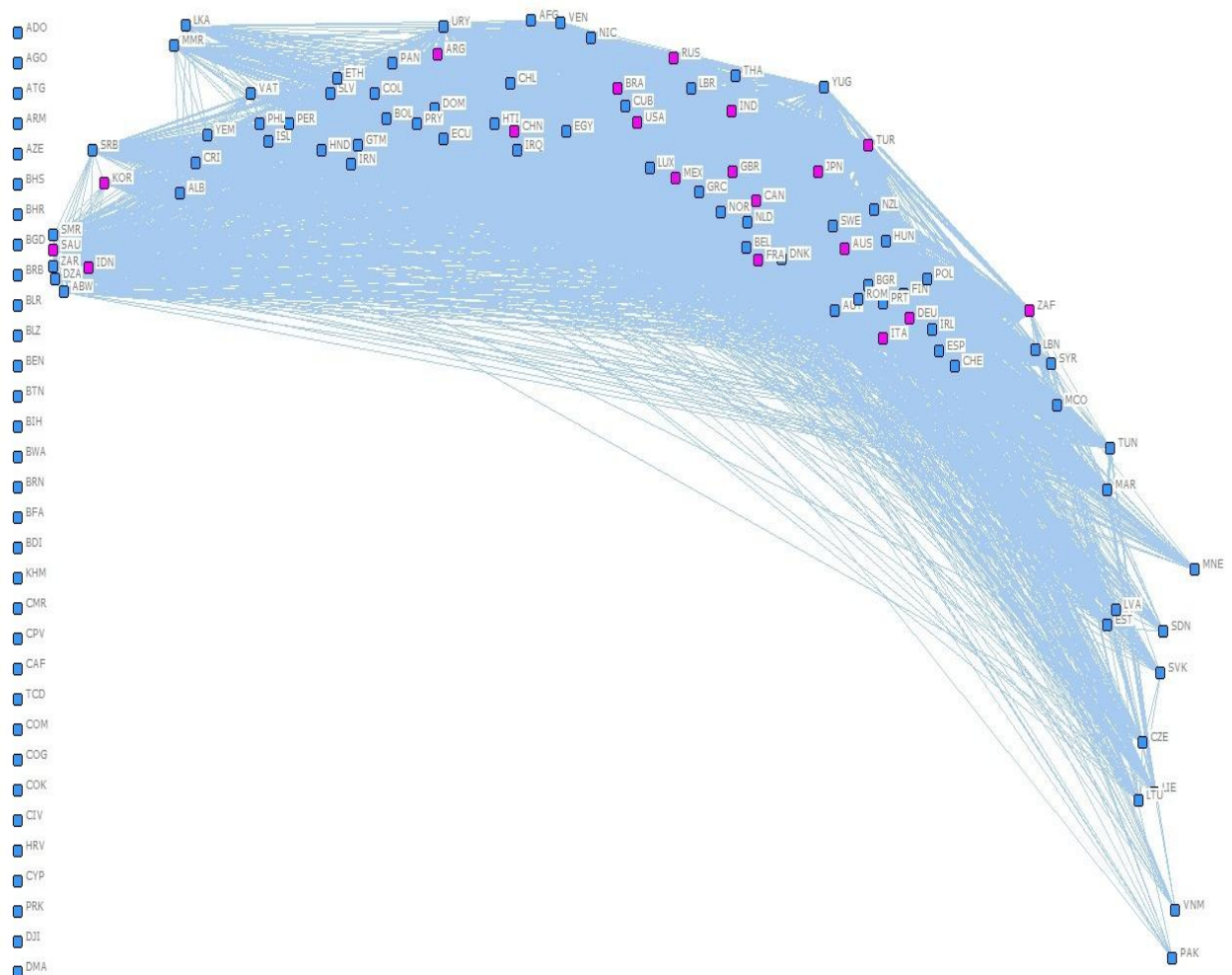


Figure 4.9: Network of State Partnerships (until the Year of 1945)

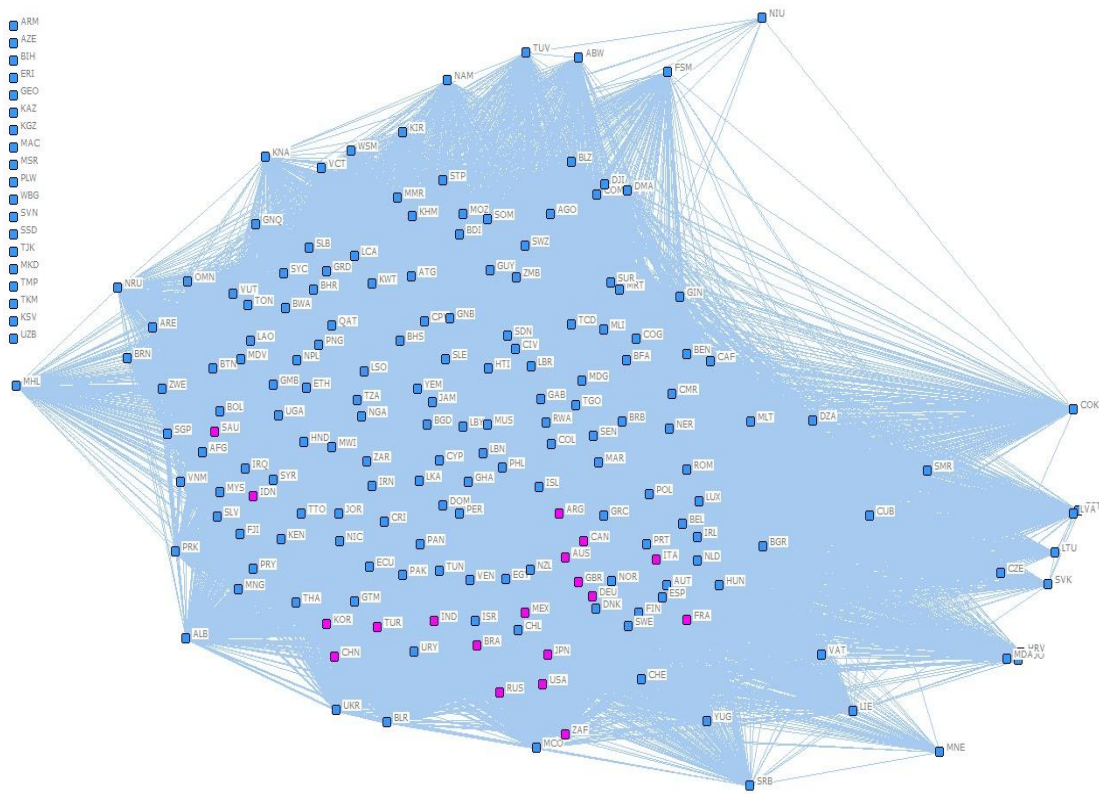


Figure 4.10: Network of State Partnerships (until the Year of 1989)

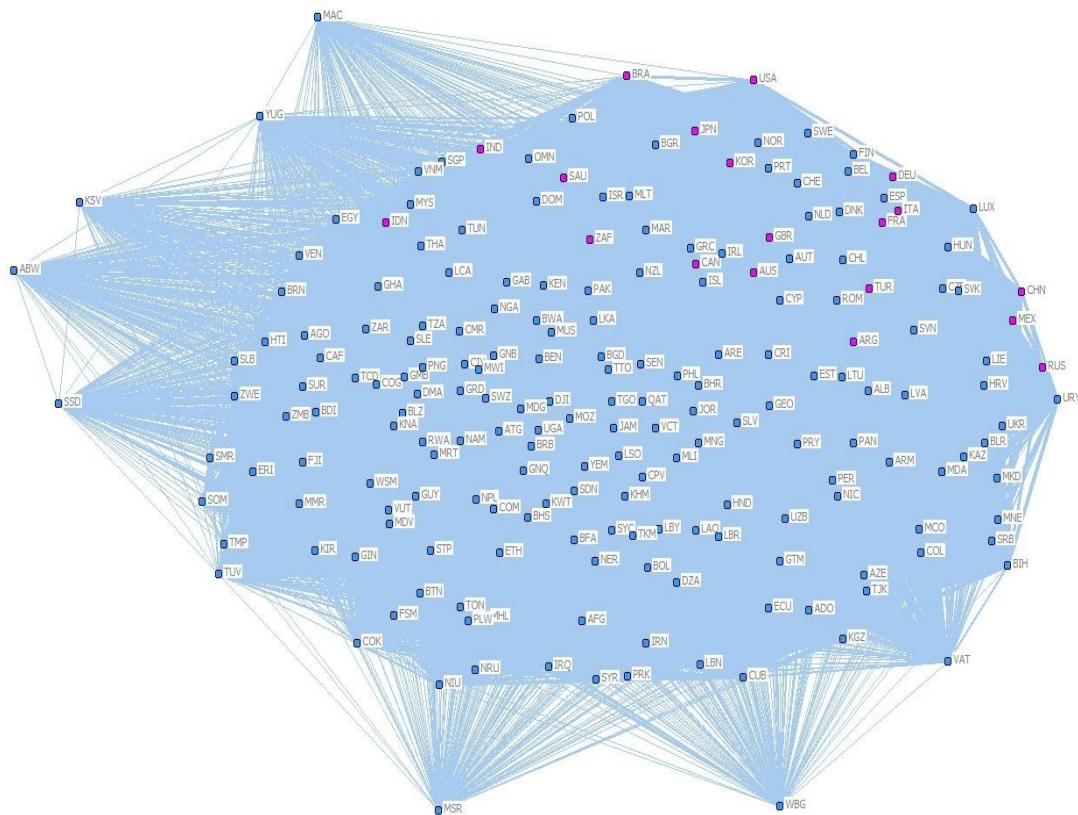


Figure 4.11: Network of State Partnerships (Current Structure)

By observing the network of state partnership throughout three different periods of time, we can find the changes in the relative positions among countries, especially among the members of G20 (which is marked in pink color). The network of state partnerships until the year of 1945 is still experienced the significant number of countries that stand outside the global governance system. Many G20 members were still being marginalized from this global governance regime system, then are pointed in the peripheral location of the two-dimensional graphical. By time, they moved into the center of the network and sit closer to the other G20 states. It can be explained by the fact that after the World War II, many of them, seen as the emerging countries, have appeared and marked their position in world politics. They have become much more important economically or politically on the global scene. However, after the Cold War, it can be clearly observed that the disparities in their position in the network are increasing. The G20 members are much farther in distance and appeared in unevenly in the network. It signals the polarity of the current world politics.

4.5 Limitation of Network Analysis Approach

As the world's interdependence expands and deepens, there is the convergence in states' position in world politics. In other words, increasingly, the little disparities between groups of countries can be observed. And with this flattening of global governance structure, it is much more difficult to distinguish the role of a given state among others by only observing their relative positions represented in a two-dimensional graphical layout of the social network approach. The main reason is that this approach focuses on relationship among actors (i.e. whether a tie of mutual membership exists or not between two state-actors) rather than the attributes of particular actor. Consequently, the other attributes, yet important, in the behavior of each state-actor in the network can be misevaluated. It is suggested that rather than only considering whether a state had ratified an international agreement or not, the analysis focusing on the distinguishable attribute of this action, such as the timeliness of ratification act should be considered. This perspective will be fulfilled by our analysis in the next chapter.

Chapter 5.

COOPERATION IN GLOBAL SCIENCE AND TECHNOLOGY GOVERNANCE AMONG STATES

5.1 Cooperation in Global S&T Governance within the Scope of Study

International S&T cooperation is used mainly for joint-research or joint-efforts to pursue some goals in scientific and/or technical works. However, the term “cooperation in S&T” in our scope of study is used in somewhat different context. It refers to the collaboration among states to pursue better management of science and technology for the sake of global sustainable security, development and prosperity. The expected rules of this kind of cooperation are increasingly materialized in the form of multilateral agreements. These agreements contain rules and principles for the better management and application of global science and technology knowledge, as well as, for the restriction of what are considered the misuses of science and technology. For the state, the decision to ratify any treaties represents the interest in a certain S&T policy area, and then reflects the willingness on the part of the ratifying country to comply with international law and thus to cooperate with other partners in governing the global S&T activities.

International agreements have no binding legal power unless and until states ratify them. Hence, understanding why some states ratify an agreement immediately after it opens for signature, whereas others wait for long years to approve it is important for understanding the willingness of states to comply with international law and thus, to cooperate with other partners in governing the global S&T processes. The swifter the ratification act, the stronger the willingness for cooperation that the

country behaves in actor-negotiated international regimes. In other words, the ratification year itself has meaning as it reflects the intense desire and the quickness or reluctance of national policy in response to the rules and principle of the global governance system. Therefore, in this research, we focus our analysis in our data of treaty ratification years by states to produce a set of quantitative measurements of states' behavior towards different issue-areas of global S&T governance. These measurements are used to reflect different aspects in the way states cooperate to each other. In one hand, the variation in the behavior of states and groups of state towards different key S&T topics of global S&T governance is captured. On the other hand, we found that the lengths of time needed to expand and consolidate cooperation in different issue-areas of global S&T governance are found to be significantly different. Moreover, we go much deeper to analyse each of the state-actor's behavior to measure her willingness or reluctance in taking part in the global S&T governance system of regimes.

The following sections of this chapter will step by step, introduce our set of quantitative measurements, as well as the obtained results and their implications.

5.2 Measuring the Length of Time for Expanding Cooperation in Global S&T Governance among States

By analysing our data of treaty ratification year, we found that, some treaties, after its declaration, seem to attract more particular attention from international community than others and then quickly reached to the global consensus and commitment of majority number of states. Therefore, they can achieve their peach in the number of membership in merely a couple of years, whereas others were still gradually changing. The global effort for a given S&T issue to reach to multilateral consensus from a great number of countries strongly depends to the quickness or reluctance of national policy in response to a global calling for cooperation. In other words, the speed for achieving highly international consensus of a multilateral treaty can be used to reflect the time consuming for policy making process from member countries towards different issue-areas of global S&T cooperation. This can be used to answer the kind of question: How long is taken for a given topic of global S&T governance to be expanded and consolidated among international community?

To find the answer for that question, we have analysed our data to find out the year when a treaty received the ratification from 50% of its current number of country

members. Based on that, how many years it takes for a multilateral treaty to attract ratification from 50% of its membership can be produced. By that way, the time of policy making for states to take part in a multilateral consensus for a shared global matter can be measured and compared among various global issue-areas.

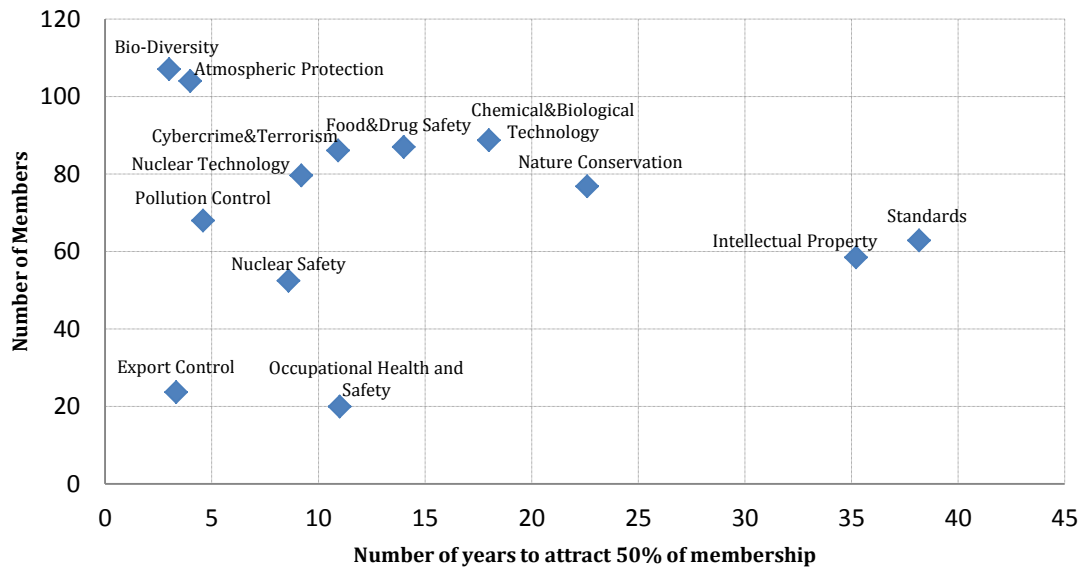


Figure 5.1: The Lengths of Time for Expanding Cooperation to 50% of Membership

Figure 5.1 shows the difference in the length of time for various key domains of global S&T governance to be expanded and to gain the multilateral consensus from 50% of member parties. It can be seen clearly that environmental movements embedded in the form of multilateral treaties quickly have received boost of support from international community. Biological diversity and atmospheric protection are among the top global issues draw attention of more than one hundred of states in merely first 4 years after their promulgation. Indeed, the issues such as climate change and global warming, ozone layer depletion or biodiversity loss are among the most serious dangers that threat human beings worldwide. The need for an effective and efficient international law that regulates the global action to mitigate these threats is in urgent and highly recognized by majority of nations around the world. That explain why an enormous number of countries have taken initiatives by committing themselves very quickly to those agreements in a short period of time. The same fact can also be observed for the issue of pollution control. Nearly 70 states, which account for 50% of current membership, had their policy decision making during the first 4 years to adopt the regulation of treaties of pollution control issue. Out of environment domain, the issue of export control for dual-use technology and goods also gain the

consensus from 50% first members in around first 3 years. The quickness of states' action towards this issue can be explained by the regional nature of the export control regime. That is why these agreements only attracted a limited number of member states.

Nuclear technology related topics, including nuclear technology control and nuclear safety management are also ranked among the top attractive topics of the world affairs. While 50% members committed to nuclear weapons related regulations in the first 9 year period, it takes only 8 years for that of nuclear safety issue. It is interesting that the other safety issues, including food and drug safety, occupational health and safety, all received the international consensus of 50% membership around 10 to 15 years after their adoptions. Another key topic, the controls of chemical and biological weapons takes 18 years to gain nearly 90 member countries committing in the relevant regulatory regime. Nature conservation takes more than that period of time, about 23 years, to gain the jointly work from nearly 80 states.

It is most surprising to find that the regulations related to the issue of technological competitiveness of the global trade system took the longest period of time (from 35 to 39 years) compared with others, to extend the consensus to 50% of their membership. It can reflect that the regulations of standards and intellectual property are more difficult to gain the unified agreement than others due to the nature of global trade competitiveness among states.

Therefore, it can be recognized that the length of time for a group of multilateral treaties to be expanded globally can also be used to describe the difficulty nature for the multilateral consensus and consolidation of a given issue-area of global S&T governance. While environmental protection actions receive the high attention from the majority of international community, the other critical issues such as occupational health and safety or intellectual property protection still gain the limited results in the way countries cooperate universally, both in the number of membership and the quickness of the action.

5.3 Measuring the Awareness Gap among Groups of States towards Cooperation in Global S&T Governance

As the world's interdependence expands and deepens, real progress on human development is not only the matter within national circumstances and policy space of

any particular state, it is also the issue at the global level of how secure these achievements are and whether conditions are sufficient for sustained human development. Environmental changes can lead to natural disasters such as floods and droughts. Economic shocks can lead to lost jobs through recession or worsening terms of trade. Health shocks can lead to reduced incomes—as well as rising medical expense—for households (UNDP, 2014). All such kinds of global challenges which are trans-border in nature can have pervasive negative impact on every state's human development. Therefore, a global cooperation effort is needed to ensure the global advances in human development.

This section takes a broader approach, emphasizing the links of the state's readiness in policy making towards these cross-border challenges in comparative with its level of national human development. By looking at national policy decision making towards global S&T issues through a human development lens, we draw attention to national policies of different groups of countries to act against global challenges and make human development progress more robust going forward. By that way, the relationship between state's readiness in policy making towards these cross-border challenges and its level of national human development is also highlighted.

Human development levels of states are represented by using the human development index (HDI) collected from the latest report of United Nations Development Programme (UNDP)—the 2014 Human Development Report (UNDP, 2014). HDI is the quantitative metric which measures the average national achievement in three basic dimensions of human development: a long and healthy life, knowledge and a decent standard of living. Thenceforth, all countries are divided into four groups based on the classification of HDI regulated by the UNDP. The very high human development country group has the highest rank of HDI score of more than 0.8. The second group comes from the high human development countries with HDI in the range of from 0.7 to 0.8. The third group is for the medium human development countries with HDI in the range of 0.55 - 0.7. Finally, the countries with the HDI value of lower than 0.55 form the fourth group. By this way of classification, the countries are clustered in the same group with others having the similar level of human development.

For each group of countries, we have tried to quantitatively measure the state's readiness in policy making towards the rules and principles of global S&T governance regimes. The faster this policy making process is, the more initiatives that country

behaves in cooperating with other states. For this purpose, we have measured how many years in average it takes for each group to ratify a multilateral treaty after its promulgation. Table 5.1 shows the results of the number of years in average for groups of countries to commit in the regulations of international treaties regarding to different key topics of global S&T governance.

Table 5.1: Average Number of Years for Group of Countries to Ratify Agreements

Country Group by HDI Key Topics	Very High HDI	High HDI	Medium HDI	Low HDI	Ratio of Low HDI to Very High HDI
<i>Nuclear Technology</i>	12.7	14.3	14.1	14.5	1.14
<i>Chemical & Biological Technology</i>	12	17.8	16.7	19.0	1.58
<i>Export Control</i>	6.8	14.6	9.5	-	-
<i>Cybercrime and Terrorism</i>	9.0	12.0	13.4	14.0	1.56
<i>Nuclear Safety</i>	8.0	14.8	15.7	22.0	2.75
<i>Occupational Health and Safety</i>	12.9	17.9	19.9	24.3	1.88
<i>Food & Drug Safety</i>	13.7	23.3	22.2	23.7	1.73
<i>Atmospheric Protection</i>	3.9	5.0	5.8	6.7	1.72
<i>Nature Conservation</i>	17.7	19.6	20.4	20.4	1.15
<i>Bio-Diversity</i>	3.6	3.8	4.0	3.9	1.08
<i>Pollution Control</i>	5.4	7.8	7.6	7.5	1.39
<i>Intellectual Property</i>	29.9	45.5	53.6	48.6	1.63
<i>Standards</i>	44.4	61.2	72.8	64.1	1.44

It can be seen from table 5.1 that there is the strong correlation between state's readiness in policy making towards the global S&T governance and its HDI level. Indeed, the countries among the top ranking of HDI are also the ones achieving the shortest time length to comply with international law. It is true for all issue-areas of

international S&T cooperation that the group of very high HDI countries have performed superlatively in giving promptly response by their quick ratification. In contrast, the countries with lowest HDI level are among the slowest respondents, especially for the key topics related safety and health issues. It took them around 24 years in average, as compared to 13 years for the very high HDI countries, to ratify the treaties regulated occupational health and safety, and food and drug safety issues. The matters related to technical competitiveness, including standards and intellectual property, are the issues that took the longest time to have the reply from states. Interestingly, the most delayed action is not from the low HDI group, yet, from the medium HDI countries. It took around 54 years and 73 years for them to ratify the treaties regulated intellectual property and international standards. Such long period of years for states to show their commitment towards one of the most important issue of the global S&T governance suggests that the global efforts to create the globally uniform framework of standard and copyrights has produced very little real progress.

From another view corner, we analysed how many percentages of countries in each group of HDI had ratified these S&T agreements (Table 5.2). As numbers of members differ among groups of HDI, the percentage numbers depict another corner of view about the difference in the policy making behavior among groups of states. As compared with table 1, table 2 shows the little disparities between groups of countries' behavior. Almost all of the key topics have received the evenly attendance of representatives from each group of countries, except for safety and health issue and technical competitiveness issue. It illustrates the same fact as table 1 that low HDI group still show an inadequate attention about these critical issues. It is only 7.4% of the countries from the low HDI group responding to the occupational health and safety regulations. Lower than 30% members of this group joining in nuclear safety, intellectual property and standards regimes.

When looking to the overall picture of the global S&T governance, the high ratio of consensus is found in the governance of global environment and security, such as atmospheric protection and bio-diversity (more than 80% for all groups), nature conservation, chemical and biological technology management, or food and drug safety (more than 60% for all groups). In contrast, the issues of cybercrime and terrorism (lower than 30% for all groups), occupational health and safety (lower than 28% for all groups) has merely received a limited attention not only from low HDI group but also for all the other groups of countries. Moreover, the issues, including

intellectual property and standards, should be deserved to have the high support, yet, received the attention from only haft number of very high HDI states.

Table 5.2: Percentage of Countries Having Ratification

Country Group by HDI Key Topics	Very High HDI	High HDI	Medium HDI	Low HDI	Ratio of Very High HDI to Low HDI
<i>Nuclear Technology</i>	78.8%	76.6%	66.7%	58.0%	1.36
<i>Chemical & Biological Technology</i>	88.2%	86.8%	74.6%	64.4%	1.37
<i>Export Control</i>	56.3%	9.4%	4.8%	-	-
<i>Cybercrime and Terrorism</i>	88.8%	81.9%	69.6%	62.5%	1.42
<i>Nuclear Safety</i>	82.1%	54.0%	40.0%	21.4%	3.84
<i>Occupational Health and Safety</i>	28.1%	21.3%	12.8%	7.4%	3.80
<i>Food & Drug Safety</i>	62.5%	82.5%	76.8%	71.6%	0.87
<i>Atmospheric Protection</i>	83.9%	94.8%	95.2%	86.4%	0.97
<i>Nature Conservation</i>	75.4%	74.0%	65.7%	62.0%	1.22
<i>Bio-Diversity</i>	83.3%	90.6%	89.3%	79.7%	1.05
<i>Pollution Control</i>	76.3%	66.4%	53.8%	48.1%	1.59
<i>Intellectual Property</i>	58.5%	51.8%	37.6%	27.0%	2.17
<i>Standards</i>	49.3%	44.3%	32.5%	30.8%	1.60

5.4 Measuring the Leadership Attitude of State towards Cooperation in Global S&T Governance

5.4.1 Global Leadership within the Scope of the Study

The leading role of a state can be judged and described in different aspects. Within the scope of this study, “global leadership” of a state is conceptually defined through her

initiative role in facilitating and promoting the norms and rules for the international cooperation.

International cooperation has been defined as a process through which policies actually followed by governments come to be regarded by their partners as facilitating realization of their own objectives, as a results of policy coordination. In this process, power often helped to create cooperation, partly through constructing international regimes that could organize interstate relation long line prepared by the leading state (Keohane, 1984). State power matters a great deal in determining who gets to make the rules, how compliance is pursued once the rules are in place, and how international institutions operate (Sell, 2002). By creating international regimes that would provide specific benefits to itself as well as its partners, strong state would facilitate and promote cooperation. Leading states can facilitate cooperation though many different pathways. In the beginning stages, they invest their power resource in building stable international agreements and institutions with known rules. These rules are constructed in the ways that suit the interests and the ideologies of powerful states. In the next stage, there is the need of leadership for providing incentives to others to strengthen a global consensus. By that way, the leading state seeks to persuade others to conform to its vision of world order and to defer to its leadership (Keohane, 1984).

This study seeks to measure states' willingness to take this global leadership position through their behavior in international regime. Our concept of global leadership aggregates the observation of state's power in relation to international treaties across various pressing issues of global governance, such as world peace and security, environmental protection, or intellectual property. More specifically, our global leadership concept is built on the role of the country in facilitating and promoting multilateral treaties by analysing their timely ratification behavior. The efforts states make to promptly ratify a treaty represent their willingness to comply with international law, and thus to cooperate with other partners. The more initiative a nation takes in international treaties, the more it shows to the international community its intention to promote international consensus-building. The states' leading role is represented by their willingness to be the first mover, and then to provide more positive incentives to other countries to comply with the expected rules of cooperation. In this sense, ratification acts can be seen as concrete instances of states performing global leadership roles.

However, what is important to note is that our analysis of global leader behavior is limited to the level of compliance of international law and not includes any interpretation from the law enforcement. Elaborating global leading role of states in the stage of international treaty enforcement is surely beyond the range of this analysis. Of course, it would be highly desirable, in another study, to analyse the global leadership behavior of state in exercising global norms.

Within that proposed scope of analysis, we have constructed a quantitative index to measure the willingness of the state to take a global leadership position in a given area of international cooperation, namely, Global Leadership Index. The following section will explain the formation of this quantitative index and its meaning.

5.4.2 Global Leadership Index

For each country, rather than only considering its presence of ratification for a certain convention, the research presents empirical analysis focusing on the time patterns of ratification to identify the first movers and thus, leaders in a in a particular issue of international cooperation. To measure how fast a country's policy response is to a typical convention, two options can be considered: (1) order in a sequence of ratification and (2) counting the delayed years between promulgation of a convention and its ratification.

For the first approach using rank, the variation in the number of delayed years could be misevaluated. For example, country i may have the same rank for two different conventions A and B , although their numbers of delayed year are different. Let us say country i ratified convention A ten years after A 's promulgation and i also ratified convention B twenty years after B 's promulgation. As long as only one country, say country j , ratified A and B earlier than country i , the rank remains the same despite the different length of elapsed time. Therefore, as with any comparison, the two different quantities in number of delayed years will not be evaluated. The ranking then itself does not reflect how quickly a country commits to a given convention.

For a typical convention, let D_i denote the delayed years between promulgation of a convention and its ratification by country i . If Y_P is the year of promulgation, and Y_i the year of ratification by country i , the second approach then measures $D_i = Y_i - Y_P$ that takes account of delayed policy making decision of a state towards a convention. Figure 21 shows the growth shape formed by D_i for some major

multilateral treaties in the different domains of politics. It is clear that the ratification pattern differs very much among treaties. Some treaties quickly reached their peak in the number of memberships in the first ten years, whereas others were gradually changing. Especially in some cases where countries were still pursuing ratification more than three decades after a convention was promulgated. Therefore, the gap of time, from the convention's date of creation to the year a state committed to follow it, representing the delayed decision by a state, is believed to be valuable in understanding state leadership behavior in the international law system.

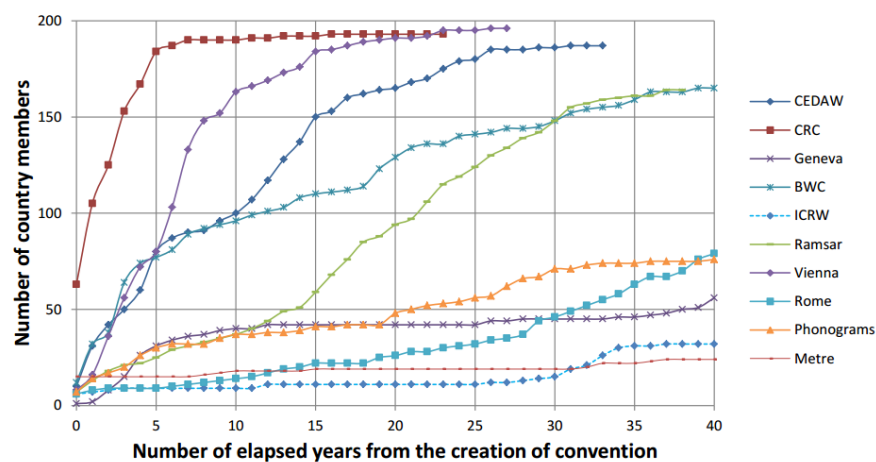


Figure 5.2: The Growth of some Major International Conventions

Policy making, such as decision of ratifying an international agreement, is a type of decision over several years and is considered as an intertemporal decision making. Intertemporal decision making over time is a type of future-oriented decision making which has extensively been investigated in the field of neuroeconomics (Cajueiro, 2006; Takahashi, 2009). In choice between smaller but sooner reward and large but later reward, future-oriented subjects prefer larger later rewards to smaller sooner one. In contrast, less future-oriented (i.e. impulsive/impatient) subjects prefers sooner but smaller rewards (Takahashi, 2009). This impulsivity in intertemporal choice has been accounted for by the behavioral/psychological tendency of temporal discounting – devaluation of delayed reward according to an increase in delay until its receipt (Federeick at al, 2002). For instance, if people are asked to choose between (a1) \$1000 in 1 year and (a2) \$1050 in 1 year and 1 week or (b1) \$1000 today and (b2) \$1050 in 1 week, then according to the expected utility theory someone who chooses (a2) in the first situation must choose (b2) in the second situation. However, greater impatience for intermediate rewards can make one choose (a2) and (b1) (Cajueiro, 2006). Studied in neoclassical economic and behavioral economics

discovered that people's time preference reverses over time, which is referred to as time-inconsistency in intertemporal choice (Thaller, 1981, Fredereich et al, 2002). Much work has been done for modelling and elucidating psychological and neural foundation of the preference reversal over time, or the time inconsistency/impatience in intertemporal choice (Takahashi, 2009).

In order to capture essential features of human decision over time, the following q-exponential temporal discounting model has been utilized in neuroeconomics (Cajueiro, 2006, Takahashi, 2009):

$$V(D) = \frac{V(0)}{(1+k_q(1-q)D)^{\frac{1}{1-q}}} \text{ (Formula 1)}$$

Where $V(D)$ is a subjective value of a reward which subject received with delay D and $V(0)$ is a subjective value of a reward which subject received with delay $D=0$. k_q and q are free parameters indicating impulsivity impatience at $t=0$ (t is a delay until the receipt of the delayed reward) and deviation from neoclassical rationality in intertemporal choice, respectively. Larger k_q values represent greater temporal discounting (impulsivity) at $t=0$. If $q = 1$, equation (1) corresponds to the exponential discount function originally proposed in neoclassical economics (Samuelson, 1937).

$$V(D) = V(0) \exp(-k_e D) \text{ (Formula 2)}$$

If $q = 0$, the time discount function is the following (simple) hyperbolic function (Mazur, 1987)

$$V(D) = \frac{V(0)}{1+k_h D} \text{ (Formula 3)}$$

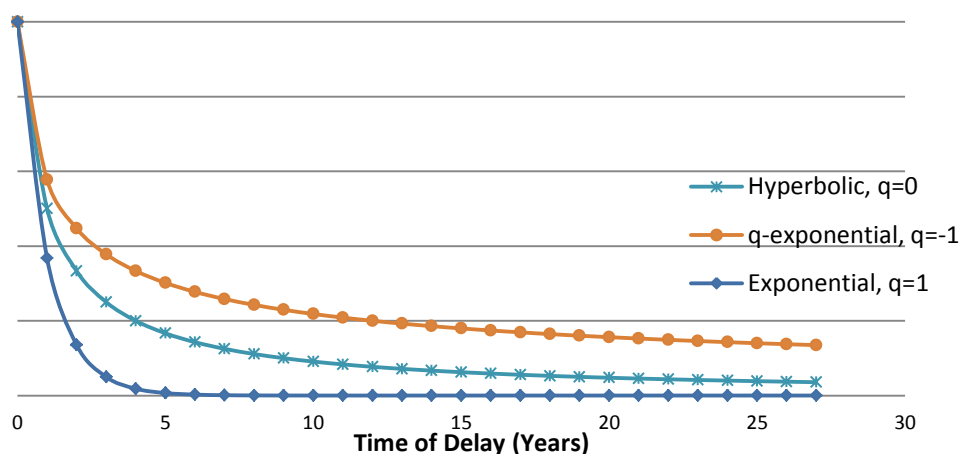


Figure 5.3: The q-exponential Temporal Discounting Model

We adopt formula 1 for modelling the state’s decision of ratifying an international agreement. What is important to consider when applying this model is that how to give an appropriate weight (i.e. the value for q in the intertemporal choice model) for capture the time of delay in ratification decision of a state. We have tried the three case of q , including: $q=1$ in the exponential model, $q=0$ in the hyperbolic model and $q=-1$ for our dataset and found that international agreements attract 50% of their memberships in the average of 20 years (Figure 5.1). The length of 20 years of delay can be used as the threshold to differentiate between the initiative ratifiers and not initiative ones. As can be seen in the figure 5.3, the hyperbolic model with $q=0$ are best fit model for our dataset to express the distinction behavior between the state who ratified an agreement earlier than 20 years of delay and the other ratified it with more than 20 years of delay. Therefore, for our modelling of sate’s ratification decision, we have chosen the hyperbolic model with $q=0$ to capture the essential feature of state’s ratification decision over time.

Therefore, a quantitative indicator, namely, Global Leadership Index (**GLI**) is constructed based on the hyperbolic model of the intertemporal choice. The country who ratified the convention immediately without any delay is rewarded the highest value of leadership score of 1 (i.e. $V(0)=1$). The metric of leadership of a given country i will take account of the delayed time of the country i ’s ratification decision by the inverse in the number of delayed years D_i , and expressed as following:

$$GLI = \frac{1}{1+D_i} \text{ (Formula 4)}$$

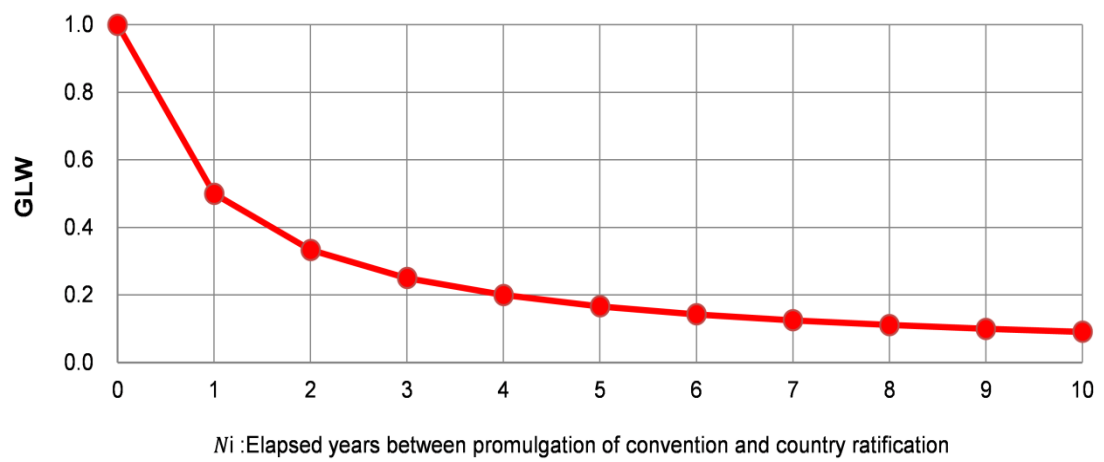


Figure 5.4: Global Leadership Index

5.5 Policy Implications for Strengthening the Global Partnership in S&T

As the world's interdependence expands and deepens, the cross-border challenges are likely to continue in coming decades. However, as pointed out by many, the current global governance architectures still short on capacity to cope with them. The demand for effective global governance continues to outstrip supply, and the gap is growing (Patrick, 2014). Why the global efforts have produced little real progress is a question frequently raised by the policy planners.

It is reflected through our analysis that the answer is partly because states don't perceive the importance of the current global matters in the same way or with the same urgency. Different global issue-matters have received different level of support from the international community. Moreover, there is a significant gap among groups of countries in the average numbers of years for them to take part in the matters of global governance by ratifying the multilateral agreements. The low HDI countries is still being marginalized from many global governance activities, especially for the issues of occupational health and safety, food and drug safety, intellectual property and standards. It suggests useful information for policy planners to make international cooperation progress more effectively achieved by paying more attention for this group of countries. Consideration should be given to proposals that enhance coordination, cooperation, coherence and policy marking across the UN system- the only truly universal and inclusive multilateral forum. Especially, effort should continue to further enhance the representation of developing countries in multilateral institutions and other norm and standard setting bodies. Because it is recognized that to achieve a more enabling and inclusive of global governance, it is critical for states to equivalently perceive the necessity of acting collectively and working to harmonize the global S&T governance across national boundaries.

Chapter 6.

EMPIRICAL TESTING OF COOPERATION WITHOUT HEGEMONY PARADIGM BY USING GLOBAL LEADERSHIP INDEX

6.1 Cooperation without Hegemony Literature Review

History has witnessed the change of world leaders throughout time. By maximizing the use of their resources, strong states often dominate the world. Especially, there is a strong link between global leadership and international regimes. For instance, there is the leadership of France, the Holy Roman Empire, Sweden, England, and the Netherlands in the process of forming the post-Westphalia system of states in Europe, and the leadership of the United Kingdom, France, and the United States in the process of forming the Versailles Treaty as a post-World War I regime. After World War II, the so-called P5, the United States, the Union of Soviet Socialist Republics (USSR), the United Kingdom, France, and China, played a critical role at several critical political points in history by exerting their veto power as a permanent member of the Security Council of the United Nations. In 1975, facing the awakening of oil powers, six economic powers, the United States, Japan, Germany, France, the United Kingdom, Italy and European Union met at Rambouillet, France, and formed a new leaders group, the G6. The addition of Canada made it the G7, and later Russia joined to make it the G8. In 1998, all the G8 countries, plus BRICs (Brazil, Russia, India, and China) and eight representatives of emerging countries, Argentina, Australia, Indonesia, Mexico, Republic of Korea, Saudi Arabia, South Africa and Turkey agreed to act jointly for the sake of solving various global issues. The G20 was formed.

However, for Ian Bremmer, an American political scientist, “for the first time in seven decades, we live in a world without global leadership” (Bremmer, 2012, p.3), and “we have entered the G-Zero” (Bremmer, 2012, p.4). In his book, “Every Nation for Itself: Winners and Losers in a G-Zero World,” he coins the term G-Zero and explains it as “a world order in which no single country or durable alliance of countries can meet the challenges of global leadership” (Bremmer, 2012, p.1). The world’s most influential nations lose their willingness to lead in solving global issues and taking new international responsibilities. Both established powers that form the G7/8 and rising states that comprise the G20 are too busy watching out for their own needs—they are too preoccupied playing their own game. It is because of “every nation for itself” that no single country or bloc of countries has the political and economic leverage—or the will—to drive a truly international agenda and to accept new risks and burdens abroad (Bremmer and Roubini, 2011). Therefore, this is not a G7, G8, or a G20 world. This is the era of G-Zero—a leaderless world.

Bremmer is indeed not the only author who is telling us about the existence of the international cooperation in the current world in the absence of hegemony. Before Bremmer, other striking discussion can be found earlier in the cooperation without hegemony literature. One of the most prominent discussions is from Keohane’s *After Hegemony*. In his book, Keohane describes the conditions by which states build international regimes in order to promote mutual beneficial cooperation. Keohane analyses the international regimes and institutions in three different issue areas of the world political economy, including finance, trade and oil and describes the evolution of these regimes. He reminds us the existence of nearly two decades after the World War II when hegemonic power and the international regimes established under conditions of hegemony combine to facilitate cooperation. Hegemony plays an important role, even a crucial one in accounting for the creation of international regimes (Keohane, 1984). Contemporary international economic regimes that were constructed under the aegis of the United States after World War II, such as the IMF and GATT, is among the typical examples of cooperation facilitated by the dominance of a single power. Therefore, there are strong theoretical reasons for believing that hegemonic cooperation relies on a dominant power making rules and providing incentives for others to conform with those rules (Keohane, 1984). However, is it the only possible form of international cooperation? Can cooperation persist without the dominance of a single power? Keohane did answer these pressing questions that cooperation does not necessarily require the existence of a hegemonic leader after international regimes

have been established. Post-hegemonic cooperation is also possible. In other words, cooperation can emerge and regime can be created without hegemonic leadership.

Continuing with the same argument, another discussion taking the sociological approach to regimes comes from Puchala and Hopkins, the theorists in *International Organization Journal's* rational designs issue. They defined that a regime exists in every substantive issue-area in international relations where there is discernibly patterned behavior. Such patterned behavior may reflect the dominance of a powerful actor or oligarchy rather than voluntary consensus among all participants (Puchala and Hopkins, 1982). They also mentioned that the decline of U.S. hegemony and the attendant reduction in resources available for enforcing norms buttressed by American power gave created challenges to existing regimes. In their opinion, disagreements have arisen over appropriate norms in the areas of trade, oil, food and even nuclear security. Later, Braithwaite and Drahos's book, "Global Business Regulation," expands the institutional literature on how to sustain cooperation by providing an innovative and systematic interpretation of the present multilateral system across a vast critical area of business regulation, from property and contract, financial regulation, corporations and securities, to trade, labor standards, environment, nuclear energy, telecommunications, drugs, food, and transport (Braithwaite and Drahos, 2000).

Recently, several new books broaden the empirical existence of such vast cooperation in the absence of hegemony. The order of the world without leadership is also described by Hale, Held and Young. Ranging over the main areas of global concern, from security to the global economy and the environment in the postwar era, their book, "Gridlock: Why Global Cooperation is Failing when We Need It Most," examines a situation called "gridlock" where tools for global policymaking, principally state-to-state negotiations over treaties and international institutions, have either failed to make breakthroughs or have had only limited success (Hale, Held and Young, 2013). They explain that the strident voices of former leading and the rise of new powers representing a more diverse array of interest make intergovernmental agreement more difficult. The lack of effective global governance in these particular issue areas in the world increasingly widens the gap between our need for global solutions and flapping ability of multilateral institutions to meet that need (Hale, Held and Young, 2013).

Other typical materials contributing to the cooperation without hegemony literature includes Gideon Rachman's *Zero-Sum Future: American Power in an Age of Anxiety* and Charles A. Kupchan's *No One's World: The West, the Rising Rest, and the Coming Global Turn*. For Rachman, he describes the international system where the win-win logic that allowed the major powers to embrace globalization is now being replaced by a zero-sum logic, in which one country's gain looks like another's loss (Rachman, 2011). Simply put, the logic of international relations has been changed. Every country is exceptional in its own way and no country can exercise global leadership. Without a dominant power, multi-polar, multinational forums for negotiation are much more difficult to reach to the final consensus or even fail. As the result, there is an increasing risk of deadlock in international forums on a set of global climate and macro-economic issues. Charles Kupchan's latest book adds to these arguments by explaining the implications of the "no one's world" situation where no great power dominates. Kupchan sees a coming "global turn" to a new international system with a structure quite different to the era dominated by a benign American unipolar hegemon. Globalization has speeded the rise of other emerging powers such as China, India and Brazil. However, these new powers will not replace the previous dominance of Western order. The twenty-first century will not belong to America, China, Asia, or anyone else. It will be no one's world. For the first time in history, an interdependent world will be without a center of gravity or global guardian (Kupchan, 2012).

6.2 Empirical Testing of the Transformation towards Cooperation without Hegemony Paradigm

How can we verify the above-mentioned authors' claim about the shift towards cooperation without hegemony paradigm on an empirical basis? To describe hegemonic leadership of a country in an international context, there are several approaches. The traditional approach of political scientists can be called a descriptive approach. It is to give a detailed account of leadership behavior that affects the behaviors of other members. The most complete picture of leadership can be attained through maximum efforts to collect materials and interpret them. This approach, however, requires a full book volume to provide a sufficient level of description. But how can we compare the leadership of a particular country at a different stage of history and in a different area of policy domains? Another approach can be labelled a schematic approach. It must use a uniform framework to understand the behavior of a

country by using a quantitative metric that can be applied to different political domains to evaluate the leadership a given state.

The study takes the second approach to develop a system of observation of global leadership change over time more systematic than the one that currently exists. The following section will provide the detailed description of our framework of global leadership analysis.

6.2.1 Framework of Analysis

In this chapter, the Global Leadership Index (GLI) which is introduced in Chapter 5, is utilized for quantitatively measuring the initiative of state's action in global norms to evaluate the her global leadership behavior. Three specific time periods of the world history (pre-World War II, post-World War II, and post-Cold War era) and three groups of states (G3, G8, and G20) representing the world's most influential countries of these periods respectively, are chosen for our observation of the global leadership changes. The dataset of 120 prominent international conventions deposited to the UN system is used as the input data for our analysis. It contains the ratification status of conventions that cover six policy domain, including human rights (H), environment (E), peace and security (P), labor (L), intellectual property (I), trade, commerce and communication (C). By comparing the metric results of GLI for key global players through different stages of world history and in different policy domains, we can identify the divergence in powers that are bound to shape twenty-first-century world politics. Moreover, by tracing changes in the leader role among established powers and rising powers, our observation shows a notable decrease in world leadership performance among countries and the convergence in states' position in world politics. Those results then are used to highlight what is stated about transformation towards the era of cooperation without hegemony.

In this sense, our study does not discuss subjects such as the decline of the United States or the rise of China and other emerging powers. It is far beyond the scope of this study. That task remains for future works. Our discussion is limited to illustrating the shift towards cooperation without hegemony paradigm and providing visualization for the idea of a leaderless world through an international regime perspective.



Figure 6.1: Framework of Global Leadership Analysis

6.2.2 Three Time Periods and Three Country Groups

One of the main concerns of the study is the selection of specific time periods in world history to observe the global leadership change. In our analysis, the conventions studied are divided into three time periods based on their year of creation. Here, the year of creation means the year when the convention was made open to ratification. And three time periods correspond to pre-World War II (before 1945), post-World War II (from 1945 to 1989), and post-Cold War era (after 1989). The years 1945 and 1989 are chosen for the analysis because they are the significant milestones that marked the biggest transformations of the international system. Let us briefly review major changes in the world political history which provide a background for why the above mentioned time periods are selected.

The birth of the world system of states can be traced back to a hundred years prior to World War I with the coalescing of the European system of sovereign states and its expanding sphere of influence. The nineteenth century witnessed tremendous economic progress in the western world. However, the expanding industrial system created unprecedented problems that forced Europe to take political leadership in the establishment of new institutions and international cooperation which helped mute conflicts among the (great) powers, as well as address common interests and concerns. The development of treaties and institutional arrangements among European governments during the nineteenth century set important historical precedents for more contemporary efforts to enhance world order. For example, the first international institutions and global norms were founded during this period, including

communications (the Universal Postal Union in 1874 and the International Telegraph Union in 1865), intellectual property (Paris Convention for the Protection of Industrial Property in 1883 and Berne Convention for the Protection of Literary and Artistic Works in 1886), and measure and technical standards (Convention de Metre in 1875). In the late nineteenth century, the world saw the leadership of European nations in pioneering international treaties and global institutions to pursue national interests and advancements in communications and transportation. In the early twentieth century, the leadership to govern human affairs continued with the expansion of the international economy, the threat of war, and an alliance formation among the great powers necessitated the establishment of international institutions and treaties.

A large change in organizing the international system followed the terrible destruction of World War I (1914-1919), which drew all the major European powers into the conflict. The World War I ended with the new world order in which the United Kingdom, France, Italy, Japan, and the United States played the role as the chief arbiters. However, it is the Treaty of Versailles in 1919 that marked the “Big Three” or “G3”—France, United Kingdom, and the United States—holding noticeably more power and influence on the proceedings and outcome of the treaty than Italy or Japan (MacMillan, 2003; Boemeke, 1998). Early in the period between the two great World Wars, these three leading states tried, with a mounting sense of urgency, to construct a global system through the creation of a number of other international organizations and treaties whose purpose is to improve governance and maintain peace among nations. For historical evidence, as we trace leadership in world politics in the pre-World War II period (before 1945), we focus more on the leading role of France, the United Kingdom, and the United States, or referred to collectively as the G3, and test whether they were dominant players in the early days of constructing a system of global norms.

Continuing through the passage of world history, the year 1945 marked the end of the World War II and there was a decisive shift in the global system since then. World War II ended with the primary victors being the United States, the United Kingdom, and the Soviet Union. Along with these three states, the Republic of China and France gained permanent seats on the United Nations Security Council. World War II produced a new system of global governance and a number of other power representatives joined it. The epoch of World Wars was a transition period from the European system of states to the world system.

Later in power politics, the rise of the ideological estrangement known as the Cold War in 1947 was the most important phenomenon to shadow international affairs after World War II (Anttiroiko, 2004). The U.S. struggle for hegemony, the rise of Japan as an Asian power, and the economic recovery of European powers such as the United Kingdom, France, West Germany and Italy culminated in the 1975 Summit in Rambouillet, France, and the creation of the G6. Later, Canada, another large industrialized country joined the group to create the G7. The addition of Russia to the group led to the G8 in 1998. The main role of this expanding group has been to provide sound economic policy leadership. For post-World War II, the G8 is an important influence in promoting change in national and international policy. To mark this critical milestone in changing world leadership, we select the years from 1945 to 1989 as the year defining our second observed period for interpreting the leading role played in the formation of international conventions among the eight established powers, including the United States, Japan, Germany, France, the United Kingdom, Italy, Canada, and Russia.

The year of 1989 is was the biggest year in world history since 1945. It was the year marked the fall of an iconic symbol of the Cold War—Berlin Wall. One year later, the Conference on Security and Cooperation in Europe, held in Paris in November 1990, in which heads of governments produced the treaty that brought a formal end to the Cold War (Anttiroiko, 2004). It marked not only the collapse of the Soviet system, but also the decline of U.S. power. The global balance of power is shifting from the United States to the European Union, China, India, Brazil and other rising states because of the recognized need for a cooperative management of world politics. A new map of world power is shaped by not only the contribution from G8 countries, but also the BRIC (Brazil, Russia, India, and China) and other emerging representatives from different continents, such as Argentina, Australia, Indonesia, Mexico, Republic of Korea, Saudi Arabia, South Africa, and Turkey. It marks the formation of the G20.

In sum, to analyze the major changes in world leadership over time, our research is organized around three time periods, before 1945, 1945-1989, and after 1989, in which we study a number of countries representing the world's most influential group of states (G3, G8, and G20).

The following section shows the results of our analysis using the Global Leadership Index. The index value for G3, G8, G20 and the world average are

calculated for these three time periods and shown for each domain of treaties. Based on that, the changes of leadership over time, regime by regime, is clearly visible.

6.2.3 Observed Changes of Leadership by Regime Categories

By using our framework of global leadership analysis, the willingness to take global leadership role behaved by states in six international regime categories, namely Peace and Security (P); Human Rights (H); Environment (E); Intellectual Property (I); Labor (L); Trade, Commerce and Communication (C), is systematically examined. The results are explained in the following sections with the visualization aids the line graph representing the change of global leadership over time.

A line graph is generated for each of the six selected international regime categories. The graph's purpose is to capture the change of leaders over time. More specifically, Global Leadership Index scores are measured for G3, G8, and G20 groups, and compared with the average score of the world, which is then shown together in each graph for each regime domain. Moreover, the upper end of the range bar corresponds to the world average plus standard deviation and the lower end corresponds to the world average minus standard deviation are also figured in the graph.

Before starting our statistical analysis, we had implemented a small test to prove that our set of data is under normal distribution. The simplest method of assessing normality that we first applied is to look at the frequency distribution histograms of which we focused on the symmetry and peakiness of the curve. Moreover, we used Kolmogorov-Smirnov test for further validating the results of these visual histograms. Kolmogorov-Smirnov test provided by Matlab tool helps us to confirm that our set of international convention data is under normal distribution with the confidence level above 90%.

By using the normal distribution theory, the range of less than one standard deviation away from the mean accounts for about 68 percent of the members. Therefore, if countries are distinct from each other, for example, they are leaders, their metric should be far away from this range. In that way, the trend of change in global leadership of the most influential group of countries and the world as a whole over time can be observed clearly.

The following sections detail, regime by regime, changes in global leadership. For each category of regime, we also list the countries that perform outstandingly well in this particular global issue along with their achieved score. We firstly start our analysis with the Peace and Security norms category.

6.2.3.1 Peace and Security

The process of shifting towards cooperation without hegemony is most clearly illustrated in the arena of state-to-state conflict, both in real and cyber fields, through our empirical testing with multilateral convention data.

First, we applied our analysis using the Global Leadership Index for the group of conventions related to Arms Control and Disarmament, Non-nuclear Zones and Non-nuclear Proliferation. The index value for G3, G8, G20 and the world average are shown in the chart below.

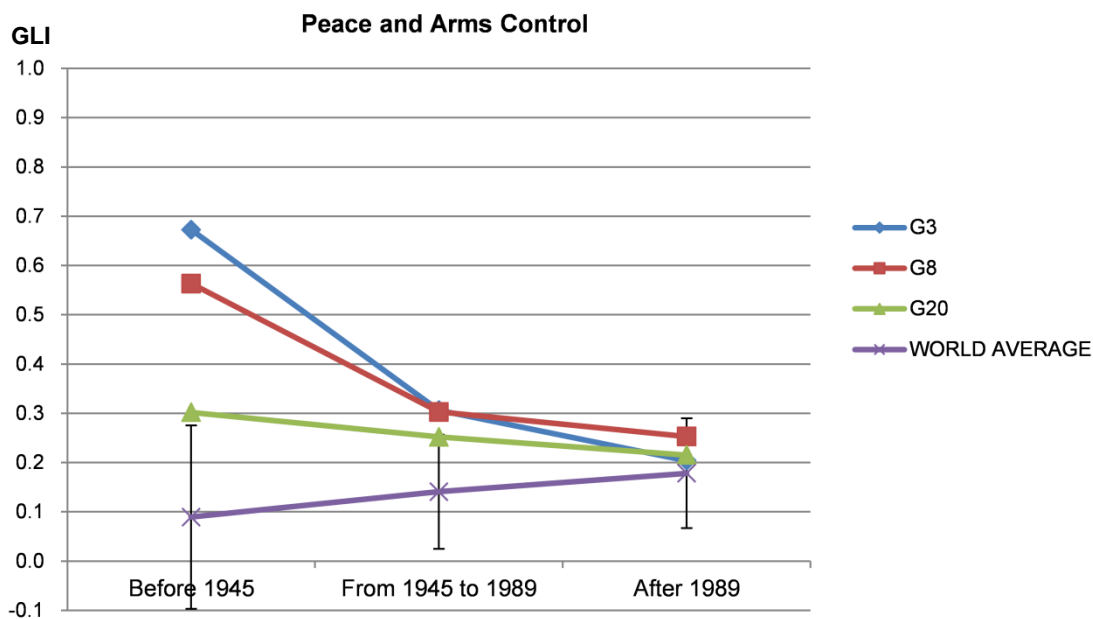


Figure 6.2: Changes of GLI through Three Periods (Peace and Arms Control)

Figure 6.2 depicts the dominant role of G3/G8 in the domain of peace and arms control for the years of the pre-World War II period. The average of GLI of the G3 and G8 members are 0.67 and 0.56, respectively, and are far above the world average point of 0.09. It means that G3/G8 members have taken initiatives by committing themselves very quickly to those conventions representing this time period. The index value of more than 0.5 means that these countries ratified the convention in the space of one year on average ($0.5=1/(1+1)$). The conventions taken for this time period are

the two Hague Conventions negotiated at international peace conferences in the Netherlands in 1899 and 1907, followed by the Geneva Protocol in 1925—a single article permanently bans the use of all forms of chemical and biological warfare. Actually in most cases, G3/G8 members were the original signatories and legal script writers of those conventions.

The following periods experienced a significant decrease in the GLI of G3 and G8 as well. From being distinct in the first period, G3/G8 turned, registering around 0.30, whereas G20 was rating a 0.25 and the world was averaging a 0.14 in the second period.

A further decline is calculated in the third period when G3 is at 0.20 and the world average is at 0.18. Without any distinguishable score in the Global Leadership Index, it is obvious that G3 is not taking the reins in the field of world peace. With the end of the Cold War and shifting centers of power, the effort to protect and enhance world peace has been transformed in a remarkable process and not by great power initiatives, but remarkably by NGOs and their partnership with governments. The International Campaign to Ban Landmines is a typical example of NGOs advocating for international peace and security. This NGO is working for a world free of anti-personnel mines and cluster munitions, and its founding coordinator, Jody Williams, shared the 1997 Nobel Peace Prize for the organization's efforts in the creation of the Mine Ban Treaty. The successful process that brought about the Mine Ban Treaty has added a new dimension to diplomacy and demonstrates that small and middle powers can work together with civil society and address peace concerns with breathtaking speed (Williams, 1999). It shows that such a partnership can present a new kind of "global leader" in the post-Cold War world.

Over three time periods, we find the most active performance from Mexico. European states such as Hungary, Denmark, Bulgaria, Sweden, United Kingdom, Austria, Russia, Netherlands and Ireland also had high achievements in this domain. But the period after the Cold War witnessed significant international legislation from Canada, and especially from several new faces, such as Mauritius, Fiji, Uzbekistan, and Turkmenistan. Swift responses to Chemical Weapons Convention (CWC), Comprehensive Test Ban Treaty (CTBT), Anti-Personal Mines Convention (APM) and Nuclear Free Zone Treaties pushed their GLI score to outstanding.

Table 6.1: Top Ten Countries in Peace, Arms Control and Disarmament Domain

Rank	All periods		After 1989	
	Country	GLI	Country	GLI
1	Mexico	0.57	Mauritius	0.75
2	Hungary	0.55	Fiji	0.63
3	Denmark	0.50	Sweden	0.46
4	Bulgaria	0.49	Uzbekistan	0.44
5	Sweden	0.48	Canada	0.42
6	UK	0.47	Turkmenistan	0.42
7	Austria	0.46	Malaysia	0.38
8	Russian	0.45	Ireland	0.38
9	Netherlands	0.41	South Africa	0.35
10	Ireland	0.40	Laos	0.35
	G3	0.36	G3	0.20
	G8	0.36	G8	0.25
	G20	0.27	G20	0.22
	World Mean	0.16	World Mean	0.18

In another aspect of the peace domain, the world has faced the threat of a “war on terrorism.” During the second half of the twentieth century, the international community faced the terrorist phenomenon and cyber-threats, and reacted with the adoption of a series of treaties targeting this specific type of world peace and security (O’Donnell, 2006). The pre-Cold War saw the formation of treaties related to safety issues of civil aviation and maritime navigation, including five adopted during the 1970s and three treaties adopted in the 1980s. G3/G8 quickly showed their obligations for acts related to criminality on aircrafts and ships within the first two years on average (GLI score of 0.3) as compared to the 7-year gap for the whole world (GLI score of 0.125).

The years after 1989 saw the adoption of treaties against terrorism and cybercrime. In these conventions, all of the needed groundwork had been established to galvanize international cooperation and states’ responsibilities to take action against these international threats. In this context, the need for leadership of powerful countries in the initiative phase is critically raised. However, as Bremmer depicts in his book: “Past efforts to develop treaties or common codes of conduct have produced little real progress, mainly because states don’t perceive their vulnerabilities in the

same way or with the same urgency” (Bremmer, 2012, p.74). And “G-Zero dilemma is that every government and institution will defend itself at the expense of others rather than cooperate to design an effective system of collective defense against a common threat” (Bremmer, 2012, p.76). This trend once again is illustrated clearly through our analysis that shows a downswing from the way states committed to the anti-terrorism and cybercrime regime in the 1990s. G8/G8/G20 all have a low score of around 0.20, an insignificant achievement gap when compared with that of the whole world, showing at 0.14.

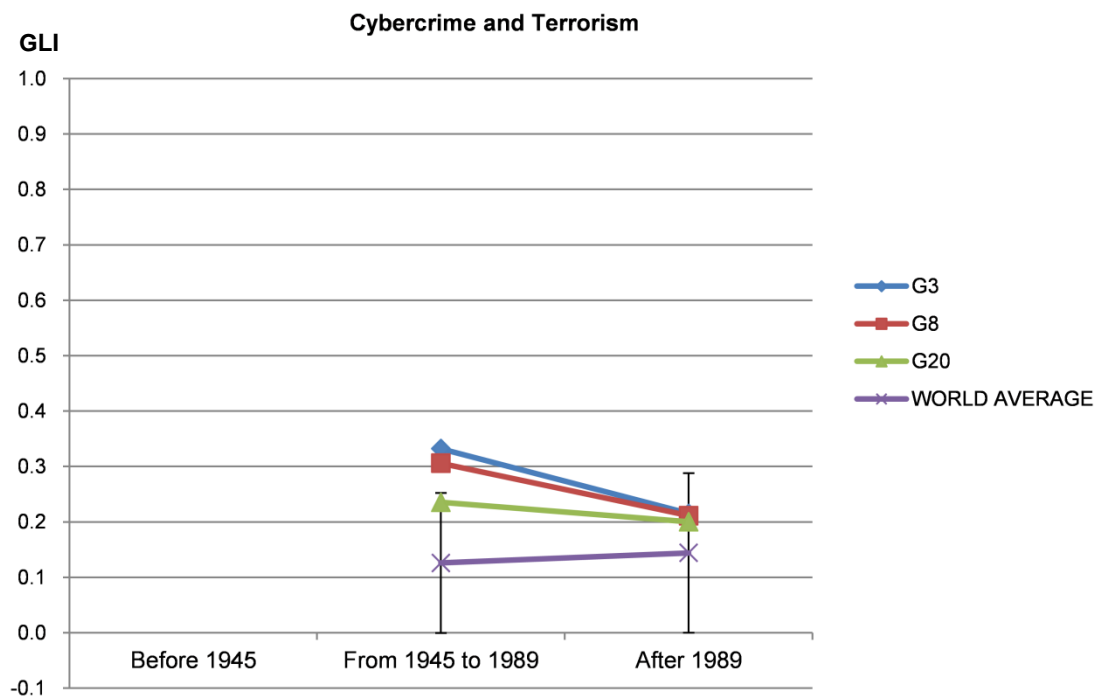


Figure 6.3: Changes of GLI through Three Periods (Cybercrime and Terrorism)

The top five countries to take a leading position in the terrorism and cybercrime domain all are European countries: Hungary, Spain, Sweden, Norway, and Austria. From the G20 group, the UK, Mexico and USA also scored high. Trinidad and Tobago, along with Mongolia also show remarkable achievement in this global regime category.

The period after the Cold War records the top position of Mexico, followed by the participation of developing countries such as Sri Lanka, Croatia, and India.

Table 6.2: Top Ten Countries in Terrorism and Cybercrime Domain

Rank	All periods		After 1989	
	Country	GLI	Country	GLI
1	Hungary	0.55	Mexico	0.48
2	Spain	0.43	Sri Lanka	0.42
3	Sweden	0.41	Czech	0.42
4	Norway	0.40	Slovakia	0.41
5	Austria	0.40	Norway	0.41
6	Trinidad and Tobago	0.35	Uzbekistan	0.39
7	UK	0.33	Croatia	0.39
8	Mongolia	0.32	Hungary	0.38
9	Mexico	0.32	Austria	0.38
10	USA	0.31	India	0.38
	G3	0.30	G3	0.23
	G8	0.27	G8	0.21
	G20	0.22	G20	0.20
	World Mean	0.13	World Mean	0.14

As we observe from our empirical analysis of global leadership on multilateral conventions related to world peace, no single country shows the desire to drive a truly international agenda as demonstrated through its level of commitment to the peace regime. Although established powers hold a distinct position in the first period, they are continuously losing their leading role by acting like many other players in the world in the ensuing years. World power is evolving so that no one takes the role of leader. This proves the scheme of the cooperation without hegemony. In the arena of world peace and security, it is evident that this is not a G7, G8 or a G20 world; this is the era of G-Zero—a leaderless world.

6.2.3.2 Human Rights

One of the first attempts at human rights protection is the creation of the 1926 Slavery Convention, internationally spawned under the auspices of the League of Nations. The Allied Powers of World War I endeavored to secure the complete suppression of slavery in all its forms and of the slave trade by land and sea (United Nations-b). That explains the high GLI score of 0.5 (i.e. ratification within the first year) of G3/G8 members in the period before World War II.

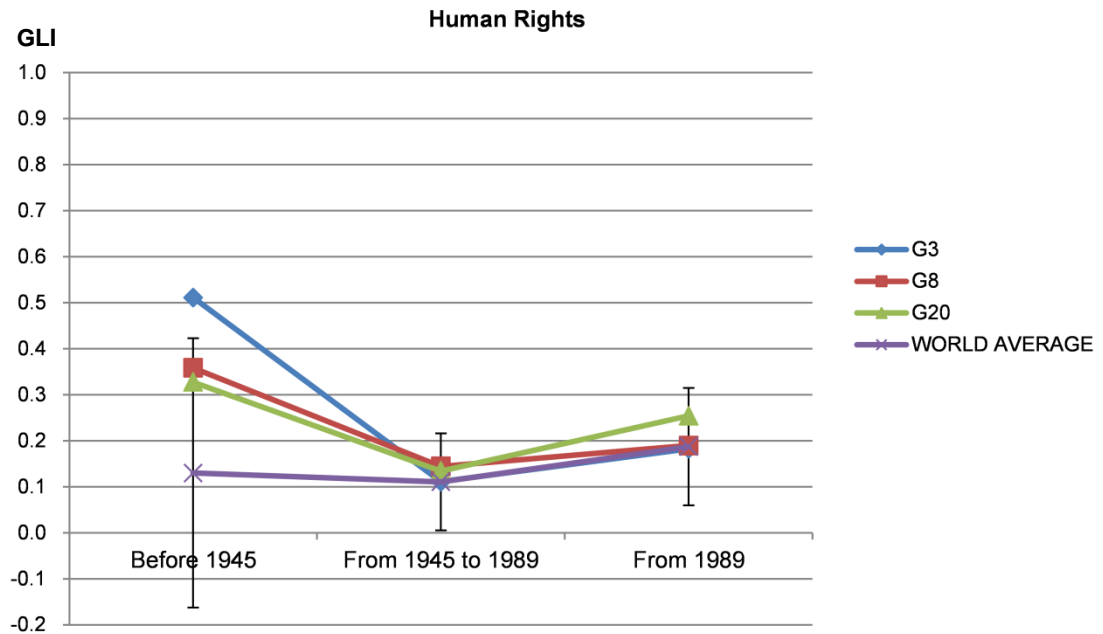


Figure 6.4: Changes of GLI through Three Periods (Human Rights)

After the establishment of the United Nations, many governments have more actively cooperated to enhance human rights in a structural form of an international regime of treaties, institutions and norms. Significant challenges to promoting human rights norms remain, however. Western countries, especially the United States, resist international rights cooperation from a concern that it might harm business, infringe on autonomy, or limit freedom of speech (Council on Foreign Relations, 2013). These concerns are reflected in the U.S. attitude and willingness to commit towards human rights conventions in the years from 1945 to 1989. Results from our analysis show that G3 has a similar score to the world average at the moderate GLI value of 0.11, slightly lower than G20 and G8 score of 0.13 and 0.14, respectively. Neither G3/G8 nor G20 is a leader in regulations on human rights protection. A similar situation continuously occurs in the period after the Cold War when G3/G8 present behaviors comparable to those of many other countries with a score around 0.18—a very modest score representing the low willingness to take a leader position. This demonstrates that established countries have not played a leading role in the domain of human rights since the end of the World Wars, at least from the perspective of human rights regime activity. On the contrary, for active commitment to the human rights regime, many of the most active participants are not major powers in the history of the world. For example, Bulgaria appeared to be active in committing to the human rights regime, followed by Ecuador, Sweden and Hungary. Among the G20, we found the high score to be with Mexico and Australia. Narrowing our focus to only the post-Cold War period,

Spain and Argentina rise to the top as new leading representatives in human rights legislation activities.

Once again, our empirical testing of the human rights regime supports the preposition about a leaderless world. No single country has risen to the forefront to lead the world in facilitating global compromise on human rights issues.

Table 6.3: Top Ten Countries in Human Rights Domain

Rank	All periods		After 1989	
	Country	GLI	Country	GLI
1	Bulgaria	0.49	Spain	0.57
2	Ecuador	0.48	Mexico	0.54
3	Sweden	0.42	Argentina	0.52
4	Hungary	0.40	Australia	0.50
5	Costa Rica	0.38	Egypt	0.50
6	Egypt	0.36	Sweden	0.50
7	Philippines	0.35	Panama	0.49
8	Mexico	0.34	Portugal	0.47
9	Australia	0.33	Namibia	0.44
10	Norway	0.33	Ecuador	0.44
	G3	0.16	G3	0.18
	G8	0.17	G8	0.19
	G20	0.18	G20	0.25
	World Mean	0.14	World Mean	0.19

6.2.3.3 Trade, Commerce, and Communication

The world has experienced two waves of globalization since the mid-nineteenth century. The first wave began around the mid-nineteenth century and ended with the commencement of World War I (roughly 1820-1914). The second wave began in the aftermath of World War II and continues until today (1960-present) (Baldwin, 1999). In both these episodes of globalization, states figure importantly in the governance of global finance in several ways: as unilateral actors, as participants in multilateral networks, and as members of suprastate institutions (Scholte, 2002). It cannot be denied that G3 and other European countries have played a critical leading role as a catalyst for the record expansion of international trade.

The world trade until the year of 1945 is characterized by the initiatives of G3 and other European countries in the creation of globally uniform standards for measurement, communication, and technique as a basic for fairness and efficiency of trade. By measuring the Global Leadership Index for multilateral commitment in ITU, Metre, UPU, and IEC, the value higher above 0.60 for G3 and G8 explains the pioneer positions of these country members compared with others who scored only 0.09.

International trade in the years following World War II entered a rapid pace never experienced before. Commercial policy and technological factors help explain the causes behind this enormously rapid growth. However, it is largely recognized that the Bretton Woods international monetary system plays an important role in providing a stable environment for trade to flourish. The G7 and its policies, the ascendancy of the Bretton Woods institutions over other parts of the UN system are all in good part assertions of states power. Coming out of World War II, the United States was only the country left standing and with its help to assist the Europeans and the Japanese, it created an architecture to pursue Washington's goal. The Bretton Woods Accord, along with IMF and World Bank, are all sound global institutions, but they are all U.S. institutions, U.S. values, U.S. priority, and U.S. allies. By that way, the United States led the way in world trade norms and institutions in the years after World War II. Our empirical testing results strongly support this statement and show evidence for the dominance of G3, especially the United States, in promoting global trade norms and institutions. Measuring the leadership score for IMF, World Bank, GATT, along with the creation of the most significant developments of the world trading system (ICAO, IMO, and ISO), we found a very high score for G3 at around 0.8. It means that G3 countries ratified the convention almost immediately after it opened. In other words, they played a critical role in initiating growth of the world trade system.

The period after the Cold War has experienced the rise of many emerging economies. The economic development and political decisiveness of these developing countries have made them become more active players in multilateral and international trade. The establishment of the G20 is one illustration of the ongoing shift and extension of global influence networks from the developed towards the developing world. The G20 score in this period is rising to be similarly equal to G3/G8 performance. However, our results show that the standard deviation value of GLI Index for this period is an exceptionally high number of 0.46. It illustrates the situation of an increasingly differentiated developing world trade system. Indeed, as Bremmer explains this situation in his book, "instead of a global trade framework, we will have a

series of commercial agreements between individual countries and among small groups of countries that create new investment limits and new trade barriers for those outside the bloc” (Bremmer, 2012, p.78). MERCOSUR (1991), Central European Free Trade Agreement (1992), North American Free Trade Agreement (1994), Shanghai Cooperation Organization (1996), Organization of Central Asian Cooperation (2006) are some of the typical examples of such regionalized trends in world trade.

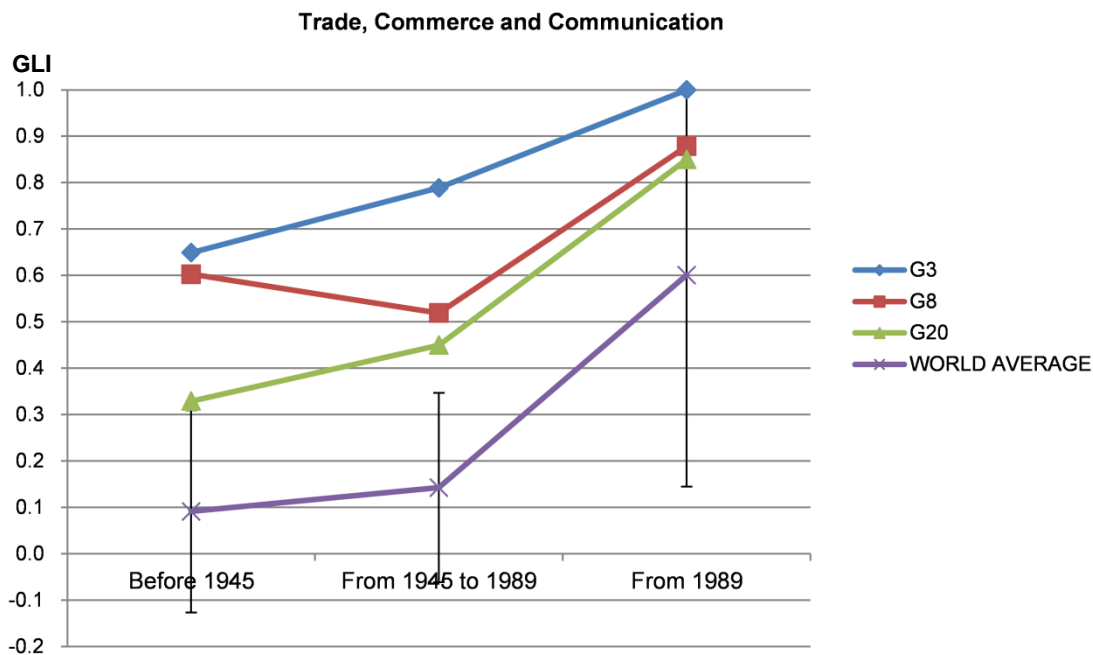


Figure 6.5: Changes of GLI through Three Periods (Trade, Commerce and Communication)

Throughout the history of international trade and communication agreements, among the top ten countries, we find the active G20 members from France, United States, United Kingdom, Canada, and Italy. Outside of G20, the active players are from Europe and include Belgium, Norway, Netherlands, Denmark, and Sweden. The countries also have important roles in creating and maintaining these world trade organizations.

Table 6.4: Top Ten Countries in Trade, Commerce, and Communication Domain

Rank	All periods		After 1989	
	Country	GLI	Country	GLI
1	Belgium	0.82	(*)	1.00
2	Norway	0.80		
3	France	0.79		
4	USA	0.78		
5	UK	0.76		
6	Netherlands	0.75		
7	Canada	0.68		
8	Denmark	0.67		
9	Italy	0.66		
10	Sweden	0.64		
	G3	0.78	G3	1.00
	G8	0.61	G8	0.88
	G20	0.48	G20	0.85
	World Mean	0.20	World Mean	0.60

(*) Note: Technical Barriers to Trade and World Trade Organization are two regime instruments that we used to measure global leadership of the state in the period after 1989. The data show that more than 100 countries had ratified them in the earliest year. Therefore, they gain the same highest z-score at 0.88.

6.2.3.4 Labor

In contrast to the enormous change in the level of commitment the international community paid to trade and commerce regimes, the labor regime appears to not receive any particular attention from states. A very moderate value of Global Leadership Index (around 0.1, i.e., countries express their ratification nearly 10 years after the first ratification) for both established powers as well as emerging powers can be observed throughout the history of international labor treaties. A low standard deviation value of around 0.07 for all three periods indicates a small variability within the world scene where states' behaviors are very similar. Neither G3/G8 nor G20 have shown the willingness to take a lead role in promoting and committing to fundamental rights and occupational safety for the workplace. Sweden in comparison has an incredibly active attitude with a GLI score of 0.63, much higher than that of G3 at 0.14, G8 at 0.12, G20 at 0.09, or the world average at 0.06. Sweden is followed by other European members—Norway, Finland, Spain, and United Kingdom. Other active levels

of commitment on labor rights come from the American continent, including Cuba, Mexico, and Ecuador. For the period after 1989, Slovakia, Finland, Spain, and some other new names also showed a remarkable change in attitude towards the labor regime.

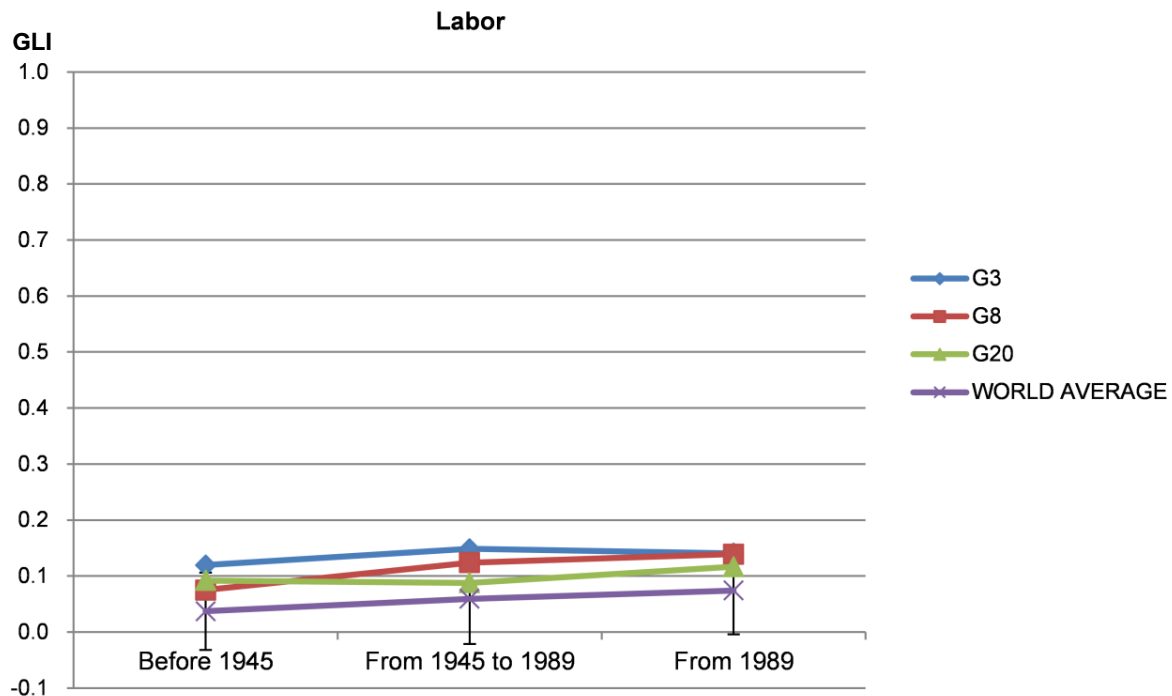


Figure 6.6: Changes of GLI through Three Periods (Labor)

Table 6.5: Top Ten Countries in Labor Domain

Rank	All periods		After 1989	
	Country	GLI	Country	GLI
1	Sweden	0.63	Sweden	0.69
2	Norway	0.33	Slovakia	0.46
3	Finland	0.28	Finland	0.42
4	Cuba	0.25	Spain	0.28
5	United Kingdom	0.24	Botswana	0.25
6	Spain	0.24	Ireland	0.25
7	Mexico	0.22	Mexico	0.25
8	Ecuador	0.20	Japan	0.22
9	Hungary	0.19	Norway	0.22
10	Switzerland	0.17	USA	0.20
	G3	0.14	G3	0.14
	G8	0.12	G8	0.14
	G20	0.09	G20	0.12
	World Mean	0.06	World Mean	0.07

6.2.3.5 Environment

Although the leadership role of G3/G8 countries in the pre-World War II era is most visible in peace, arms control, and human rights domains, G3/G8 leadership surged in the environment and intellectual property domains in the period from 1945 to 1989. The sudden increase in the exchange of knowledge, trade, and capital around the world in the mid-twentieth century ushered in the era of globalization, which in turn generated many environmental challenges and intellectual property protection concerns.

For the global environment issue, with a GLI score of nearly 0.50 as compared to 0.14 as the world average, G3 had a leading role in environment during the years after World War II. Other members that formed G8 also have taken an active role in promoting the environmental protection regime by gaining 0.42 in the value of the GLI index. It is commonly known that multilateral environmental agreements adopted in the period from 1945 to 1989 targeted building coherence among countries as the first step in strengthening environmental management in diverse areas, including freshwater and land resource management; the conservation and sustainable use of biodiversity; and marine and coastal ecosystem management (UNEP, 1999). These conventions are concerned mainly with the nature component of the environment, and, therefore, have widespread support and receive a quick response from the international community. CITES, the Montreal Protocol and the Basel Convention, among others, all have 170 or more parties. Meanwhile, the years of the post-Cold War era are marked by cooperation for environmental monitoring and assessment of cleaner industrial production and eco-efficiency, which is closely linked with economic benefits, responsibilities and obligations from member countries. As a result, some international environmental agreements established during the 1990s incorporate trade-related provisions as part of the range of measures designed to effectively address environmental challenges. The UN FCCC, Kyoto Protocol, PIC and POPs are some examples of agreements that emphasize trade-related aspects of the environment issue. Therefore, from the perspective of the country, the decision to ratify these conventions takes into account consideration of trade policies. It makes some governments, which are fearful of strict environmental obligations, unwilling to commit to the conventions adopted in the third period. This explains why our analysis results for the 1990s period saw a marked drop in the leadership score of G3 countries.

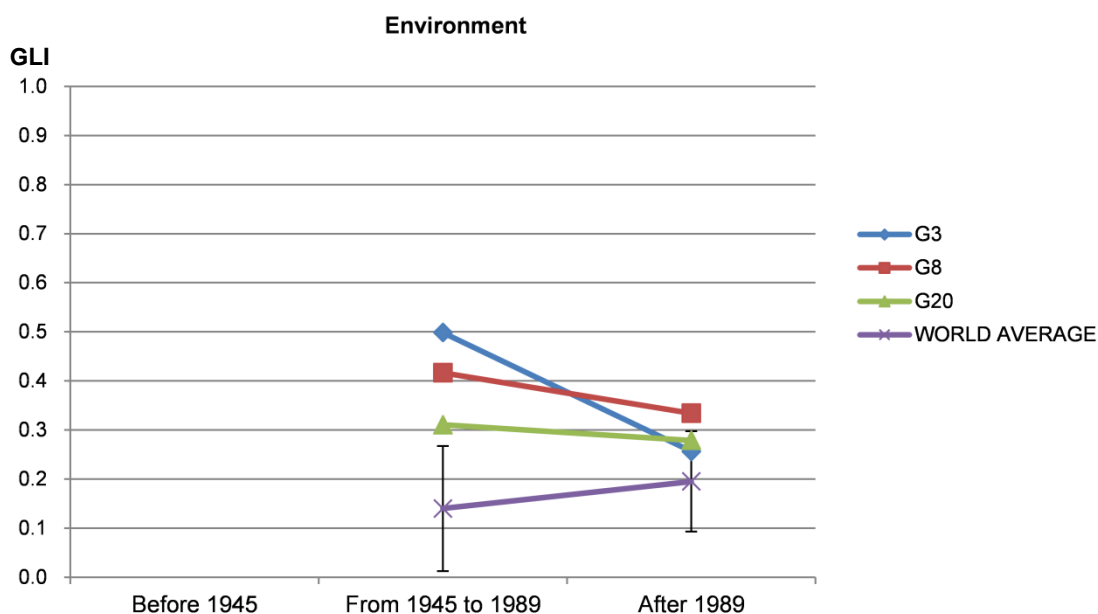


Figure 6.7: Changes of GLI through Three Periods (Environment)

Throughout our empirical testing with multilateral convention data, it is evident that G20 shows its leading role in global environment issues. Among the top ten, the most active representatives from G20 are Canada, the United States, Australia, United Kingdom, and Russia. Outside G20, we find European countries such as Norway, Sweden, Denmark, and Finland have taken a leading role. The post-1989 period has seen a rise in commitment from new active players in the environment regimes such as Maldives, Germany, Czech Republic, Fiji, and Slovakia among others.

Table 6.6: Top Ten Countries in Environment Domain

Rank	All periods		After 1989	
	Country	GLI	Country	GLI
1	Norway	0.56	Canada	0.70
2	Canada	0.47	Norway	0.56
3	Sweden	0.46	Maldives	0.47
4	USA	0.46	Germany	0.46
5	Denmark	0.40	Czech	0.44
6	Australia	0.39	Fiji	0.43
7	Mexico	0.38	Slovakia	0.42
8	UK	0.38	Sweden	0.41
9	Russian	0.37	Mauritius	0.38
10	Finland	0.36	Marshall Islands	0.38
	G3	0.40	G3	0.26
	G8	0.36	G8	0.33
	G20	0.28	G20	0.28
	World Mean	0.15	World Mean	0.20

6.2.3.6 Intellectual Property

A similar scenario to that experienced on environment issues has unfolded in the domain of intellectual property. In the first period, G3 and several other European leaders bore the leadership mantle for the establishment of basic protection mechanisms of intellectual works. Berne Convention for copyright protection and Paris Convention for patents are the remarkable multilateral conventions governing intellectual property protection in the pre-World War II era. During this period, works are presented in the form of traditional mediums and unauthorized copying was done by other people, not machines.

Later, in the twentieth century, we saw a large advancement in the technology of intellectual works. Initially, it appeared as analogue technology, such as phonograms, films, etc., and later in the 1980s, in the form of digital technologies that produce products such as CDs, DVDs, etc. All these technologies have spawned a boom in the media industry and boosted its development in the last few decades. This new situation necessitated a global legal framework for the regulation of technology, in addition to the regulation of human behavior. It leads to a striking change in the global environment for the protection of intellectual property (patents, copyrights, trademarks, trade secrets) rights.

In the period from 1945 to 1989, many conventions were created to extend the global reach of international property regulation, such as Universal Copyright Convention, Rome Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations, Convention for the Protection of Producers of Phonograms against Unauthorized Duplication of Their Phonograms, and Patent Cooperation Treaty. G3 and G8 are still playing a leading role in the formation of international norms in this arena.

In particular, several trends that emerged in the 1970s and accelerated in the early 1980s began to weigh heavily on U.S. policy-makers' minds. TRIPS is the most typical example of a norm that has become an integral part of the identity of the United States in the global political economy. It is illustrated through our analysis by the impressive score of global leadership for the U.S. in these periods.

But in the period after 1989, we saw a change. After the emergence of digital audio visual technologies, the copying of music and images becomes a great deal easier and far more accurate (we can even say identical). And along with this trend,

protection of intellectual properties becomes more and more technically complicated. WIPO Millennium Treaty is another good example. It regulates conflicts between countries regarding contents production, media production, and contents consumers. Also in the TRIPS case, it represented the high water mark of “hard law” for the commercial intellectual property agenda in a multilateral context, and the momentum of the TRIPS protests, particularly with respect to patents, has created a much more difficult political environment for industry (Sell, 2002). The strict legal enforcement may explain the overall decrease in the leadership index in the third period in this area.

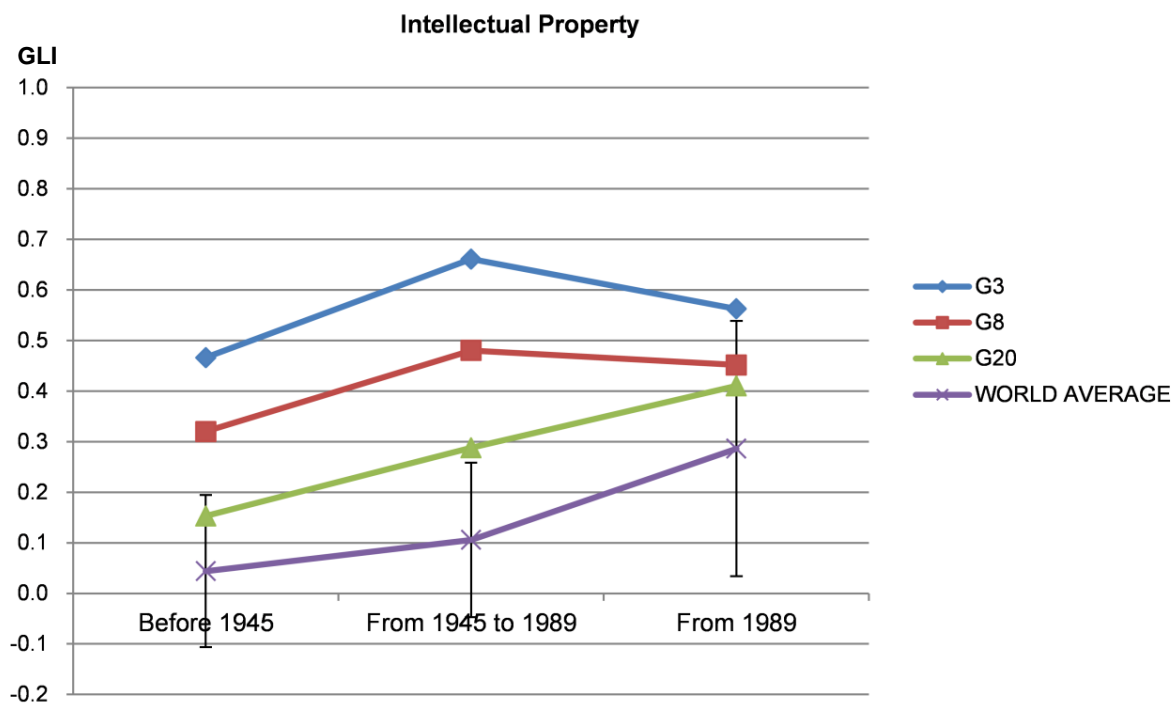


Figure 6.8: Changes of GLI through Three Periods (Intellectual Property)

Overall, United Kingdom, Germany, France, the United States, and Mexico are countries among G20 that show an active role in the intellectual property protection domain. Switzerland, Spain, and Sweden also achieved a high score in this arena. The 1990s period marks the rise in leadership of Czech Republic, Japan, Slovakia, Hungary, Slovakia, and Romania who have also exercised outstanding score in intellectual property rights.

Table 6.7: Top Ten Countries in Intellectual Property Domain

Rank	All periods		After 1989	
	Country	GLI	Country	GLI
1	United Kingdom	0.68	Czech Republic	1.00
2	Switzerland	0.60	Japan	0.88
3	Germany	0.59	Slovakia	0.88
4	Spain	0.58	Hungary	0.83
5	France	0.55	Romania	0.83
6	USA	0.50	USA	0.80
7	Sweden	0.44	Slovenia	0.79
8	Mexico	0.40	Costa Rica	0.77
9	Japan	0.40	Peru	0.77
10	Denmark	0.40	El Salvador	0.77
	G3	0.58	G3	0.56
	G8	0.43	G8	0.45
	G20	0.28	G20	0.41
	World Mean	0.14	World Mean	0.29

6.2.4 Overall Assessment

Throughout these three time periods of world history, the overall picture is that although G3 and G8 keep their distinct positions through the first two periods, they fall to the range of, and share the same behavior as, other groups. G3 and G8 members become like many other players in the world, that is, they lose their leadership role. All countries have converged to the same point where no one takes the lead in international cooperation. That prove what the political authors claimed about the cooperation without hegemony paradigm—that no country exercise global hegemonic leadership. Established powers for many reasons, in many domains, lack the political will to continue as the role of primary global leadership. Moreover, other emerging countries have appeared and marked their position in world politics. These countries have become much more important economically or politically on the global scene, thus they are much less prepared to follow others. As Bremmer pointed out, today, “no single country has the political and economic muscle to impose and enforce rules to drive a global agenda” (Bremmer, 2012, p. 68).

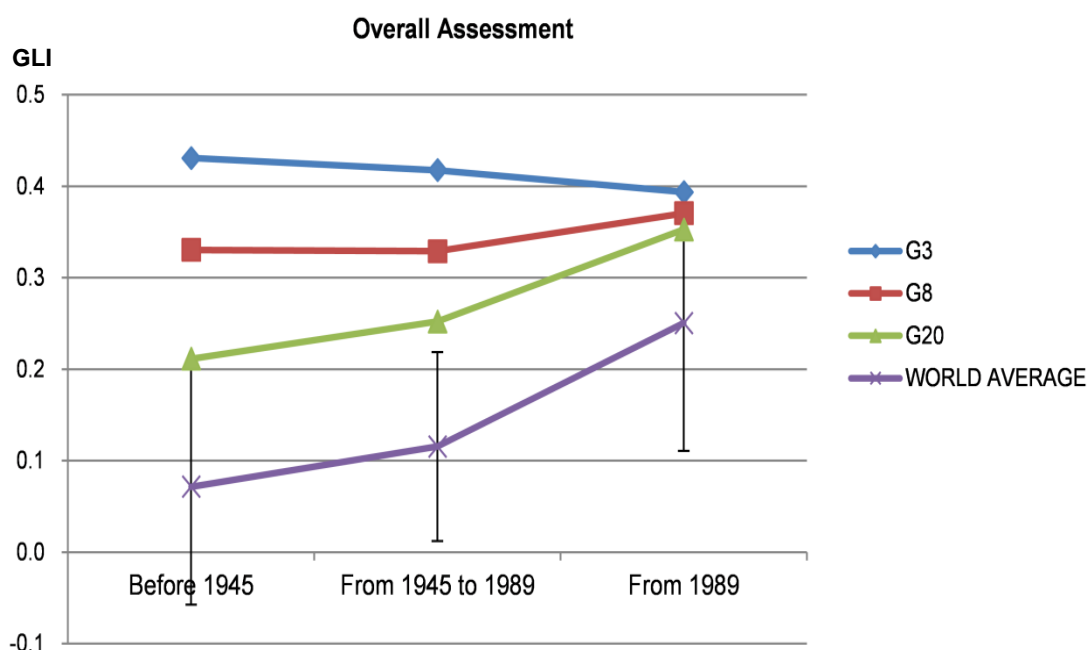


Figure 6.9: Changes of GLI through Three Periods (Overall Assessment)

From another view corner, we rank the top ten states having the highest Global Leadership Index metric (Table 6.8). Although the ranking list shows many newcomers are playing the most active role in the global norm system, it also serves to illustrate the trend in leadership has faltered among G3, G8, and G20 through the three periods of world politics.

Table 6.8: Changes of Overall GLI - Top Ten Countries and G3, G8, G20

Rank	Before 1945	GLI	From 1945 to 1989	GLI	After 1989	GLI
1	Belgium	0.63	Sweden	0.52	Mexico	0.54
2	Spain	0.59	UK	0.49	Slovakia	0.54
3	UK	0.51	Norway	0.45	Sweden	0.53
4	Sweden	0.47	G3	0.42	Czech	0.52
5	Portugal	0.47	USA	0.39	Hungary	0.49
6	Denmark	0.46	Mexico	0.39	Spain	0.48
7	France	0.45	Denmark	0.38	El Salvador	0.48
8	Austria	0.45	France	0.37	Japan	0.48
9	Switzerland	0.44	Hungary	0.36	Romania	0.47
10	G3	0.43	Canada	0.36	Argentina	0.46
...						
12			G8	0.33		
16	G8	0.33				
26			G20	0.25		
28	G20	0.21				
33					G3	0.39
43					G8	0.37
52					G20	0.35

To sum up, through our research results, the extent of the shift towards cooperation without hegemony paradigm is much more apparent. What we depict about the leaderless era is strongly coherent with what many political scientists have argued about the current world situation. Our analysis of multilateral conventions data has produced positive empirical testing results for the phenomenon of cooperation without hegemony in the world politics.

6.3 Hexagonal Profile of State towards International Cooperation

A country's political attitude is characterized in a hexagonal graph that plots six measurements of its global leadership in six regime domains. The plotting point in each angle of the hexagonal graph reflects how many standard deviations above or below the world mean a country exercised, which is called the z score. Thus, a positive score represents a country that has experienced a Global Leadership Index value above the world mean, whereas a negative score represents a country that has experienced a Global Leadership Index below the world mean. This kind of score is called standardized or normalized and is used to capture the comparative evaluation among countries. As our set data is under normal distribution, if we have the world mean μ ("mu"), and standard deviation σ ("sigma") of all country scores, we can standardize each country's Global Leadership Index value, GLI, by converting it into a z score using the following formula:

$$z = \frac{GLI - \mu}{\sigma}$$

By that way, a z score represents a country's relationship to the world's mean, thus it can illustrate whether a country is leading the world or not on a given global issue. For instance, if country A has the z score of 1.0 (A is noted as A (1.0) with her z score in parentheses), in the normal distribution, we can infer that country A achieved better than 68 percent of countries in the world and ranked roughly among the top 60 countries (32% x 200). Likewise, B (2.0) means that country B achieved better than 95 percent of the countries in the world and is among the top 10 countries of the world. Using the same type of interpretation, when C achieved better than 99.7 percent, C will be written as (3.0), and C will be the best performer in the world. With that scaling of measurement, it can be interpreted that, a country having the z score in a given regime domain of 2.0 or higher is outstanding and leads the world in that field.

Figure 6.10 is one example of our generated hexagonal graph. The red line represents the z score values achieved by a given state and the black line shows the world's average. They highlight the comparable evaluation of the state's policy attitude characterized in six global subject matters of Peace and Security (P); Human Rights (H); Environment (E); Intellectual Property (I); Labor (L); Trade, Commerce and Communication (C),

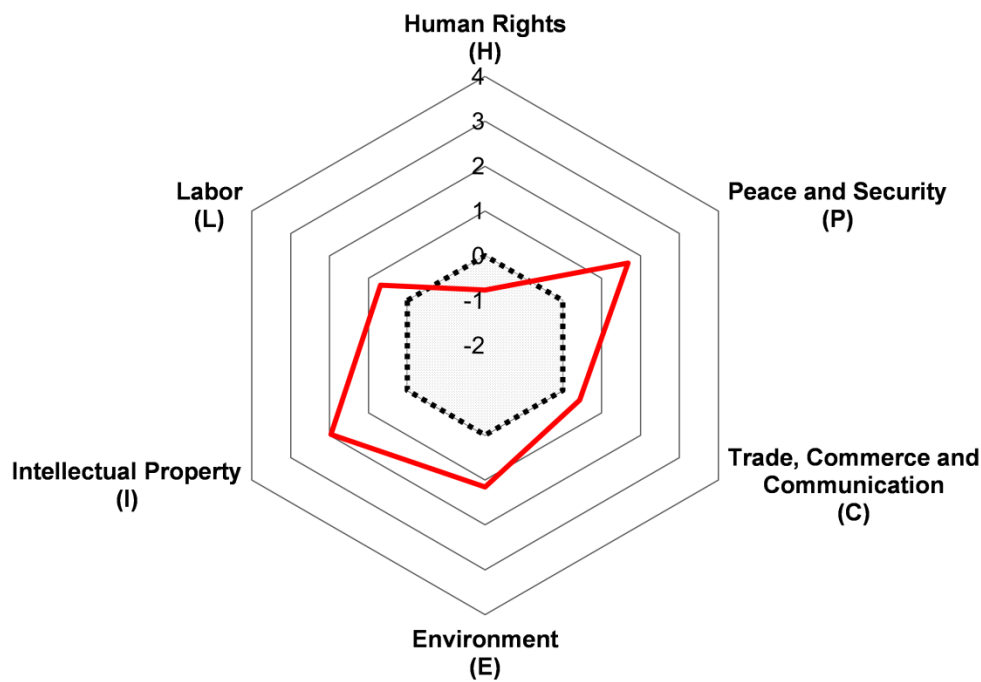


Figure 6.10: Example of Hexagonal Profile of a Country

We next tried to count how many regime categories countries achieved a z score of more than 2 (e.g. they are global leaders) over the three periods of examined world history. The results show that among G20, United Kingdom and Mexico have been leading the world in five different regime categories (their z scores in these five categories are more than 2). Needless to say, both the United Kingdom and Mexico are arguably under the strong shadow of the United States, if only because of their historically special relationships. United States and France have exercised global leadership in three domains. Other G20 countries, Australia, Canada, and Russia have taken leadership initiative in two domains. The most active country of the world is, however, from outside G20, Sweden, who has achieved superlatively in all six global arenas. We also have strong international regime commitment from other countries: Norway (four domains), Spain (three domains), Denmark (three domains), Austria (two domains), Bulgaria (two domains), Finland (two domains), and Hungary (two

domains). In total, 15 countries are found to be leaders in the formation process of at least two categories of international regimes. Another 12 countries have taken a leading position in one regime domain, they are Belgium, Costa Rica, Cuba, Egypt, Germany, India, Italy, Luxembourg, Mongolia, Netherlands, Philippines, and Switzerland. The full listing of hexagonal graphs from 193 country members of UN can be found in Appendix 2.

Chapter 7.

CONCLUSIONS

7.1 Summary of Findings

Firstly, this research has successfully built up the database composing more than one hundred prominent international agreements deposited to the UN system and the ratification status of 193 member states, which can be seen as the most concrete instances and important source of global governance system nowadays. The records about these treaties are mainly based on physical collection with a lot of labor from various reliable resources. The domain of subjects in the database has been also widened to cover not only the issues related to the management and control of S&T (e.g. dual-use technology, environmental protection, food and drug safety...) but also the other major global issues for today's world, such as human rights, trade, commerce and communication, intellectual property or labor.

For maximizing the usefulness of the database, multiple frameworks of analysis are adopted. Firstly, we investigated the evolution of the norms and rules of regime over time by measuring the level of support of international community towards different key topics of global science and technology governance. Since international regimes reflect patterns of cooperation and discord among nations, throughout this analysis, we can provide the overall picture of the continuity and development of the global governance throughout the twentieth century towards the twenty-first century.

Secondly, the social network analysis approach is applied to provide the overall structure description of global joint-partnership among states and the changes in the system of regimes throughout different periods of time. However, the social network perspective seems to be unable to produce significantly meaningful results. The main reason is that this approach focuses on relationship among actors (i.e. whether a tie of

mutual membership exists or not between two state-actors) rather than the attributes of particular actor. Consequently, the other attributes, yet important, in the behavior of each state-actor in the network can be misevaluated. It is suggested that rather than only considering whether a state had ratified an international agreement or not, the analysis focusing on the distinguishable attribute of this action, such as the timeliness of ratification act should be considered. This perspective was also achieved in the third stage of the study.

Therefore, the study was followed by capturing the difference in the behavior of states and groups of state towards various key topics of global S&T governance. It can be observed through our analytical results that states don't perceive the importance of the current global matters in the same way or with the same urgency. Different global issue-matters have received different level of support from the international community. Moreover, there is a significant gap among groups of countries in their behavior towards the matters of global governance. The low HDI countries is still being marginalized from many global governance activities, especially for the issues of occupational health and safety, food and drug safety, intellectual property and standards. Consideration should be given to proposals that enhance the representation of developing countries in multilateral institutions and other norm and standard setting bodies to harmonize the global S&T governance across national boundaries.

Finally, the study has contributed to the field of political science by providing empirical testing and support for the idea of cooperation without hegemony. This is the preposition about a new world order where no power or group of powers can sustainably set an international agenda. We have constructed a qualitative metric to measure states' actions in global regimes to evaluate their willingness to take a leadership position in international cooperation for solving shared global issues. Our findings show the current political situation in the world is not led by the G7, G8, or G20. This is a leaderless world. Moreover, our analysis results describe a striking perspective on world politics and provide evidence to argue that our current world is actually without consistent global leadership. By comparing the leadership score for key global players through different stages of world history and in different policy domains, we can identify the divergence in powers that are bound to shape twentieth-first-century world politics.

7.2 Future Perspectives

One of the future perspectives for extending the scope of this study is accessing different areas in the cooperation of global S&T governance, such as health and agriculture. Moreover, in the further research, we will expand our database to cover not only the relations between countries in negotiating international treaties, but also in different aspects of international relations such as diplomatic, military, economic and trade, social and cultural relations. This database is expected to be one of the most impressive databases that fully cover different domains in the international exchanges and relations.

Table 7.1 is the listing of different social-cultural-political aspects in the relations among states. The process of recording these kinds of data will be surely required a lot of sophisticated labor. Once the dataset is created, the graphs will be created. Based on set of countries and their relations' attributes, we will category graphs in two types, which are: weighted directed graph (noted by NW in table 2) and bipartite graph (noted by BG in table 2). For example, the relation of (Country \Leftrightarrow Treaty) will be represented by a bipartite graph which is a kind of special graph that the link occurs only between two groups of nodes (Countries) and (Treaties), not within those groups. In the next step, we will convert the two-mode bipartite graph representing the relation country-convention into the one-mode graph that only shows the relation between country and country. This relation is characterized by the common membership among countries. Moreover, in the case of Export Relation, the relation of (Country \rightarrow Export \rightarrow Country) will be represented in the weighted network whose vertices are the country and links are directed and has its own weight by the value of exports.

Table 7.1: Extended State-State Relation Database

Domain	Data	International Exchange/Relation	Data Type	Data Source
Diplomacy and Military	Treaties	BG: Country \Leftrightarrow Treaty	Ratification Year	Convention Secretariat, and other sources
	International Organizations	BG: Country \Leftrightarrow International Organizations	Accession Year	Agency Secretariat
	Diplomatic Messages	NW: Country \rightarrow Message \rightarrow Country	Degree of Importance	Newspaper Information, and other sources

	VIPs Visits	NW: Country → Dignitaries → Country	Rank	Newspaper Information, and other sources
	Stationed (dispatch) Army	BG: Country ↔ Stationed (dispatch) Army	Start Year, Scale	SIPRI, and other sources
Economy and Trade	Trade	NW: Country → Export → Country	Value of Exports	IBRD, WTO
	Investment	NW: Country → Investment → Country	Investment Amount	IMF
	Energy	NW: Country → Energy → Country	e.g. Petroleum Exports	IEA
	Multinational Companies	BG: Country ↔ Multinationals Companies (Production Base)	Year	Various
	Aviation Transportation	NW: Country → Airways → Country	Frequency	ICAO
Society and Culture	Immigration	NW: Country → Immigration → Country	Scale	Various
	Foreign Students	NW: Country → Students → Country	Scale	IIE
	Language	BG: Country ↔ Language	Language by Number of Speakers	Ethnologue, and other sources
	Religion	BG: Country ↔ Religion	Number of Believers	Various
	International News Agencies	BG: Country ↔ International News Agencies	Link Density	Web Survey

We will apply various concepts created in the graph theory and network theory and develop algorithms and mathematical model for analysing the structure of this dataset, and based on that to represent the current situations of real world, with the expectation of getting fruitful insight of international relations. The results about the relationship among states and the overall structures of the world system will be used for the empirical testing of important subjects in international relations and different pressing issues in world politics today.

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APPENDIX 1. LIST OF MULTILATERAL CONVENTIONS COVERED BY THE STUDY

Acronym	Convention Name	Year of the first ratification
AG	Australia Group	1984
Air Pollution	Convention on Long-range Transboundary Air Pollution	1980
Aircraft	Convention on Offences and Certain Other Acts Committed On Board Aircraft	1964
Airport Protocol	Protocol for the Suppression of Unlawful Acts of Violence at Airports Serving International Civil Aviation	1988
Apartheid in Sports	International Convention against Apartheid in Sports	1986
APM	Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction (Mine Ban Treaty)	1997
Bangkok	Bangkok Treaty	1996
Basel	Basel Convention on the control of Transboundary Movements of Hazardous Wastes and Their Disposal	1989
Berne	Berne Convention for the Protection of Literary and Artistic Works	1887
BWC	Biological Weapons Convention	1972
C100	Equal Remuneration Convention	1952
C105	Abolition of Forced Labor Convention	1957
C111	Discrimination Convention	1959
C115	Radiation Protection Convention	1961
C119	Guarding of Machinery Convention	1964
C120	Hygiene (Commerce and Offices) Convention	1965
C127	Maximum Weight Convention	1969
C13	White Lead (Painting) Convention	1922
C136	Benzene Convention	1972
C138	Minimum Age Convention	1975
C139	Occupational Cancer Convention	1975
C148	Working Environment (Air Pollution, Noise and Vibration) Convention	1978
C155	Occupational Safety and Health Convention	1982
C161	Occupational Health Services Convention	1986
C162	Asbestos Convention	1987
C167	Safety and Health in Construction Convention	1989
C170	Chemicals Convention	1992

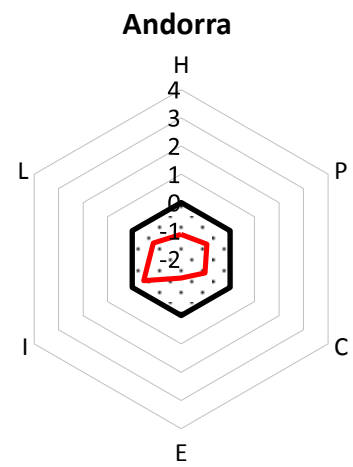
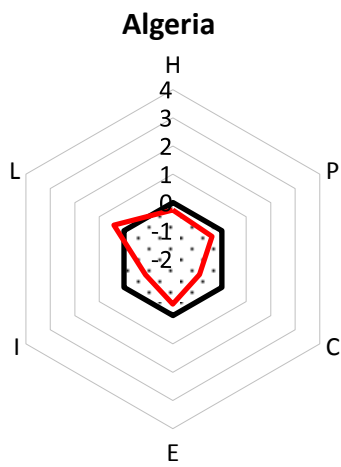
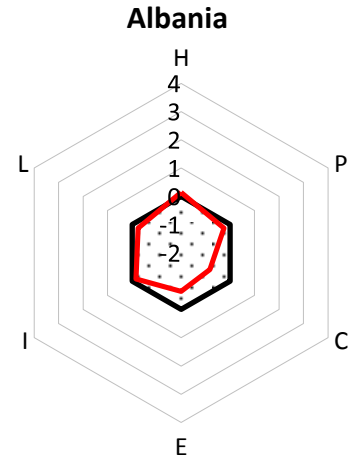
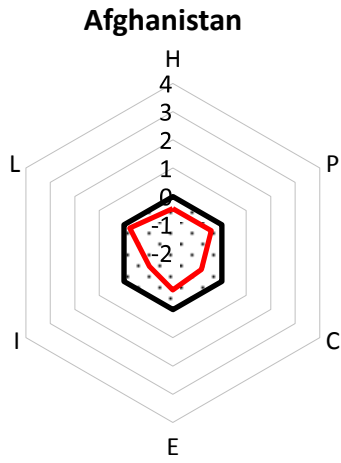
C174	Prevention of Major Industrial Accidents Convention	1994
C176	Safety and Health in Mines Convention	1997
C182	Worst Forms of Child Labor Convention	1999
C184	Safety and Health in Agriculture Convention	2002
C187	Promotional Framework for Occupational Safety and Health Convention	2007
C29	Forced Labor Convention	1931
C45	Underground Work (Women) Convention	1936
C62	Safety Provisions (Building) Convention	1940
C87	Freedom of Association and Protection of the Right to Organize Convention	1949
C98	Rights to Organize and Collective Bargaining Convention	1950
CACNARE	Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	1986
CANWFZ	Treaty on a Nuclear Weapon Free Zone in Central Asia	2007
CAT	Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment	1986
CBD	Convention for Bio-Diversity	1992
CCW	Convention on Prohibition or Restrictions on the Use of Certain Conventional Weapons which may be Deemed to be Excessively Injurious or to Have Indiscriminate Effects	1982
CEDAW	Convention on the Elimination of All Forms of Discrimination against Women	1980
CEENA	Convention on Early Notification of a Nuclear Accident	1986
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora	1974
Civil Aviation	Convention for the Suppression of Unlawful Acts against the Safety of Civil Aviation	1972
CMS	Convention on the Conservation of Migratory Species of Wild Animals	1983
CNS	Convention on Nuclear Safety	1994
CODEX	Codex Alimentarius Commission	1963
CRC	Convention on the Rights of the Child	1990
CRPD	Convention on the Rights of Persons with Disabilities	2007
CTBT	Comprehensive Nuclear-Test-Ban Treaty	1996
CWC	Chemical Weapons Convention	1993
Cybercrime	Convention on Cybercrime	2002
Diplomatic Agents	Convention on the Prevention and Punishment of Crimes against Internationally Protected Persons, including Diplomatic Agents	1974
Disappearance	International Convention for the Protection of all Persons from Enforced Disappearance	2007
FAO	Food and Agriculture of the United Nations	1945
Fixed Platform	Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on	1989

	the Continental Shelf	
GATT	General Agreement on Tariffs and Trade	1948
Geneva	Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare	1926
Genocide	Convention on the Prevention and Punishment of the Crime of Genocide	1949
Hague	Hague Agreement Concerning the International Deposit of Industrial Designs	1928
Hague 1899	Hague Convention on the Laws and Custom of War on Land in 1899	1900
Hague 1907	Hague Convention on the Laws and Custom of War on Land in 1907	1909
Hostages	International Convention against the Taking of Hostages	1980
IAEA	International Atomic Energy Agency Safe Guard Agreement	1962
ICAO	Convention on International Civil Aviation	1945
ICCPR	International Covenant on Civil and Political Rights	1968
ICCPR Protocol 1	Optional Protocol to the International Covenant on Civil and Political Rights	1968
ICCPR Protocol 2	Second Optional Protocol to the International Covenant on Civil and Political Rights, aiming at the Abolition of the Death and Penalty	1990
ICERD	International Convention on the Elimination of All Forms of Racial Discrimination	1966
ICESCR	International Covenant on Economic, Social and Cultural Rights	1968
ICRW	International Convention For The Regulation Of Whaling	1948
ICSPCA	International Convention on the Suppression and Punishment of the Crime of Apartheid	1974
IEC	International Electrotechnical Commission	1906
IMF	International Monetary Fund	1945
IMO	International Maritime Organization	1948
IPPC	International Plant Protection Convention	1951
ISO	International Standardization Organization	1947
ITU	International Telecommunication Union	1866
JCS	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management	1998
Kyoto	Kyoto Protocol to the United Nations Framework Convention on Climate Change	1998
LC72	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	1975
LOS	United Nations Convention on the Law of the Sea	1982
Madrid	Madrid Agreement Concerning the International Registration of Marks	1892
Maritime	Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation	1989

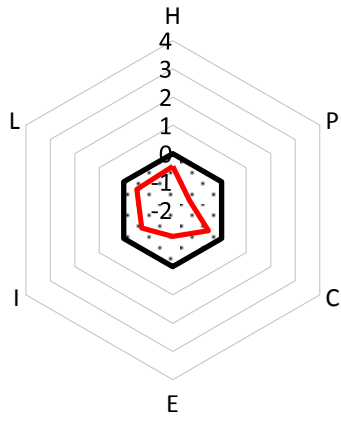
Metre	Convention de Metre	1875
Montreal	The Montreal Protocol on Substances that Deplete the Ozone Layer	1988
MTCR	Missile Technology Control Regime	1987
MWC	International Convention on the Protection of the Rights of All Migrant Workers and Members of their Families	1993
NPT	Non-Proliferation of Nuclear Weapons	1968
Nuclear Materials	Convention on the Physical Protection of Nuclear Material	1980
Nuclear Terrorism	International Convention for the Suppression of Acts of Nuclear Terrorism	2006
Paris	Paris Convention for the Protection of Industrial Property	1884
PCT	Patent Cooperation Treaty	1978
Pelindaba	Pelindaba Treaty	1996
Phonograms	Convention for the Protection of Producers of Phonograms Against Unauthorized Duplication of Their Phonograms	1973
PIC	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides	1998
Plastic Explosives	Convention on the Marking of Plastic Explosives for the Purpose of Detection	1992
POPs	Stockholm Convention on Persistent Organic Pollutants	2001
PTBT	Partial Test Ban Treaty	1963
Ramsar	Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat	1975
Rarotonga	Treaty of Rarotonga	1985
Rome	Rome Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations	1964
Slavery	Geneva Slavery Convention	1927
TBT	Technical Barriers to Trade	1995
Terrorist Bombing	International Convention for the Suppression of Terrorist Bombings	1998
Terrorist Financing	International Convention for the Suppression of the Financing of Terrorism	2000
Tlatelolco	Treaty of Tlatelolco	1967
TLT	Trademark Law Treaty	1996
TRIPS	Trade Related Aspects of Intellectual Property Systems	1995
UCC	Universal Copyright Convention	1955
UNFCCC	United Nations Framework Convention on Climate Change	1992
Unlawful Seizure	Convention for the Suppression of Unlawful Seizure of Aircraft	1971
UPOV	International Convention for the Protection of New Varieties of Plants	1968
UPU	Universal Postal Union	1875

Vienna	The Vienna Convention for the Protection of the Ozone Layer	1986
WA	The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual- Use Goods and Technologies	1996
War Crimes	Convention on the Non-Applicability of Statutory Limitations to War Crimes and Crimes Against Humanity	1969
WB	World Bank (International Bank for Reconstruction and Development)	1945
WCT	WIPO Copyright Treaty	2002
WH	Convention concerning the Protection of the World Cultural and Natural Heritage	1973
WHO	World Health Organization	1946
WIPO	World Intellectual Property Organization	1970
WPPT	WIPO Performances and Phonograms Treaty	2002
WTO	World Trade Organization	1995

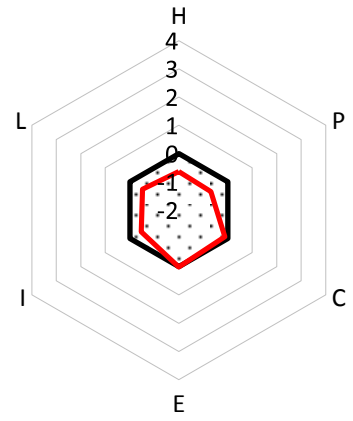
APPENDIX 2. HEXAGONAL PROFILES OF 193 MEMBER STATES OF UNITED NATIONS



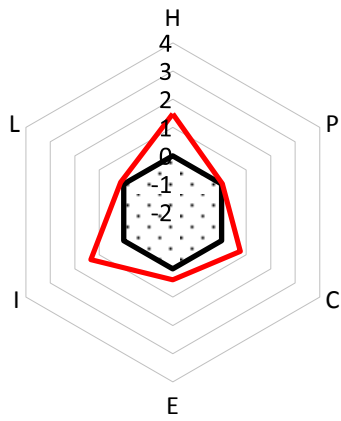
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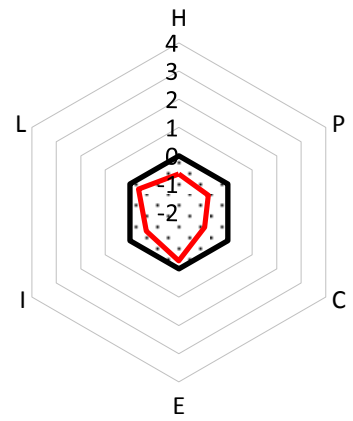
Antigua and Barbuda



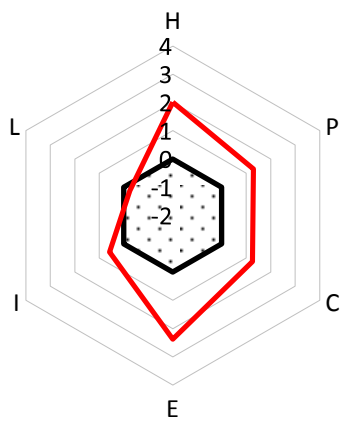
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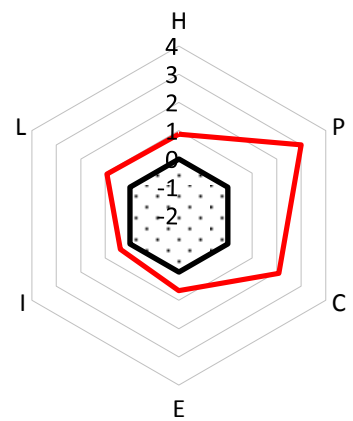
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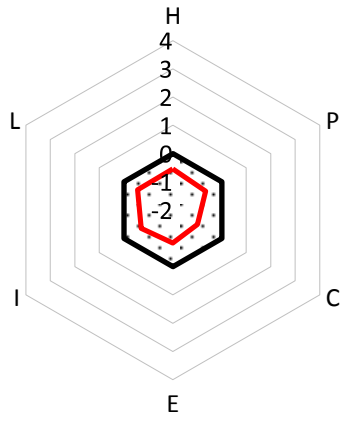
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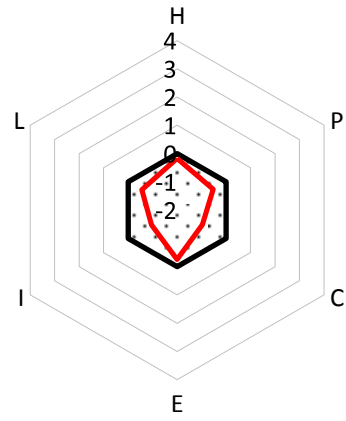
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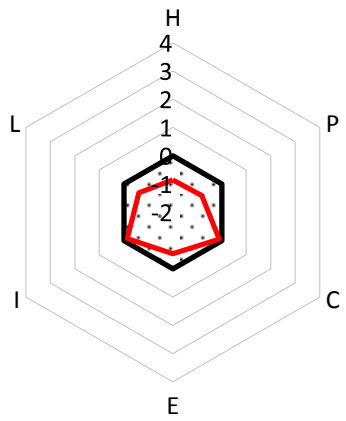
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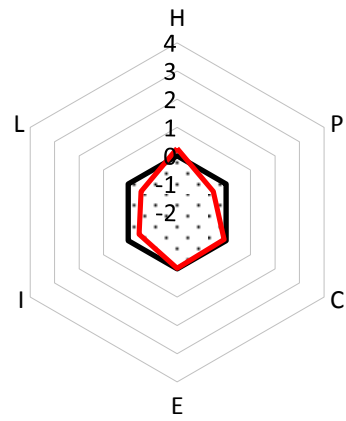
Bahamas



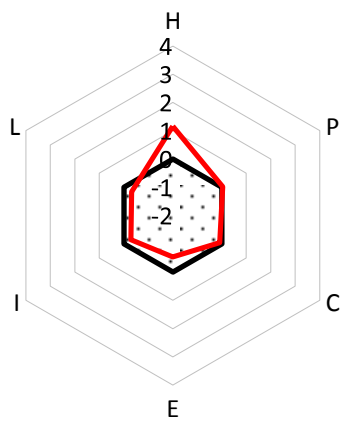
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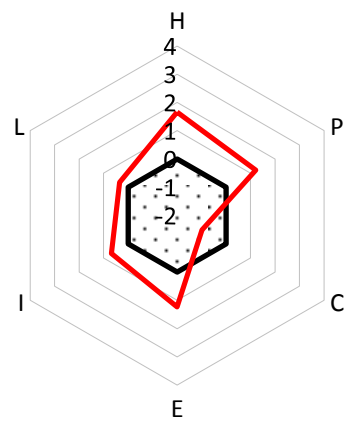
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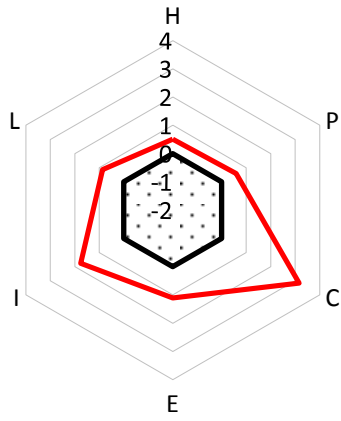
Barbados



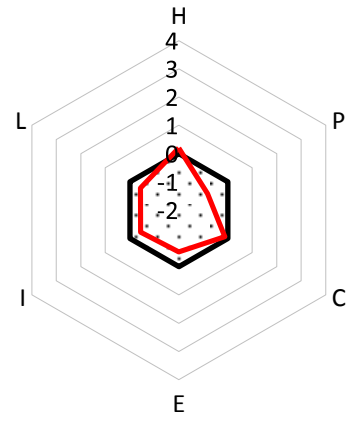
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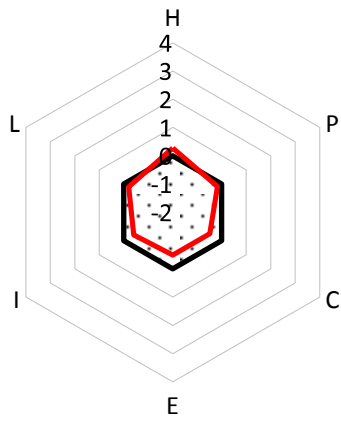
Belgium



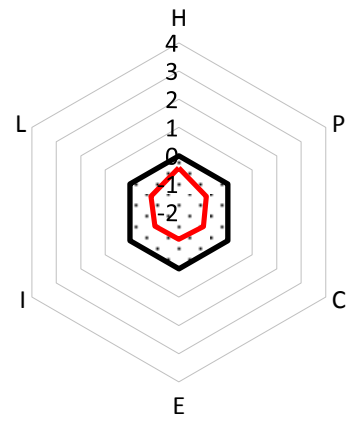
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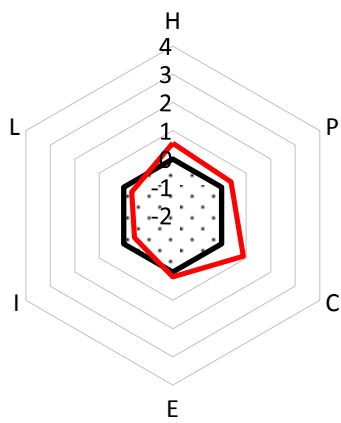
Benin



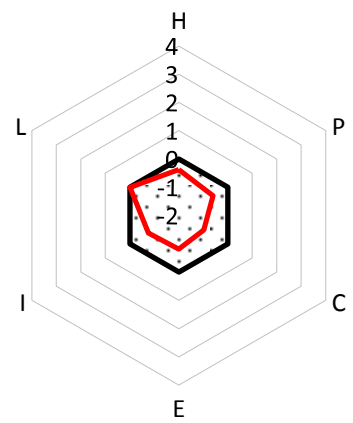
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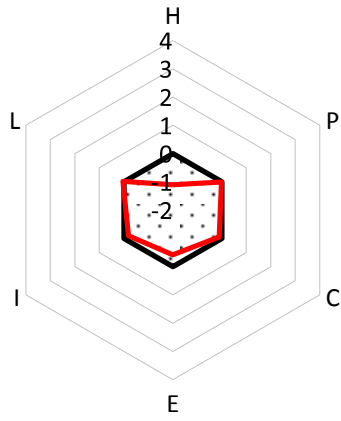
Bolivia



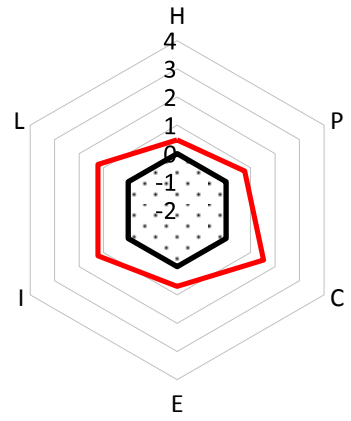
Bosnia and Herzegovina



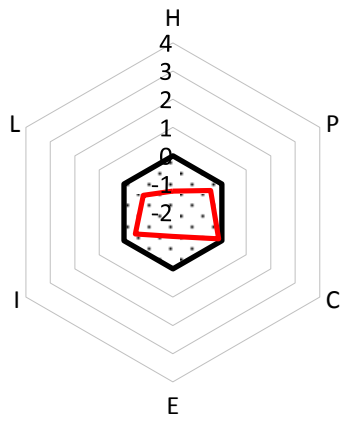
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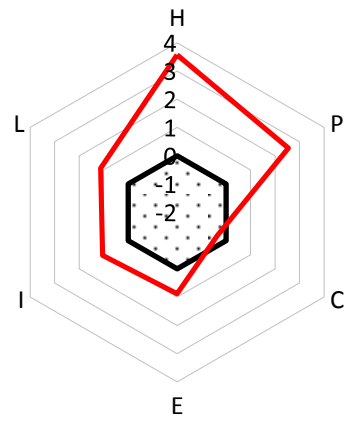
Brazil



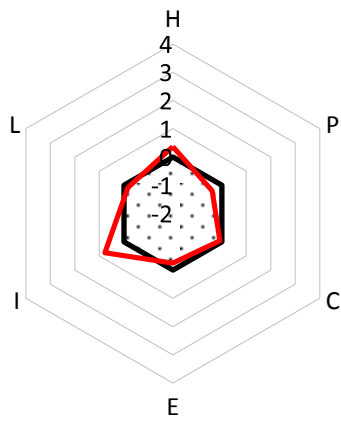
Brunei Darussalam



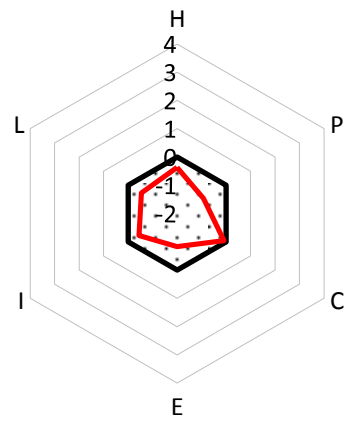
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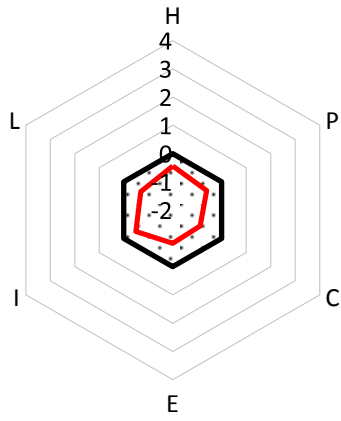
Burkina Faso



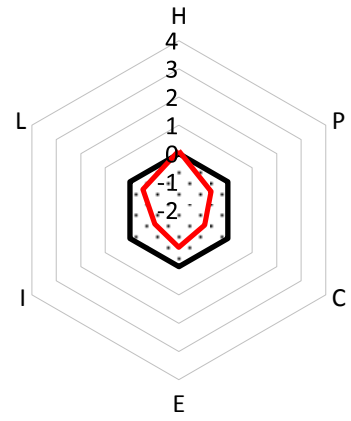
Burundi



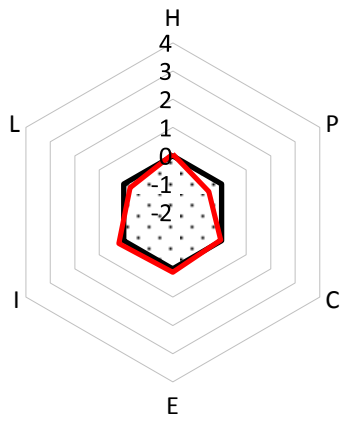
Cambodia



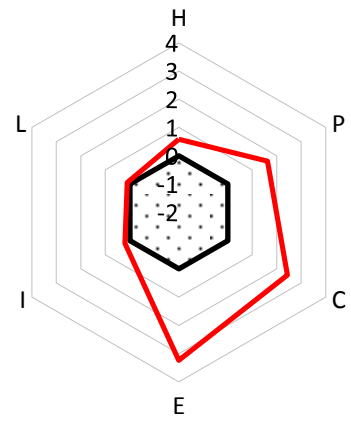
Cabo Verde



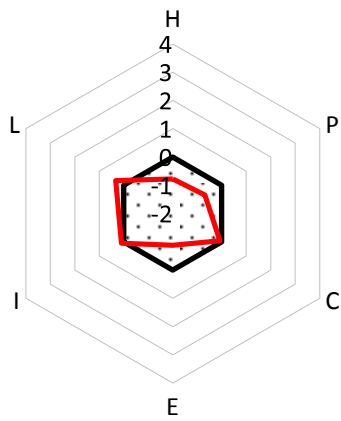
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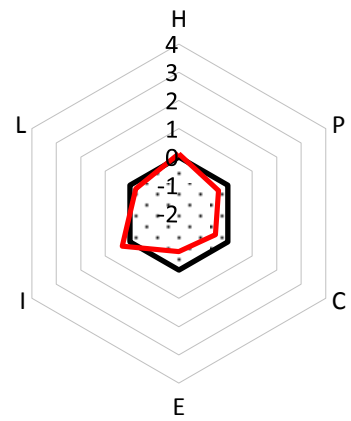
Canada

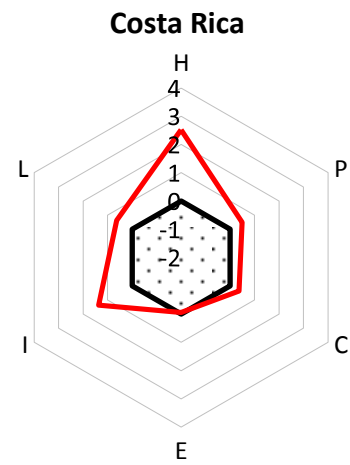
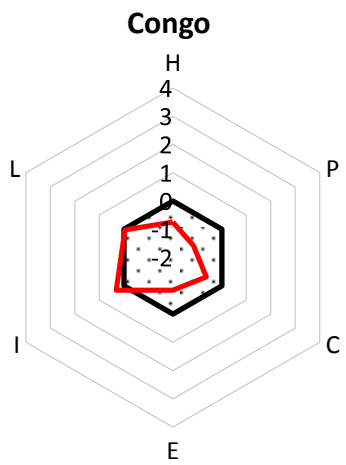
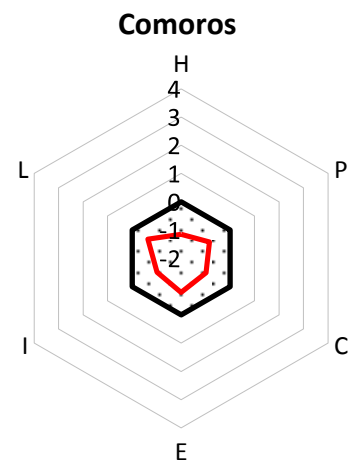
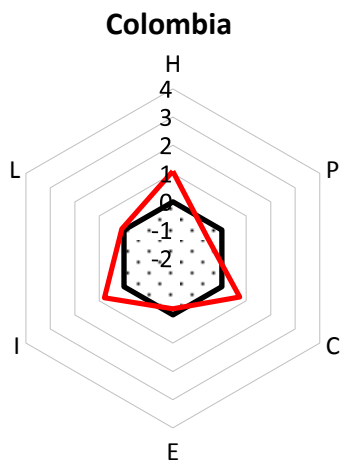
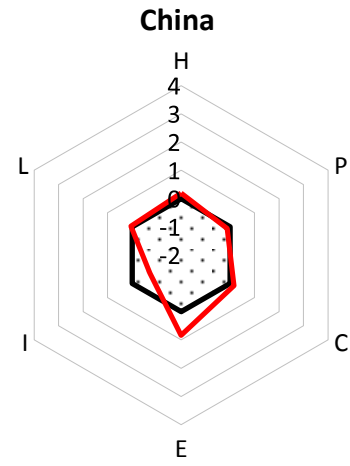
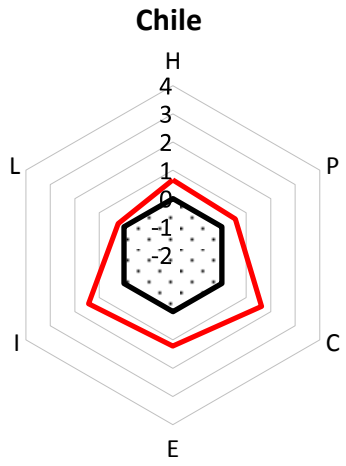


Central African Republic

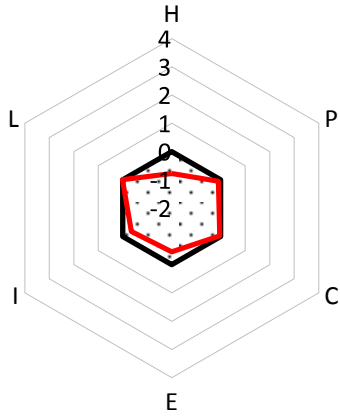


Chad

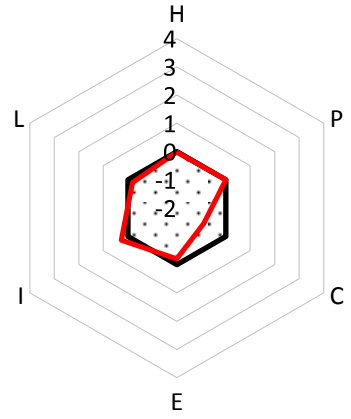




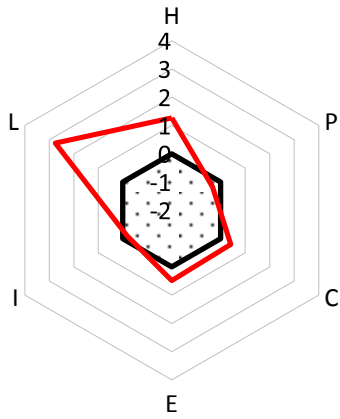
Cote d'Ivoire



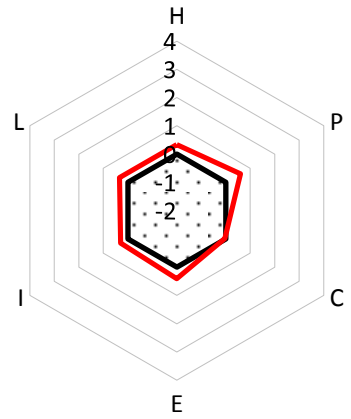
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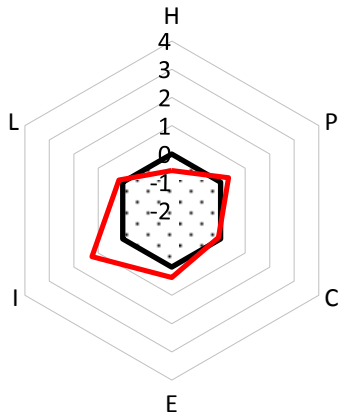
Cuba



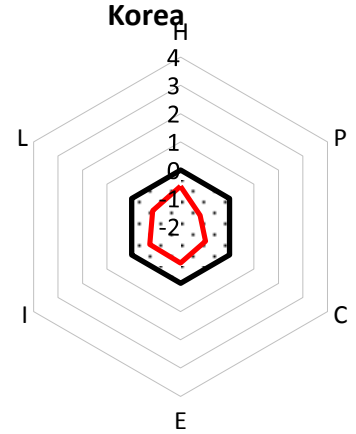
Cyprus



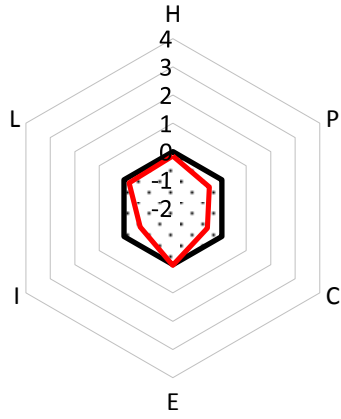
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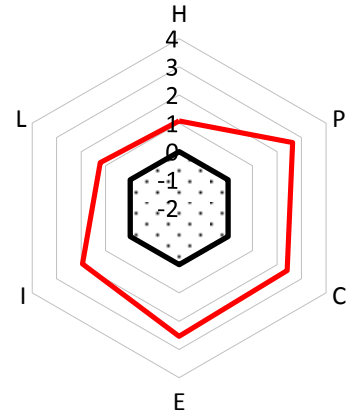
Democratic People's Republic of Korea



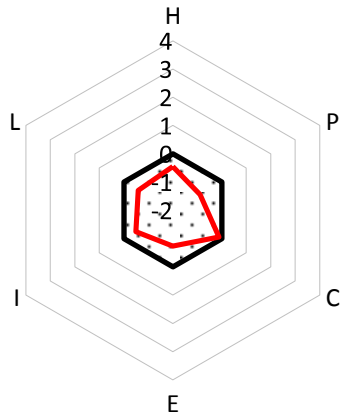
Democratic Republic of the Congo



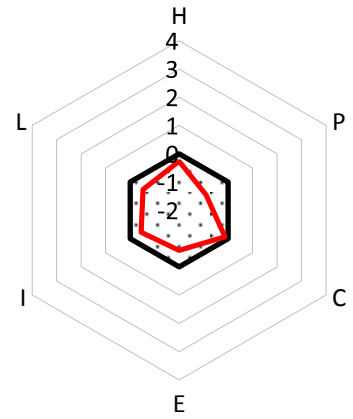
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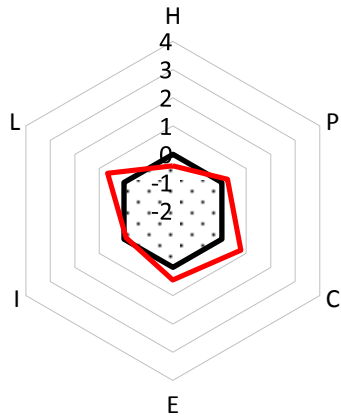
Djibouti



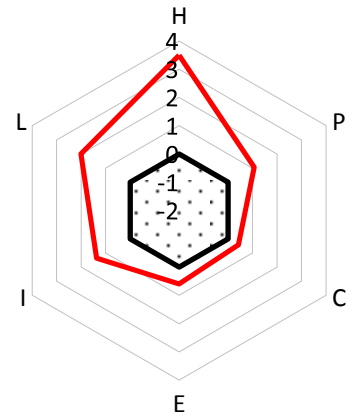
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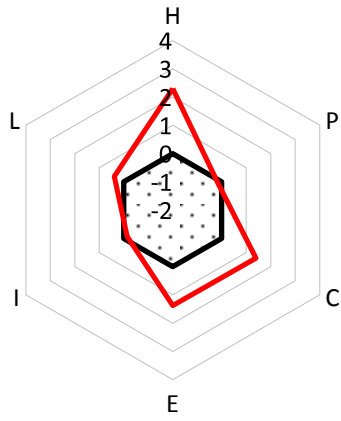
Dominican Republic



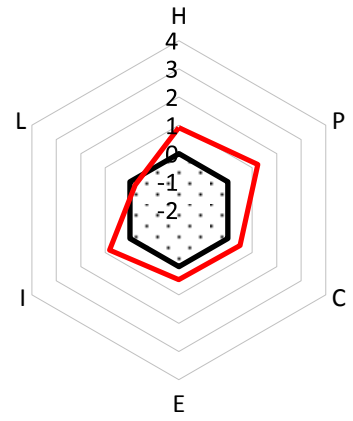
Ecuador



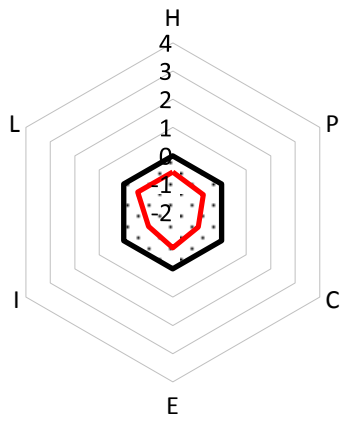
Egypt



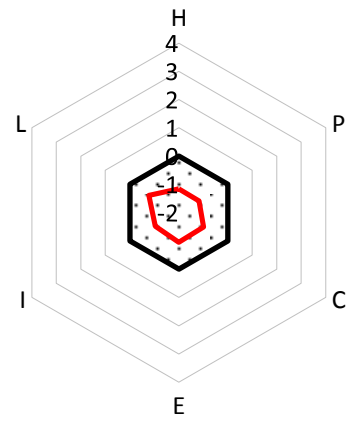
El Salvador



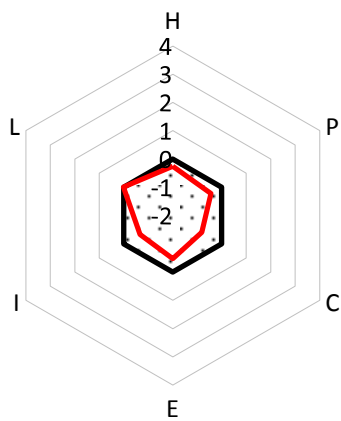
Equatorial Guinea



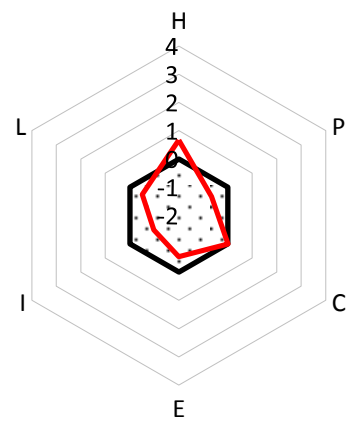
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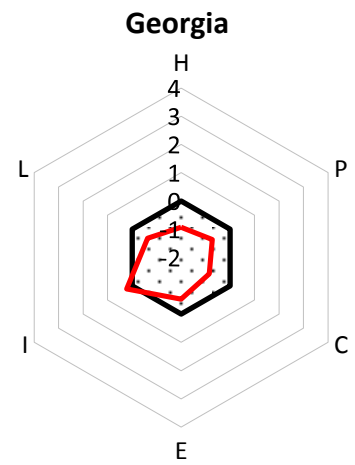
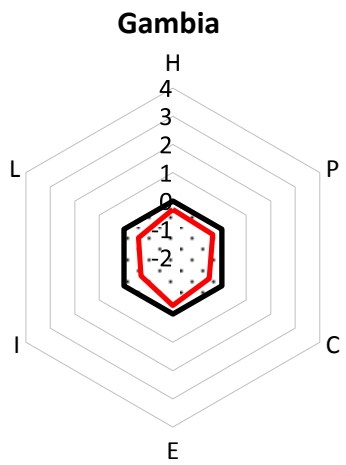
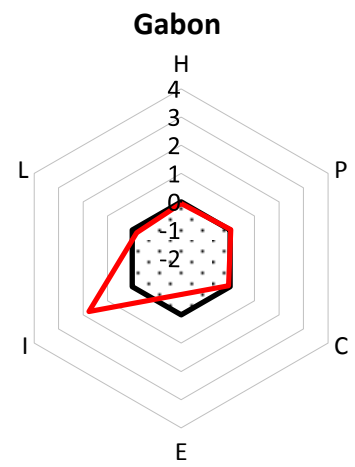
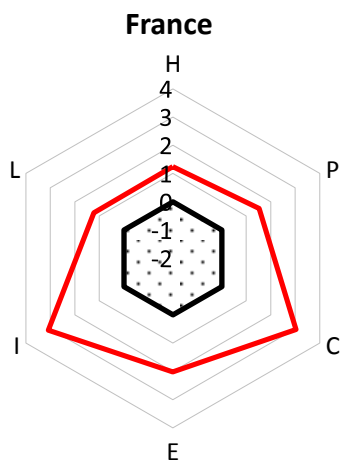
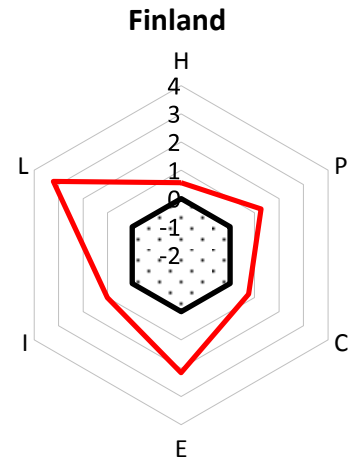
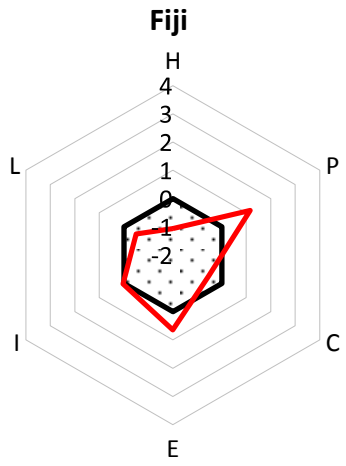


Estonia

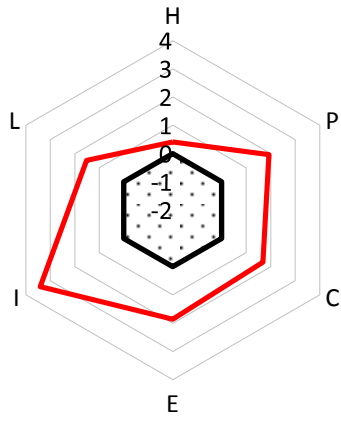


Ethiopia

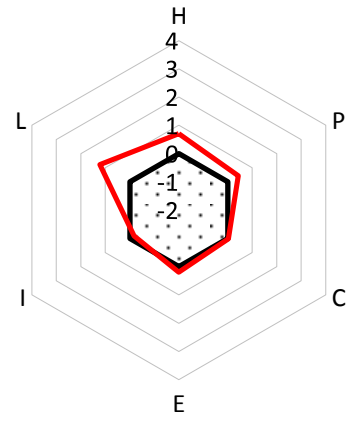




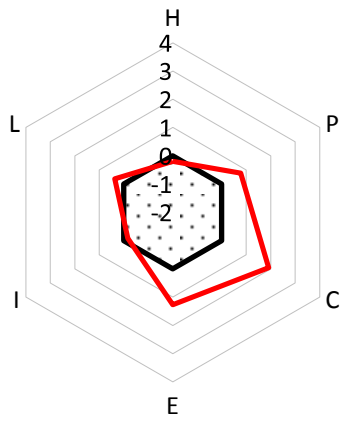
Germany



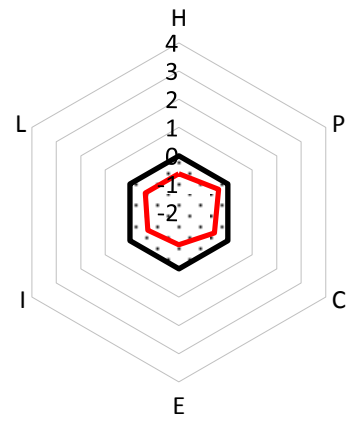
Ghana



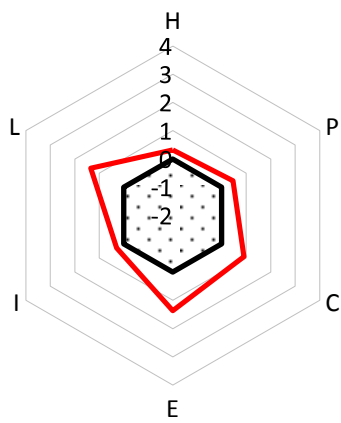
Greece



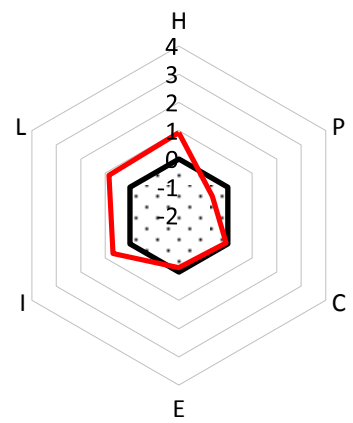
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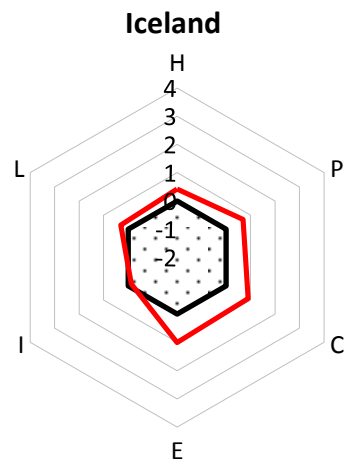
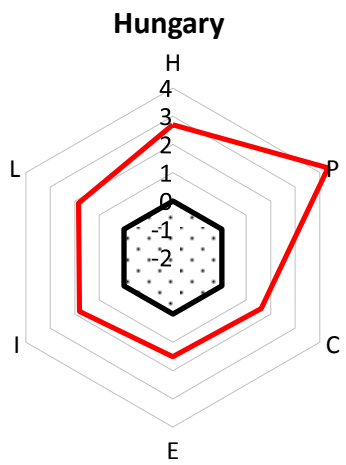
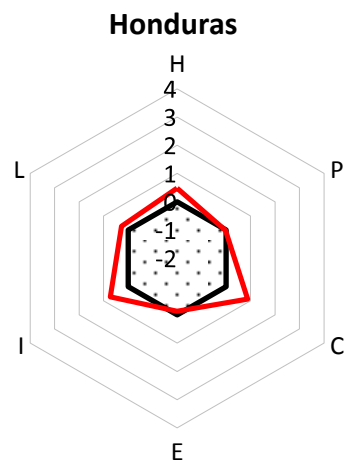
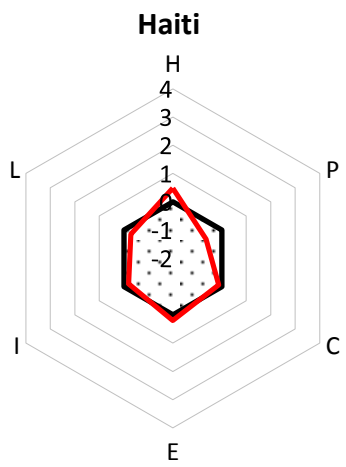
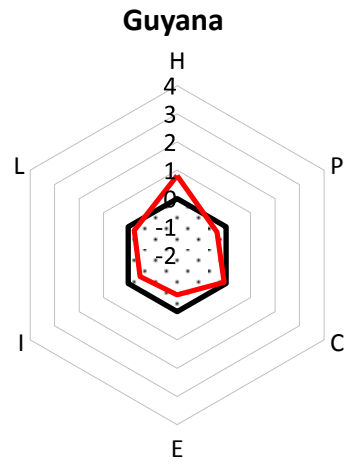
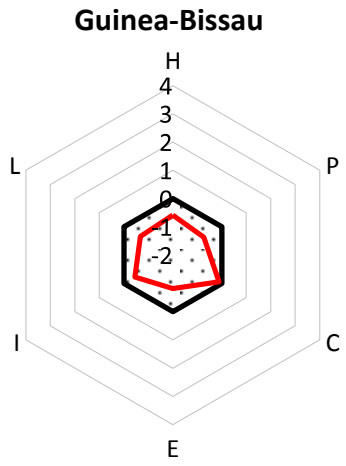


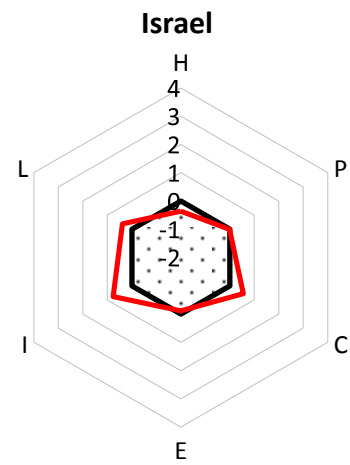
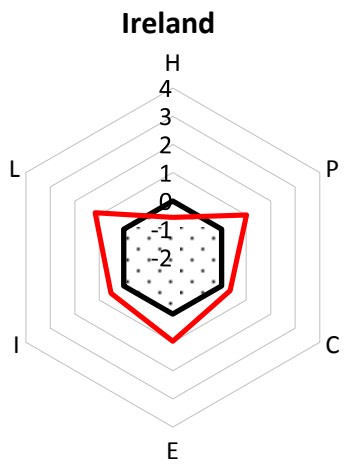
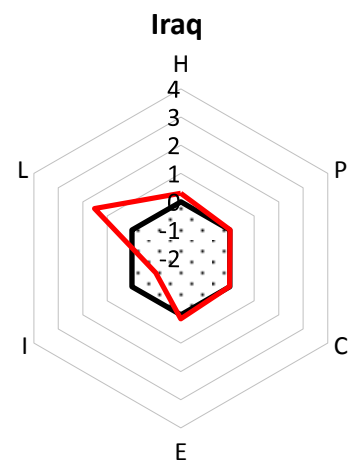
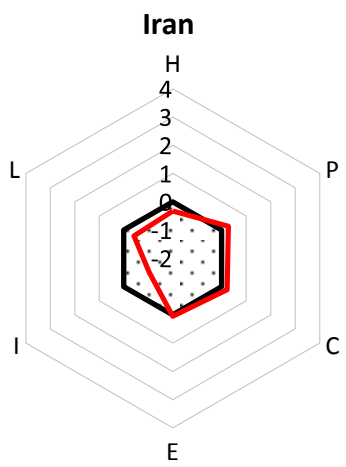
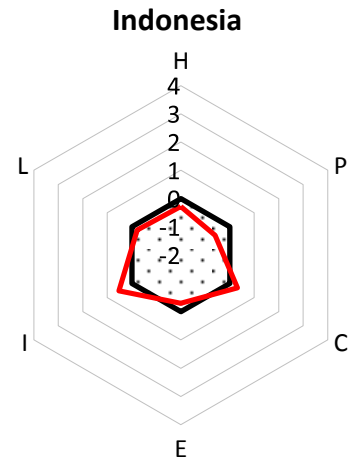
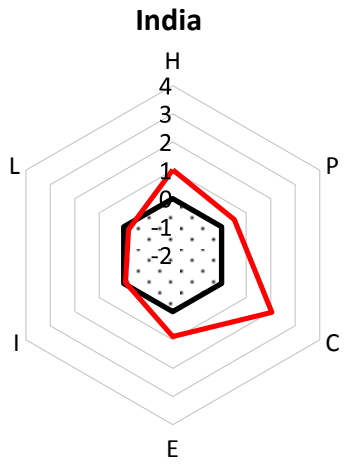
Guatemala

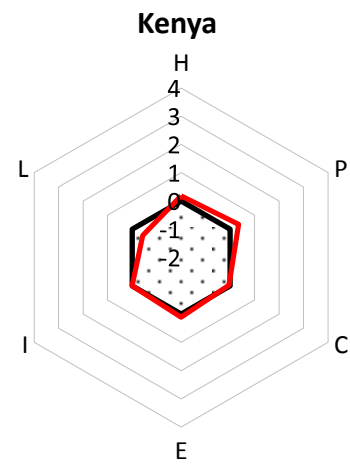
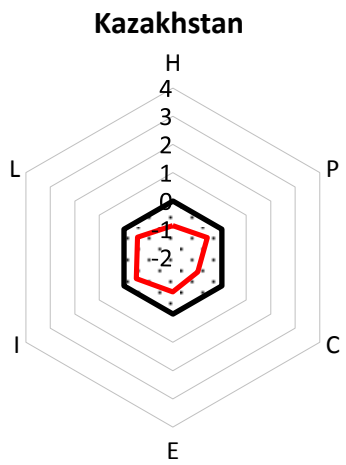
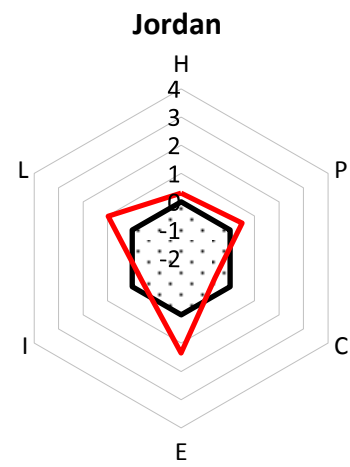
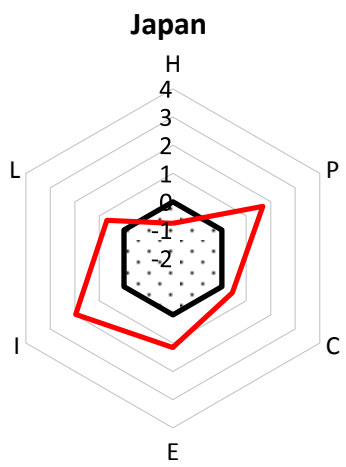
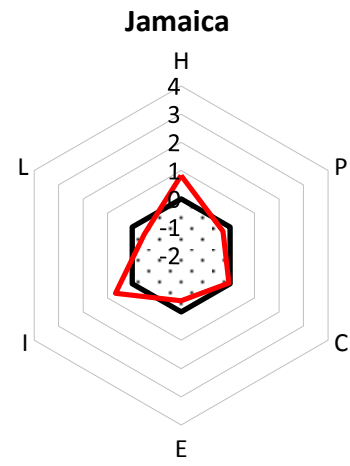
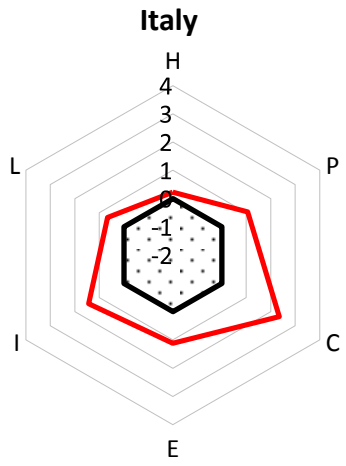


Guinea

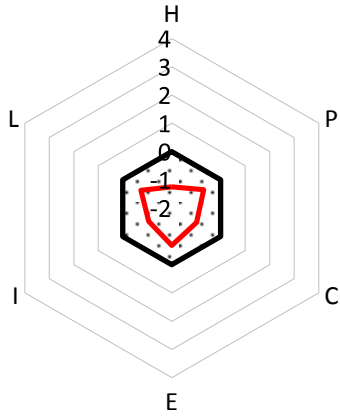




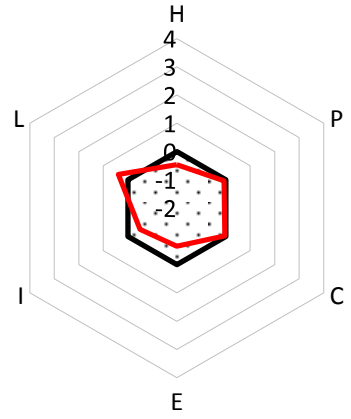




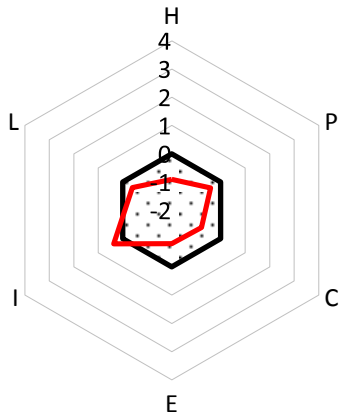
Kiribati



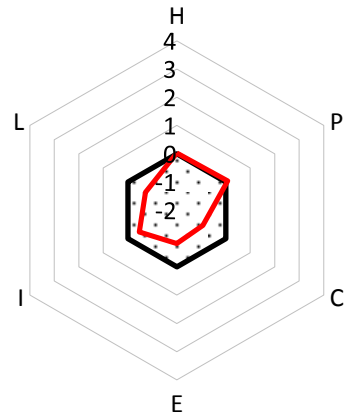
Kuwait



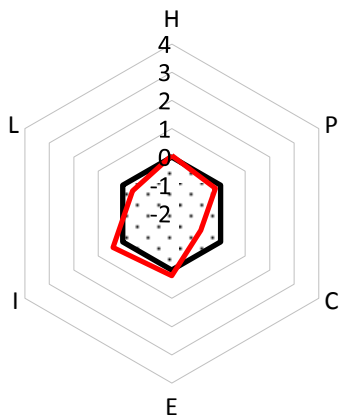
Kyrgyzstan



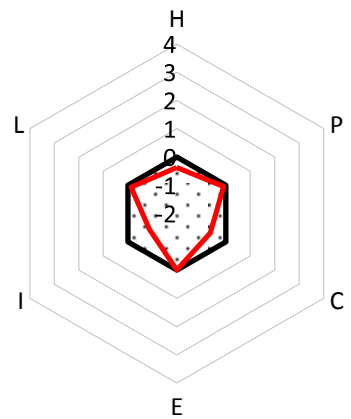
Lao People's Democratic Republic



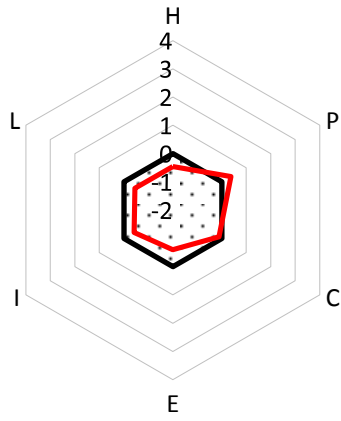
Latvia



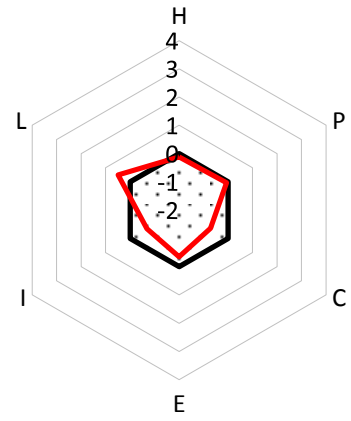
Lebanon



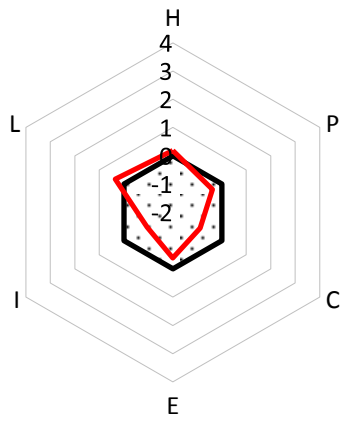
Lesotho



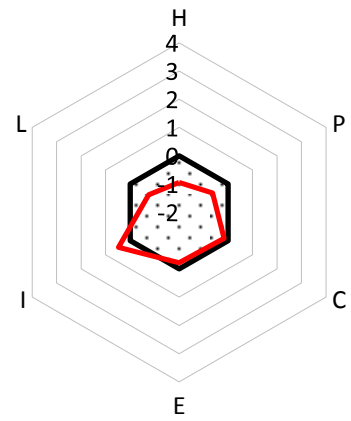
Liberia



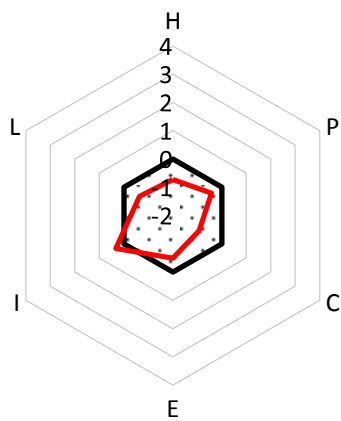
Libya



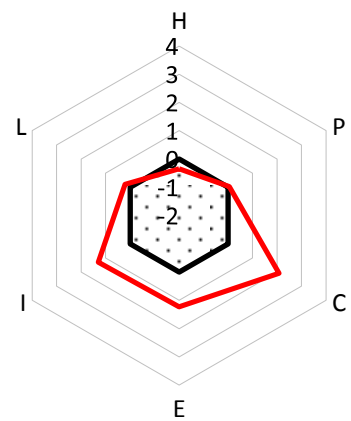
Liechtenstein



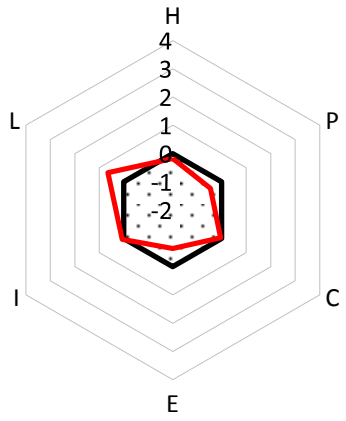
Lithuania



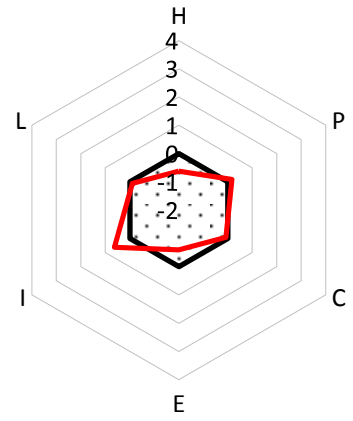
Luxembourg



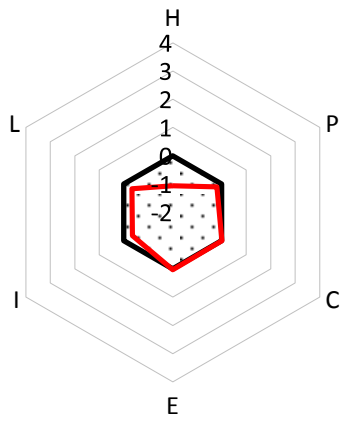
Madagascar



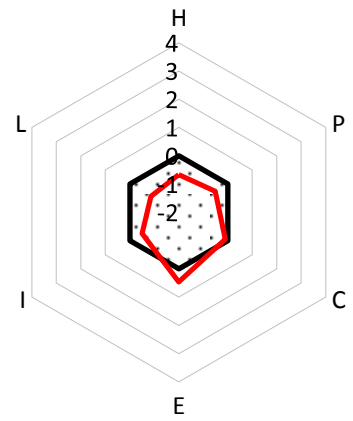
Malawi



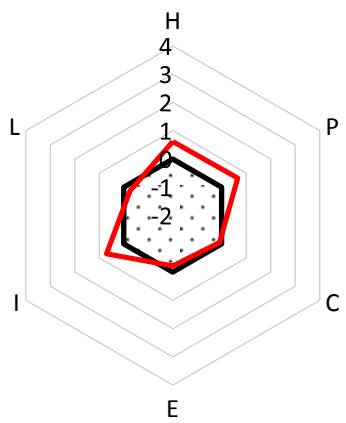
Malaysia



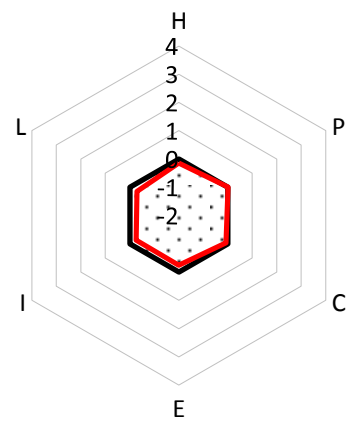
Maldives



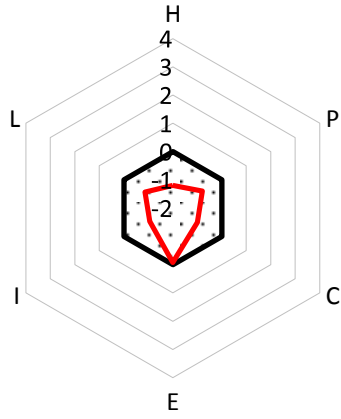
Mali



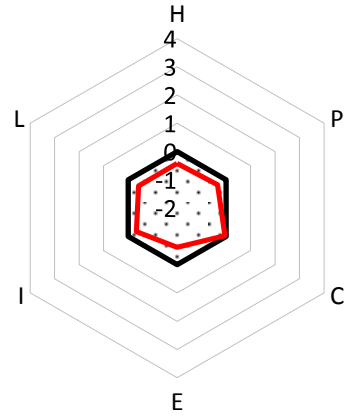
Malta



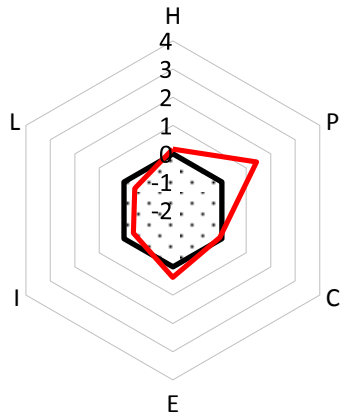
Marshall Islands



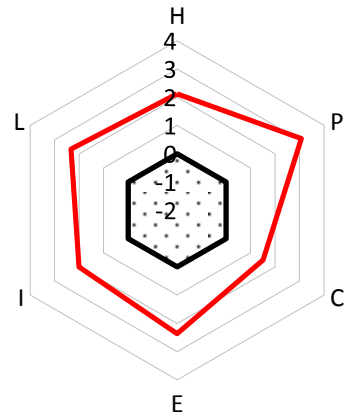
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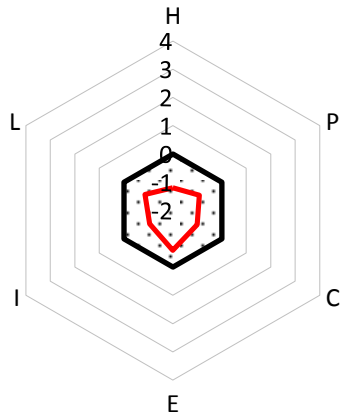
Mauritius



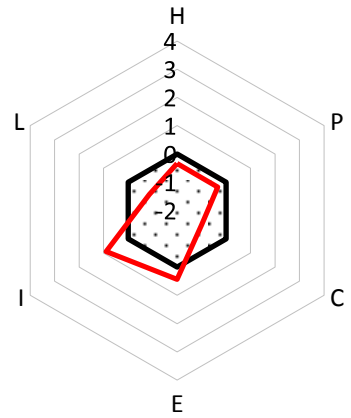
Mexico



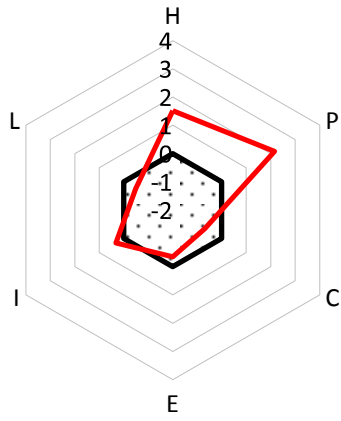
Micronesia



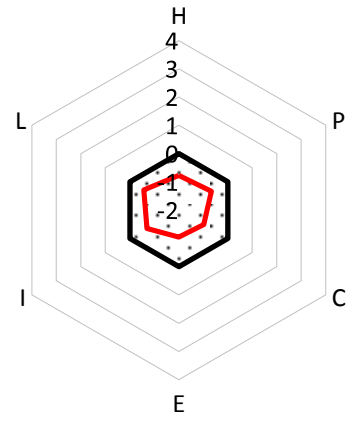
Monaco



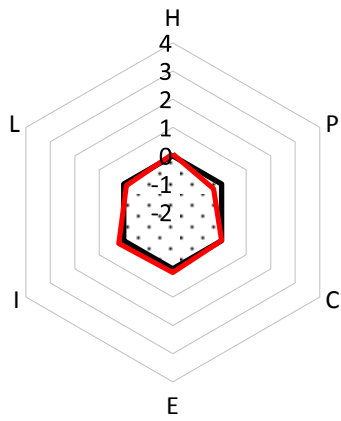
Mongolia



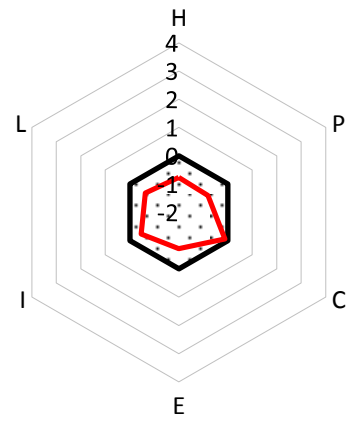
Montenegro



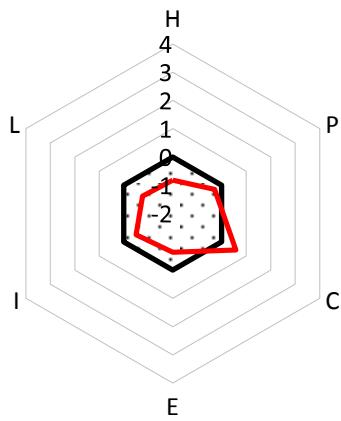
Morocco



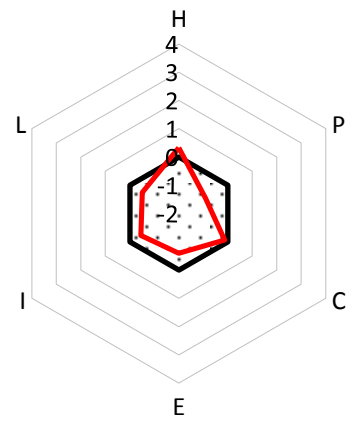
Mozambique



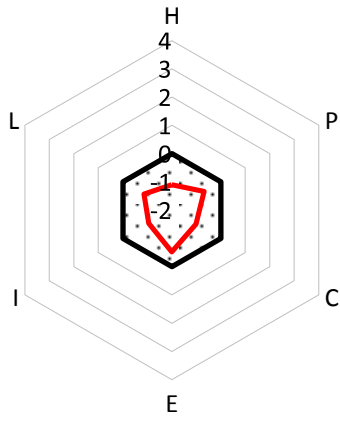
Myanmar



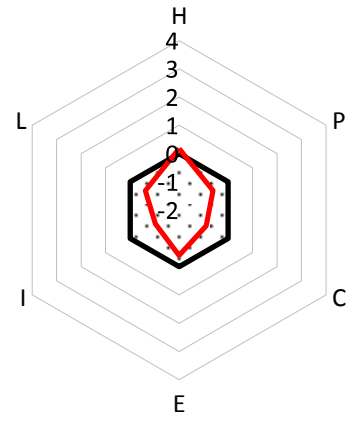
Namibia



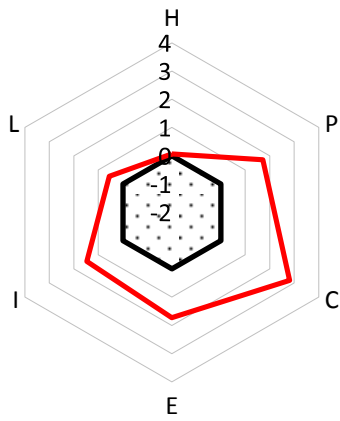
Nauru



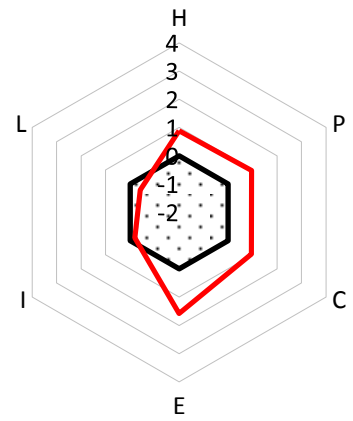
Nepal



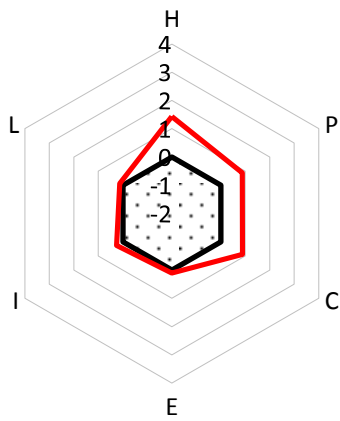
Netherlands



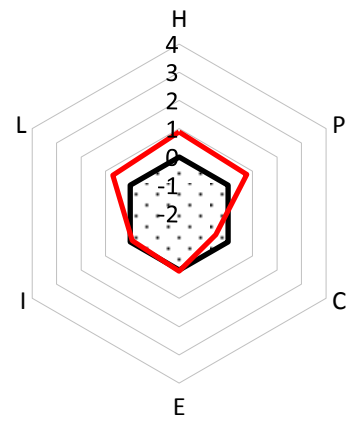
New Zealand



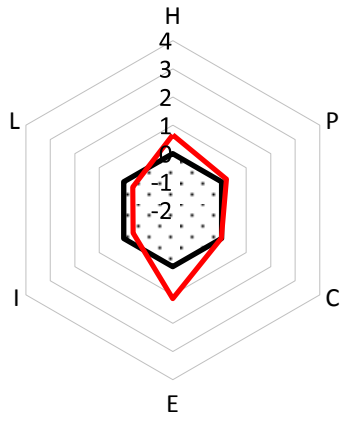
Nicaragua



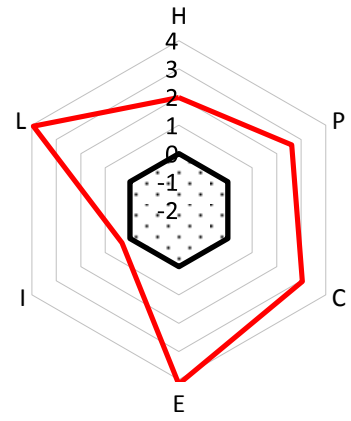
Niger



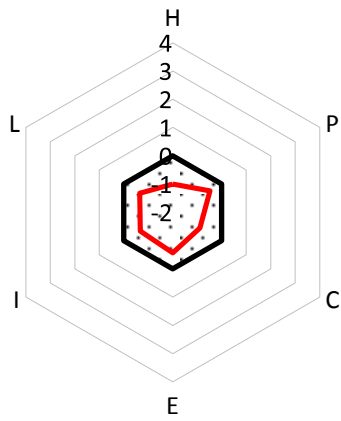
Nigeria



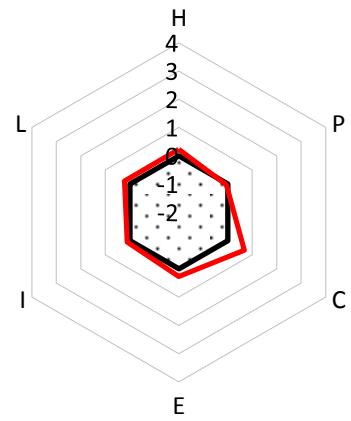
Norway



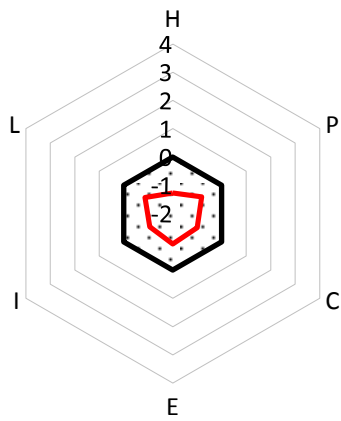
Oman



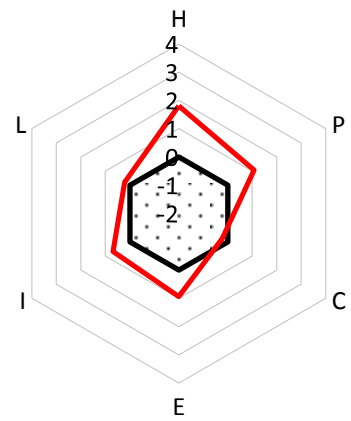
Pakistan



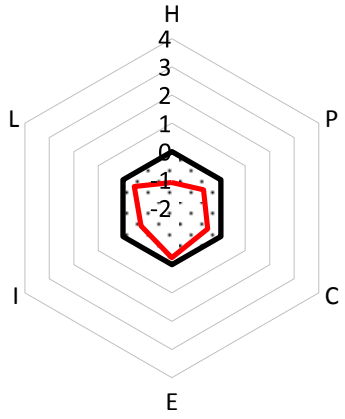
Palau



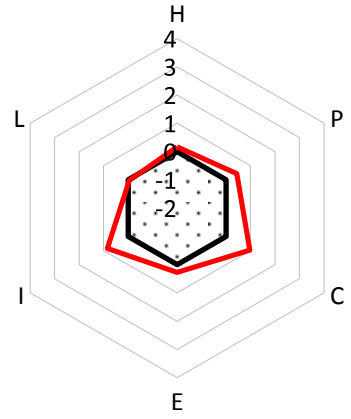
Panama



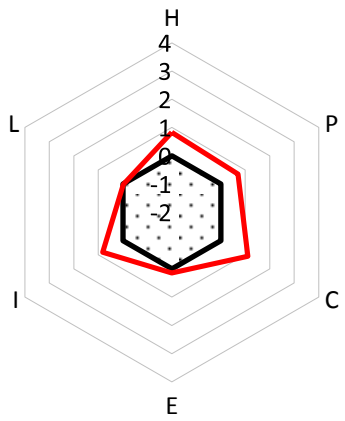
Papua New Guinea



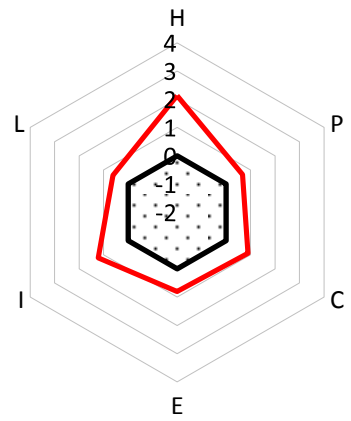
Paraguay



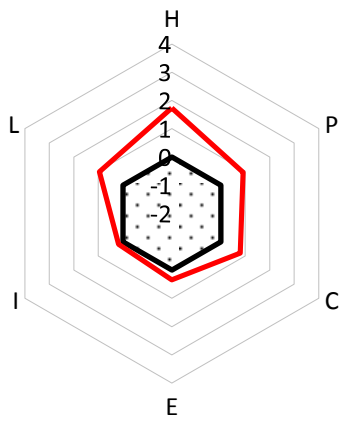
Peru



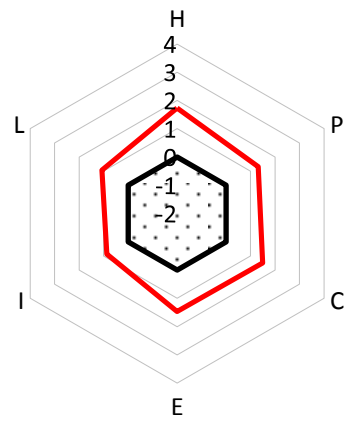
Philippines



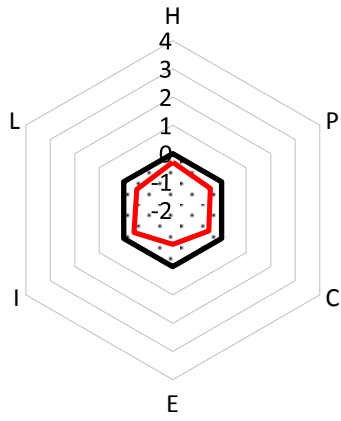
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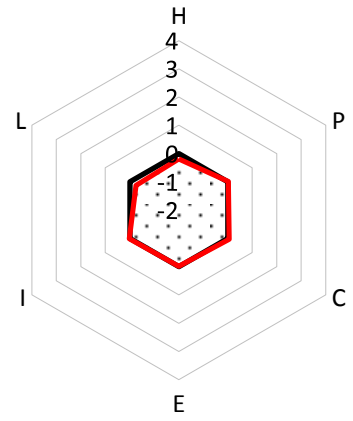
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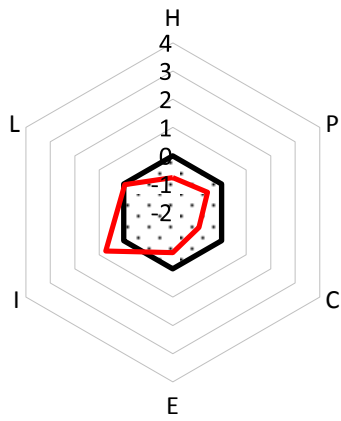
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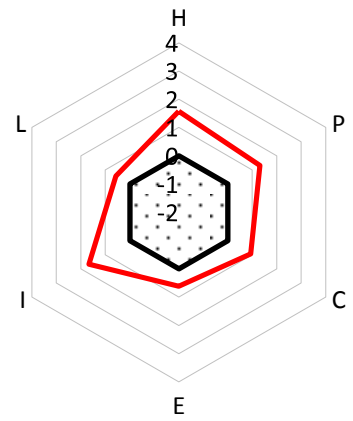
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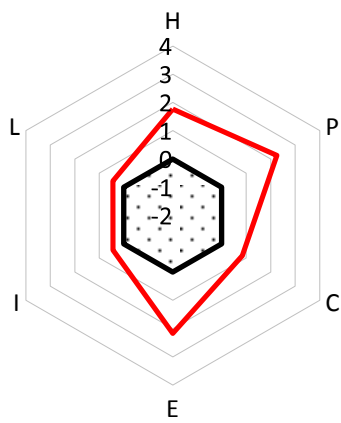
Republic of Moldova



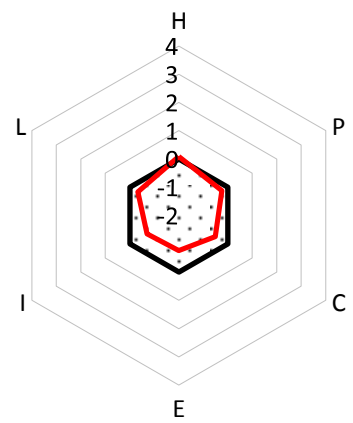
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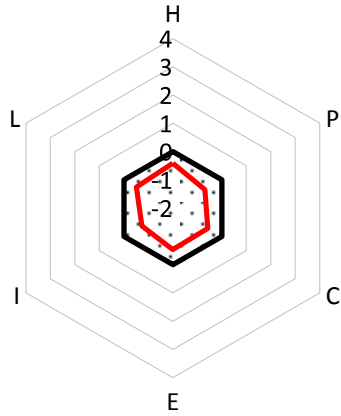
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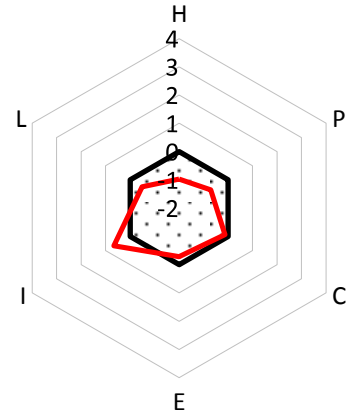
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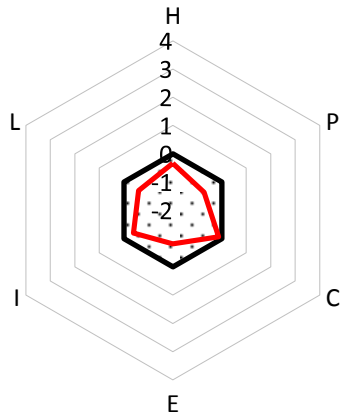
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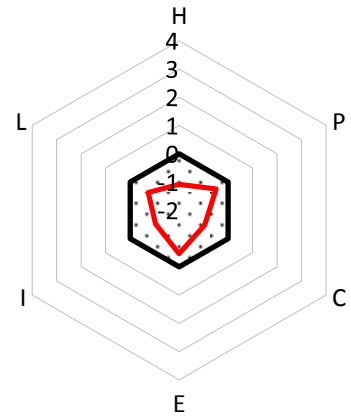
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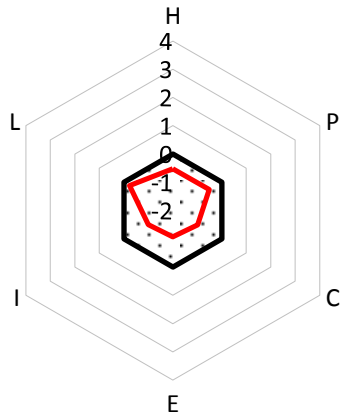
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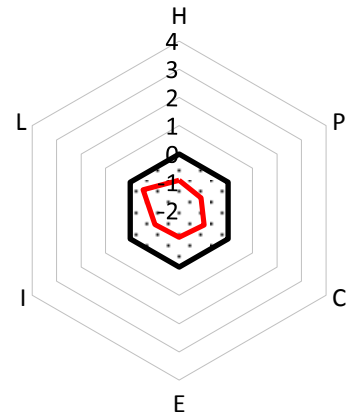
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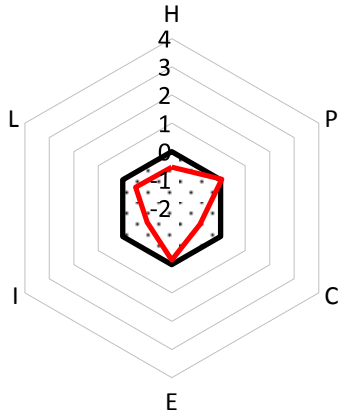
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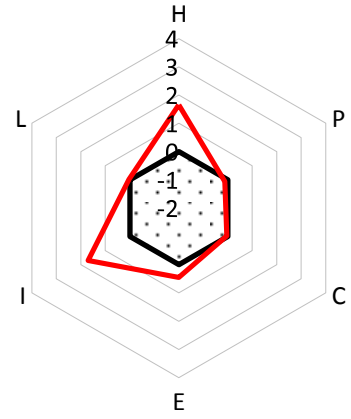
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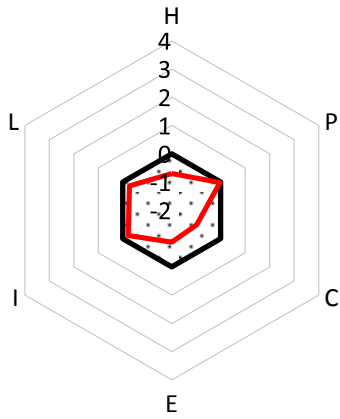
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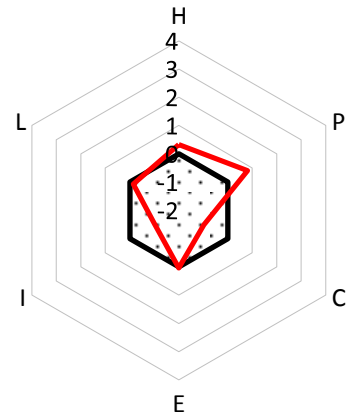
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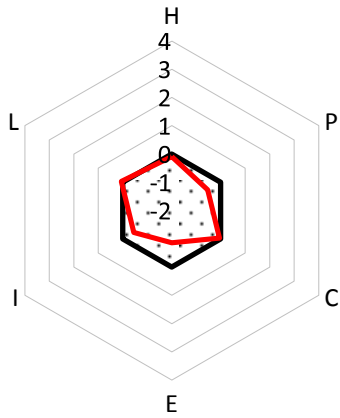
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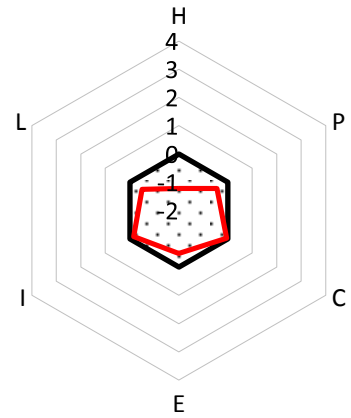
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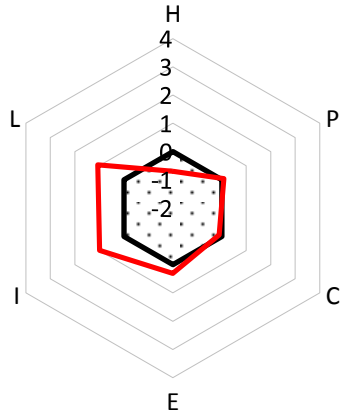
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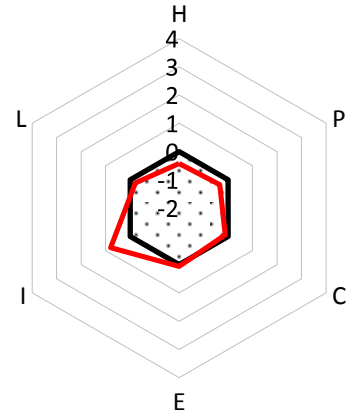
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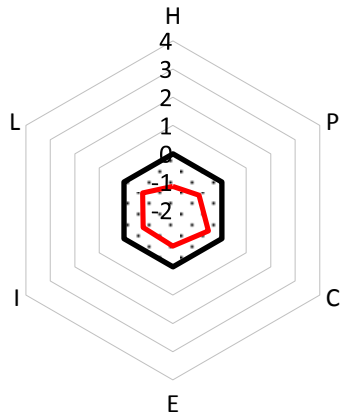
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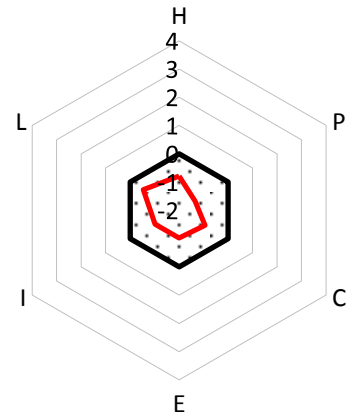
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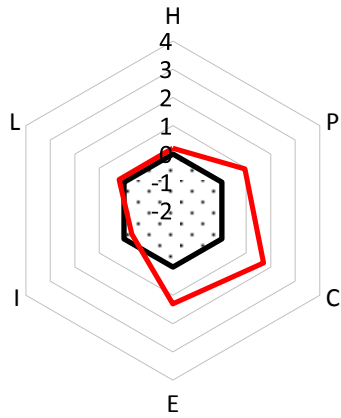
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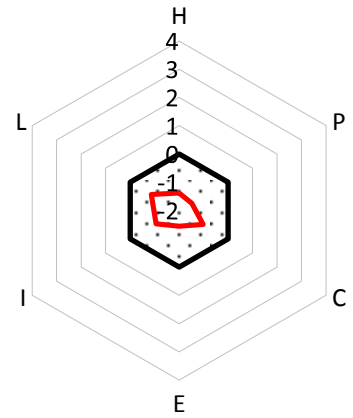
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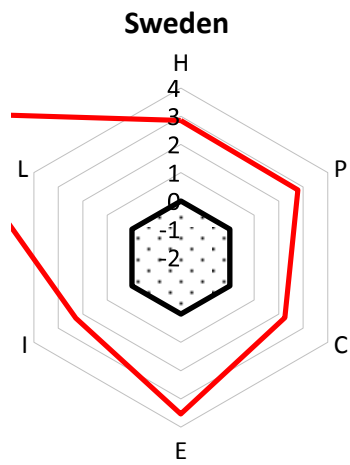
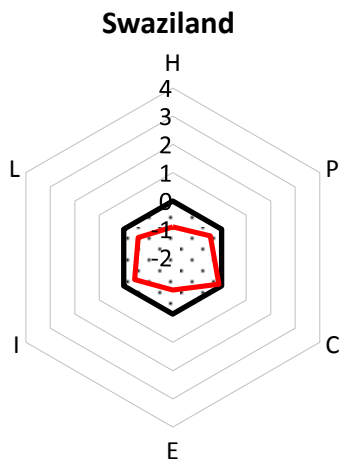
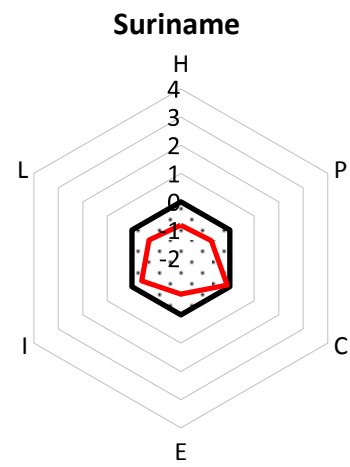
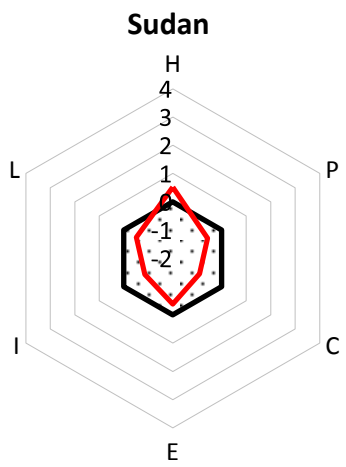
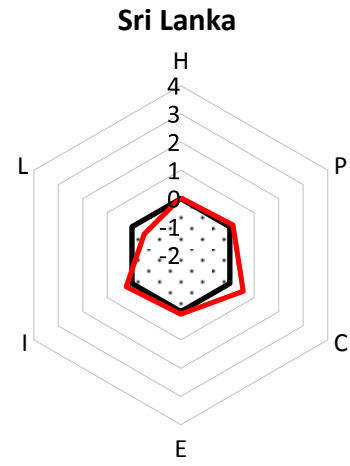
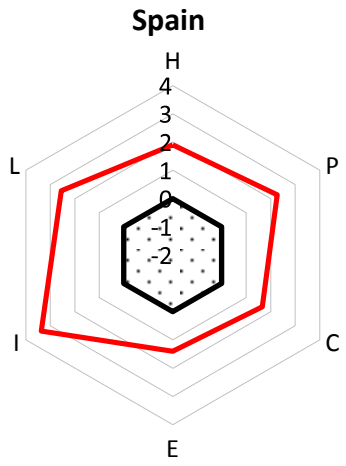


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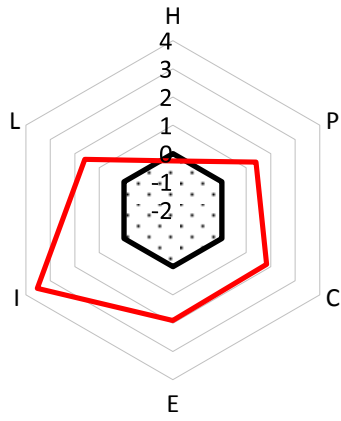


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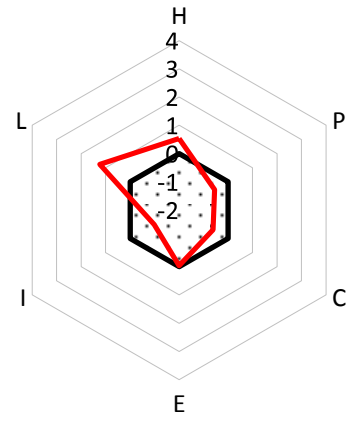




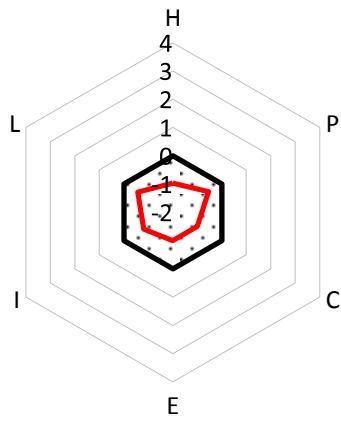
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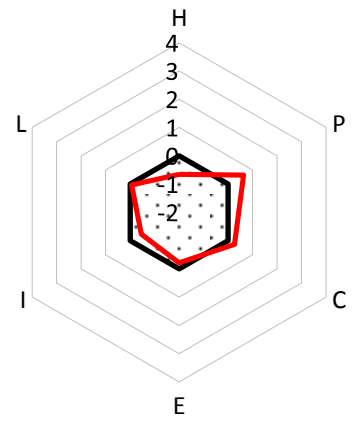
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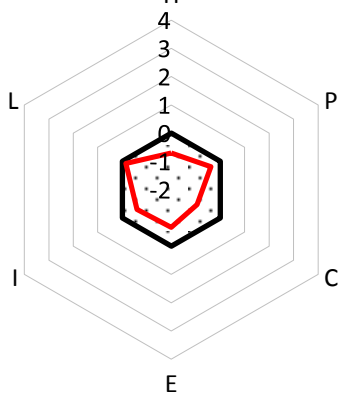
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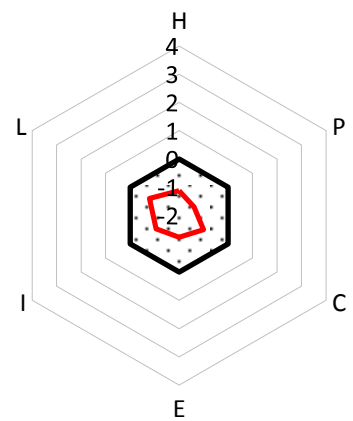
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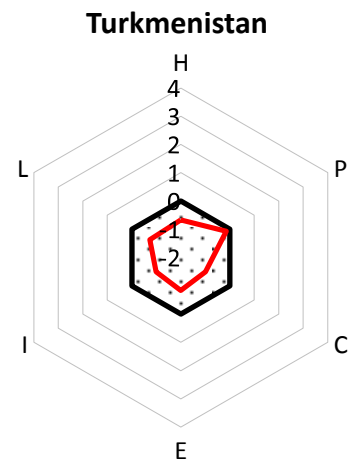
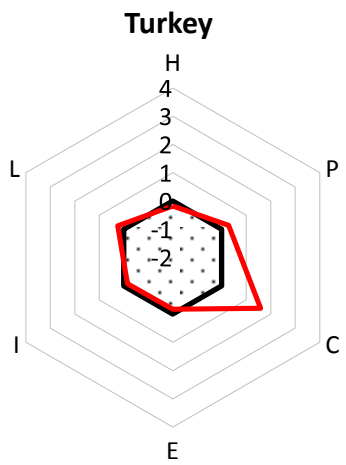
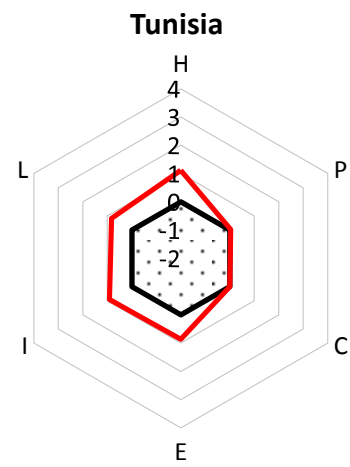
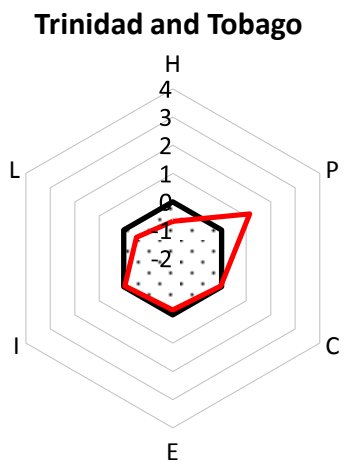
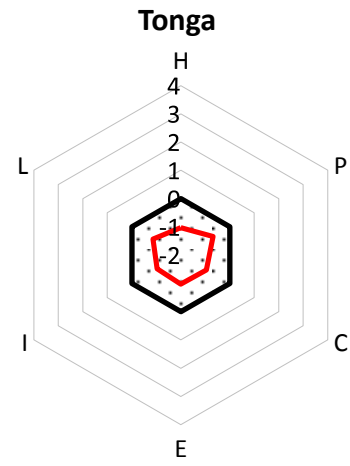
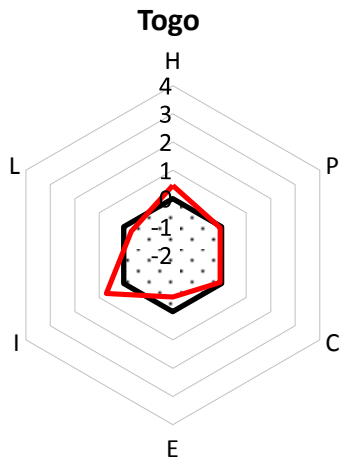


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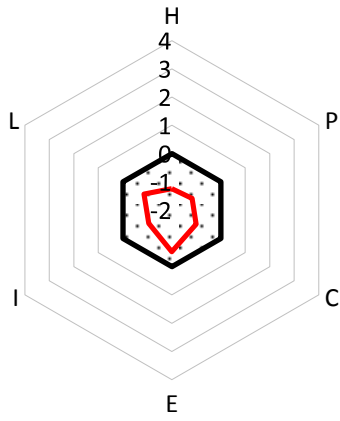


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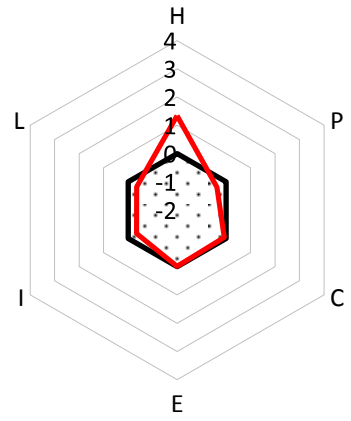




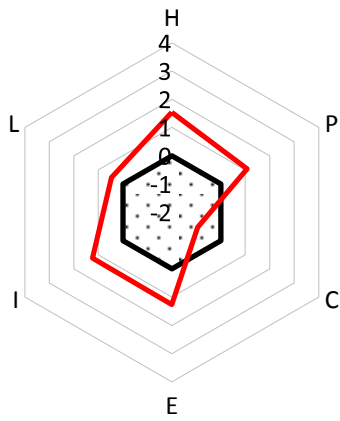
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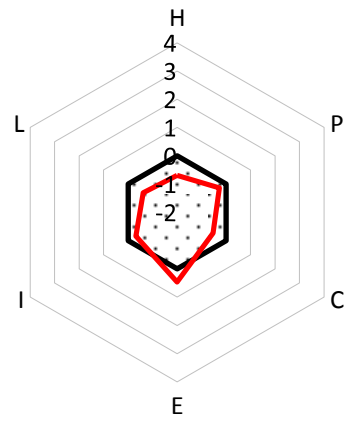
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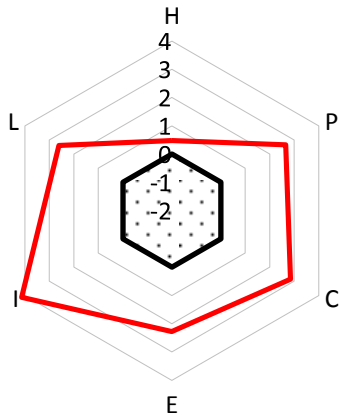
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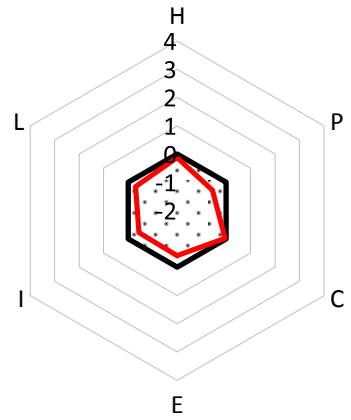
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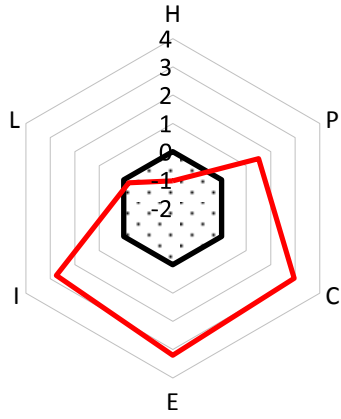
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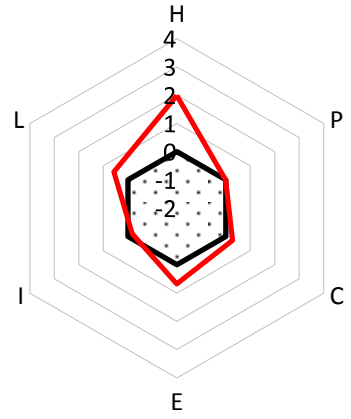
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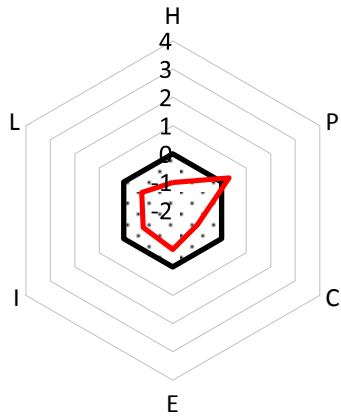
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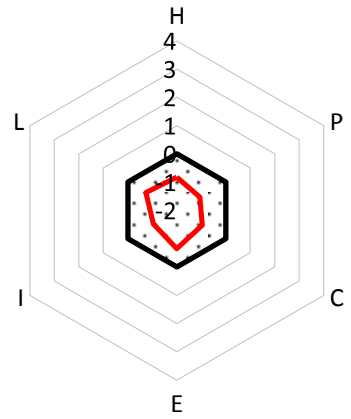
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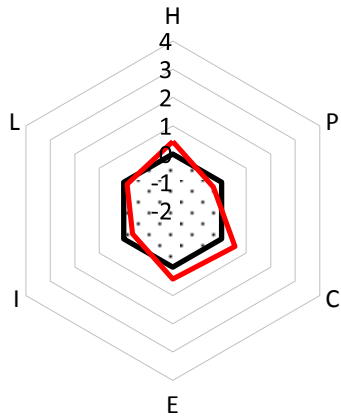
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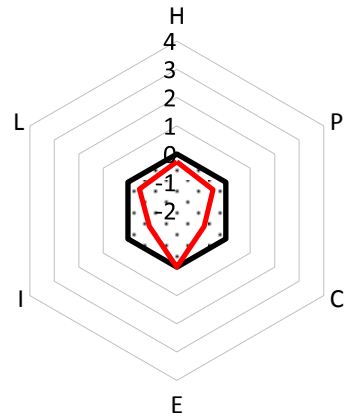
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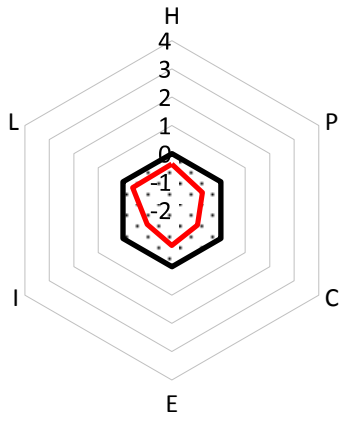
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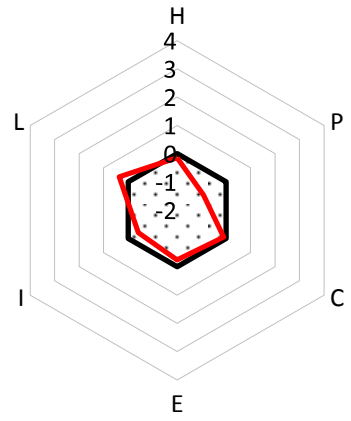
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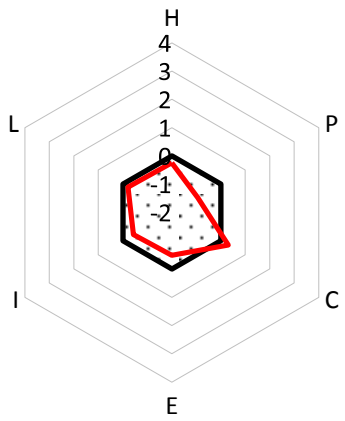
Yemen



Zambia



Zimbabwe



LIST OF ACHIEVEMENTS

International Journals

- Lien Thi Quynh Le, Yoshiki Mikami, Takashi Inoguchi, *Global Leadership and International Regime: Empirical Testing of Cooperation without Hegemony Paradigm on the Basis of 120 Multilateral Conventions Data Deposited to the United Nations System*, Japanese Journal of Political Science, Cambridge University Press, Vol. 15, Part 4, pp. 521 – 601, December, 2014
- Lien Thi Quynh Le, Yoshiki Mikami, *Meeting Global Challenges through International Science and Technology Cooperation - A Glance at United Nations' Multilateral Treaties*, International Journal of Scientific and Technology Research, Volume 3, Issue 10, October 2014 Edition - ISSN 2277-8616

Conferences

- Lien Thi Quynh Le, Yoshiki Mikami, Takashi Inoguchi, *Cooperation without Hegemony*, Empowering Multilateral Institutions Conference, Tokyo, Japan, November 22nd, 2014
- Lien Thi Quynh Le, Yoshiki Mikami, Takashi Inoguchi, *Empirical Testing of Cooperation without Hegemony Paradigm on the Basis of 120 Multilateral Conventions Data Deposited to the United Nation Systems*, The Japan Association of International Relations Annual Convention 2014, Fukuoka, Japan, November 14th -16th, 2014
- Lien Thi Quynh Le, Yoshiki Mikami, Takashi Inoguchi, *Cooperation without Hegemony*, Conference on Positive Political Science, Tokyo, Japan, October 10th, 2014

- Lien Thi Quynh Le, Yoshiki Mikami, *Visualization of Global Support for Science and Technology Policy*, The 3rd International GIGAKU Conference, Nagaoka, Japan, June 20th – 22nd, 2014
- Lien Thi Quynh Le, Yoshimi Mikami, *Analysis of International Commitment and Policy Attitude in Global Environment Issue*, The 1st International Conference on Energy, Environment and Human Engineering (ICEEHE), Yangon, Myanmar, December, 2013
- Lien Thi Quynh Le, Yoshimi Mikami, *Analysis of Global Commitment and Policy Attitude in Occupational Safety and Health Issues*, The 2nd International GIGAKU Conference, Nagaoka, Japan, June 21st – 23rd, 2013