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Governance and Inclusiveness of International Standard-Setting: The Case of the International Electrotechnical Commission

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Abstract

This dissertation scrutinizes international technical standard-setting with a special focus on the participation of stakeholders. Using the International Electrotechnical Commission (IEC) as a case study, this dissertation examines how and under what conditions stakeholders participate in IEC standard-setting in the wake of several events that presumably impacted the global standard-setting system over the past two decades. Among others, technological change, shifts in the global economic power structure, and Standard Developing Organizations' (SDOs) introduction of various opening up measures to improve their inclusiveness have all not only altered stakeholders' participation in this realm but also raised numerous challenges for the SDOs themselves. Through a mixed-methods approach, this dissertation utilizes an original two decades-long dataset as well as numerous empirical evidence collected from a number of public and private sources to conduct the analyses in the four studies comprising this research. The findings show that stakeholders' participation in the IEC continues to involve traditional power-bargaining dynamics. Moving beyond frameworks interpreting participation in international technical standard-setting as being largely driven by country-level economic power, this dissertation offers a framework that fully appreciates the effect of the national industrial-specific capability—electrotechnology in the IEC case. Additionally, the findings show that stakeholders' participation in the IEC reflects—to a certain extent—the recent shifts in the global economic power structure. A few emerging economies are playing an increasingly growing role in IEC standard-setting, and China's participation is as high as that of the most active member countries. Thanks to some of its attributes and effective response to most of these developments, the IEC will probably continue to play an influential role in global governance.

Contents

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Chapter 1 – Dissertation Introduction

This dissertation is concerned with a phenomenon that is involved in one way or another in almost every aspect of our lives. Take a look around you and try to perceive how much of our world is regulated by certain rules through which our everyday lives are eased or even made possible. Assuming that you are reading this document using an electronic device, the order of the letters on your keyboard is the same for all keyboards of the language you are using on almost all devices ever created. With this fixed layout, you do not need to learn the order of the letters every time you use your language keyboard on a different device. Similarly, the connecting ports installed on your device are among a small group of ports used by almost all electronic devices existing worldwide. Using these ports, you can connect as well as exchange data with numerous other devices without worrying about compatibility-related issues. These are just two examples of the millions of things around you regulated by the phenomenon studied in this dissertation, namely international technical standards.

Simply put, a standard is a documented, agreed-upon way of doing something.[1] Standards emerge through different mechanisms and dynamics and often get selected among alternatives by certain interested individuals.[2] Resultant standards, in turn, often end up serving as the basis for addressing various problems in our daily lives, ultimately touching on far-reaching issues such as public health and safety, labor rights, and even the World's Sustainable Development Goals.

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[1] There is no universal definition of a standard (for extended discussions, see Busch, 2011; de Vries, 1997; Fried & Glaa, 2020; Timmermans & Epstein, 2010). One of the most important Standards Developing Organizations (SDO), the International Organization for Standardization (ISO), defines a standard as "a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes, and services are fit for their purpose" (ISO/IEC, 2004). In this dissertation, standard-setting and standardization are viewed essentially as describing the same activity. As described below, I differentiate between two types of standards: technical and non-technical standards. The phrases "international standards" and "international technical standards" are used interchangeably.

[2] Interested individuals include everyone with an interest affected by a given standard (i.e., stakeholders).

In case you are using an English keyboard, it most probably has the so-called QWERTY keyboard layout of letters that three American individuals first developed in the mid-1800s (for a historical review, see David, 1985; Kay, 2013). Despite its inferiority to another layout called Dvorak, the QWERTY was set as an international standard by another group of stakeholders who met in the ISO later in 1971 (Noyes, 1983). In the case of connecting ports, your device probably has the Universal Serial Bus (USB) designed during the mid-1990s by a group of Intel employees. With the help of other companies, Intel made the USB a standard on a global scale (i.e., an international standard), ultimately killing many other alternatives, such as the FireWire port developed by Apple, and securing high revenues from relevant Intellectual Property Rights (van den Ende et al., 2012).

As in the case of many other standards around you, certain individuals believed that the QWERTY layout and the USB would be better choices for all stakeholders, including you as an end-user.[3] With these decisions, making changes to standards, if at all possible, would cause substantial loss of various resources. Imagine what would need to be done to replace the QWERTY with another layout as an international standard for English keyboards.

At the time of writing this dissertation, the world is going through the COVID-19 pandemic, and many countries are facing different challenges with medical devices and measures necessary to fight the virus.[4] Standards are playing a vital role in, among others (Marhold & Fell, 2022), assessing what is safe for the treatment of infected patients and what is not. For instance, standards such as the IEC 60601 and IEC 62366—developed by the IEC—were considered essential for evaluating the safety of ventilators (Kazlovich et al., 2022, p. 4). In the United Kingdom, hundreds of mechanical ventilators imported from China were

[3] As I show in the following section, standard-setting often involves compromises about technical as well as non-technical issues. Resultant standards are, therefore, not necessarily always (technically) best among the existing alternatives.

[4] For instance, many countries reported shortages in ventilators, including countries with strong health systems, such as the United States (Ranney et al., 2020). The European Commission has recently identified the standardization of the process of developing a COVID-19 vaccine as a top priority (European Commission, 2022).

considered unsafe for COVID-19 treatment by senior British doctors due to what was recognized as “issues in the standards of production” (Smith, 2020).

Similarly, regardless of the origin of your electronic device, it most probably has complied with a set of electrical safety requirements written in the standards IEC 60950-1 and IEC 60320-1, both of which are probably also referred to in your country’s relevant national regulation(s). In addition to ensuring your device can be safely used, compliance with these standards allows it to be powered by different incompatible electrical wall sockets.[5] Note that although these standards were developed at the international level, they ended up shaping national regulations of countries worldwide. Indeed, standards have different jurisdictions, such as national, international, or sometimes an individual organization.

As a result of all this, stakeholders, including but not limited to manufacturers of related products, relevant public authorities, and product end-users, all become affected in one way or another by the content of (international technical) standards. This becomes particularly critical when standard-setters are operating at the international level as they are affecting issues and stakeholders on a global scale as opposed to standard-setting at other levels. The importance of standards, above all for industry players, has contributed to transforming international standard-setting into a battleground whereby nations/stakeholders compete for influence. Over the past century, standard-setting has been institutionalized in international SDOs (for a historical overview, see Yates & Murphy, 2019b), which serve as platforms for deliberations among stakeholders over standards that are, in principle, aimed at promoting global welfare. Meanwhile, and similar to other global organizations, SDOs have been repeatedly criticized for being biased in favor of powerful nations and their industrial stakeholders (for instance, see Louis & Ruwet, 2017).

[5] Specifically, the interoperability requirements for connectors of power supply cords in the IEC 60320-1 standard allow Personal Computers to be safely powered by different electrical wall sockets.

Yet, despite their critical role in regulating our world, international standards are often overlooked or taken unquestioned, not least because of the background role they play (Timmermans & Epstein, 2010, p.84) as opposed to governmental regulations.[6] As I show in the subsequent section, the existing literature tells us little about the making of international technical standards. Importantly, we know little about which and how countries/stakeholders participate in international technical SDOs, especially in the wake of important recent events, such as shifts in the global power structure and the opening up of different global organizations. This dissertation seeks to contribute to filling these gaps in the literature.

The remainder of this introductory chapter proceeds as follows: in Section 2, I situate the dissertation within the broader literature while emphasizing the gaps it seeks to fill. In Section 3, I present the dissertation's aim, questions, and structure. I discuss the overarching methodological approach and research design in Section 4. In Section 5, I introduce the SDO wherein this research has been conducted.[7]

1. LITERATURE REVIEW AND RESEARCH GAP

Standards as a subject of study have only recently become an area of active (interdisciplinary) research. For a long time, research on standards and standard-setting was sparse or, at best, dispersed. Despite the recognition of their importance by many scholars and practitioners, standards did not attract systematic scholarly attention until the early 1980s. This, however, has dramatically changed in the wake of an explosion in the number as well as the scope of

[6] The authors of a United States Congress study mention: "Standards generally go unnoticed. They are mostly quiet, unseen forces…how standards come about is a mystery to most people should they even ponder the question." (Andelin & Curlin, 1992, foreword, p. iii).

[7] The IEC introduction that I present in Section 5 is largely an overview of the IEC "on paper." That, in turn, is scrutinized in the following chapters.

standards over the course of the subsequent two decades.[8] Ever since, scholarship on standards has proliferated as if it was trying to catch up with their global diffusion.

1.1. The Rise of International Standards

In the political science literature during the 1960s and 1970s, standards were not considered in themselves a worthy focus of analytical attention. Standards were brought up by political scientists' works only as anecdotes, such as the incompatible European and Russian railroad gauges at the time of World War I (e.g., Evangelista, 1982, p. 122). Even the clearly political dimensions of standard-setting were more likely to be discussed by economic historians (for instance, see Weidlein & Reck, 1956) and legal scholars (such as Nader, 1965; Opala, 1969) than by political scientists. Much of this work criticized policymakers' reliance on standards developed by non-governmental and/or non-transparent organizations in public policy well before a political scientist explicitly examined such aspects for the first time (Jacobson, 1973).

International Relations scholars were probably the first among political scientists to engage seriously with standards-related topics. For example, Nye and Keohane (1971), Kaiser (1971), and later Strange (1976) recognized the then-new non-state transnational actors shaping the rules governing various industries.[9] Later works built on these studies and showed that the rules of these actors could have an ultimate impact on consumer safety (Cheit, 1990), market share (Grieco, 1990) and different emerging technologies (Cowhey, 1990; Genschel & Werle, 1993; Salter, 1988).

Meanwhile, greater attention was being devoted to standards in the management and economics literature (for a review, see Narayanan & Chen, 2012). Many scholars examined

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[8] The proliferation of international standards was largely a result of several interrelated global events, such as the growth of international trade and globalization. Meanwhile, establishing the World Trade Organization (WTO) and the Agreement on Technical Barriers to Trade (TBT) gave international standards greater importance. Among others, international standards were viewed as key to eliminating potential barriers to trade created by differences in national standards and/or regulations.

[9] Transnational governance here refers to "processes in which non-state actors adopt rules that seek to move behavior toward a shared, public goal in at least two states." (for a literature review, see Roger & Dauvergne, 2016). I view international standard-setting as a form of transnational (private) governance.

how standard-setting can lead to both pro-competitive and anti-competitive outcomes by affecting, among others, market share, network externalities, and the installed base of industry players (for example, see Besen & Saloner, 1989; Katz & Shapiro, 1985; Lecraw, 1984).[10] Standards, including the product compatibility resulting from standard-setting, have been viewed as public/collective goods that are vulnerable to opportunistic behavior and distributional conflicts among the standard-setters (Berg, 1989; Hemenway, 1975; Kindleberger, 1983; Matutes & Regibeau, 1988). For instance, the political and commercial interests of the United States, Germany, and France were the determining factors for developing an international standard for color televisions instead of technical superiority among the existing technological alternatives (Crane, 1979). Castañeda (2007) later argued that the same situation complicated the global technological transformation from analog television to digital format, ultimately delaying the introduction of the latter technology and causing a negative impact for the end user.

Results of other studies showed that private and political interests tend to prevail over non-commercial interests in standard-setting and how such dynamics can lead to socially suboptimal outcomes (Berg, 1989; Besen & Johnson, 1986; David, 1985; Farrell & Saloner, 1985), such as locking-in on inferior technologies or standard battles (de Vries, 2001; de Vries, 2006). Committee standard-setting was nevertheless viewed as a superior decision-making process to its governmental counterpart or market selection (Farrell & Saloner, 1988).

Scholars also conceptualized standards as technological discontinuities/change or dominant designs that can emerge through market competition (Abernathy & Clark, 1985; Tushman & Anderson, 1986; Utterback & Abernathy, 1975) or winner-takes-all battles whereby losers might end up out of the market (Besen & Farrell, 1994; Cusumano et al., 1992; Rosenbloom & Cusumano, 1987; Shapiro & Varian, 1999). Owners and supporters of widely

[10] An externality occurs essentially whenever "one actor's conduct affects the wellbeing of another." (Abbott & Snidal, 2001, p. 347).

implemented standards gain greater competitive advantages, ultimately leading to a lock-in effect that guarantees long-term profits, sometimes irrespective of the technical superiority of the standard (Arthur, 1989; Besen & Saloner, 1989). Much of this work was focused on one main category of standards that emerge through different market mechanisms and economic approaches, namely de facto standards.[11]

With the increasing influence of international standards, scholars have begun to subject standard-setting at SDOs—whereby de jure standards get developed—to greater scrutiny. De jure—also called formal—standards are "the product of a deliberately steered process of decision-making" formally taking place in SDOs' committees (Brunsson et al., 2012, p.617). In this stream of studies, scholars reported that SDOs' committees are dominated by private technical experts (David & Greenstein, 1990) equipped with greater access to information and resources as opposed to stakeholders representing other/non-commercial interests (David & Steinmueller, 1994) and showed that such composition of standard-setters could extend the deliberation time (Farrell & Saloner, 1988; Farrell & Simcoe, 2012; Lehr, 1995).

Other scholars emphasized the compromise behind standard-setting and that economic and competitive factors sometimes override technical concerns in standards deliberations, some of which take place in informal meetings (Sirbu & Laurence, 1985). Indeed, scholars such as Weiss and Sirbu (1990) repeatedly argued that the technological/standard choice in SDOs is not explained by the technical superiority of a given standard but by other factors, such as the financial strength of the participating actors.

Much of the early work remained focused on the impact of international standards, with very little attention to standard-setting in SDOs or the actors involved. However, this has

[11] International standard-setting is a dynamic phenomenon (Brunsson et al., 2012) emerging through different decision-making processes, modes and (types of) stakeholders (for discussions, see Marhold & Fell, 2022; Wiegmann et al., 2017). Depending on their development process, standards can be categorized as de facto or de jure standards, albeit this categorization is controversial in nature (for discussions, see Belleflamme, 2002; de vries, 1999). This dissertation is focused on de jure standards developed in and promoted by international SDOs.

changed with the growing scholarly attention to standards over the past two decades. Scholars from different disciplines have been building on early findings and opening up new research agendas scrutinizing numerous topics related to international standard-setting.

1.2. Opening the Black Box of Standard-Setting

Later studies from numerous disciplines, including but not limited to political science, sociology, and law (for a recent literature review, see Grillo et al., 2021), recognized a proliferation of organizations exerting a new form of regulatory authority at the global level (Abbott et al., 2015; Abbott & Snidal, 2009a, 2009b; Kingsbury et al., 2005; Mattli & Büthe, 2003). In these Global Governance Organizations (GGOs), consequential decisions are transnationally made across numerous regulatory issue areas, bypassing states (Abbott & Snidal, 2009b) and ultimately shaping national public policies worldwide (Kingsbury et al., 2005). Many of these organizations operate through decision-making processes distinct from democratic and participatory mechanisms commonly implemented in traditional global/political organizations (Black, 2008). Standards Developing Organizations, which are considered transnational private standard-setting bodies, are viewed as one form of these GGOs.

More recent studies echoed previous research that warned about the inherent risks of international standard-setting. Among others, scholars further documented the uneven distributional gains among stakeholders participating in standard-setting (Büthe & Mattli, 2011), the socio-technical compromise behind the process (Hargrave & Van De Ven, 2006; Von Burg, 2001), and the possible anticompetitive effect of Intellectual Property Rights (IPR) and patenting on emerging standards (Contreras, 2013; Miller & Toh, 2020; Singh, 2022).[12] Ultimately, competition in standard-setting can go beyond the participating actors to

[12] Standard-setting often involves selecting a standard that includes certain patents over competing/alternative standards and patents. In case patent holders are represented/participating in standard-setting, they might advocate for standards that contain

be among their respective states in the form of protection of national interests/stakeholders (Lee & Oh., 2008). This is especially true because participation in international standard-setting proved to improve economic growth (Egyedi & Spirco, 2011; Spencer & Temple, 2016).

Moreover, while international standards are increasingly touching on far-reaching issues beyond mere industrial, such as consumer choice and safety and ethical considerations (Blind, 2016; de Vries et al., 2018; Folmer & Jakobs, 2021; John-Stewart & Vladislav, 2019; Miller et al., 2021; Ponte et al., 2011; Tamm Hallström, 2004; Wickson & Forsberg, 2015), these standards sometimes fail to achieve their noble objective of promoting global welfare (Alshadafan, 2020; Bartleson, 2010; Bartley, 2018; Bijlmakers, 2022; Cargill, 2011; Higuchi & Troutt, 2008; Kerret & Tal, 2005; Masumy, 2018).[13]

Rashid and Simpson (2021) showed how the competing technical work in multiple SDOs failed to safeguard the consumers' interest in setting standards embedded in the European wireless communication policy. Smythe (2009) showed how the powerful actors of the Codex Alimentarius Commission have for years opposed a labeling standard for genetically modified food in order to protect their own commercial interests.[14] Nevertheless, international standards continue to be embedded in national regulations worldwide (Higgins & Tamm Hallström, 2007) as means to bridge "regulatory gaps" typically left by national legislatures due to the lack of necessary technical capabilities (for discussions, see Eberlein, 2019; Jacobsson, 2002).

The biased composition of SDOs' committees and the possible consequences of this issue continued to be a prominent agenda in the more recent literature on standard-setting. A

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their own patents, even while hiding this information. While such tactics guarantee greater market share and royalty fees for patent holders, other stakeholders often have to face substantial consequences.

[13] The analysis of Elalfy et al. (2021) shows that organizations following international standards are more likely to consider the United Nation's Sustainable Development Goals in their operations.

[14] The Codex Alimentarius Commission is essentially an international SDO for food standards that are, in principle, aimed at protecting consumers' health and ensuring fair trade. Standards often specify or act as a basis for the information that needs to be shown on product labels, such as the various products' technical characteristics. Labeling information can be presented in a way to serve certain interests (for example, see Davies & Wright, 1994; Lyon & Maxwell, 2011).

stream of studies showed that the actors participating in different global regulatory issue areas are not on a level-playing field in terms of the ability to integrate their preferences/inputs into international standards (Bexell et al., 2010; Büthe, 2010b, 2010c; Dingwerth, 2008; Fuchs et al., 2011; Graz et al., 2020; Hauert, 2010; Heß, 2020; Louis & Ruwet, 2017; Marchetti, 2015; Rashid & Simpson, 2021; Tamm Hallström, 2004; Zoo et al., 2017). Industrial stakeholders from powerful countries dominated many GGOs and often produced rules that were in their favor (Avant et al., 2010; Benvenisti, 1999; Borraz, 2007; Clapp & Fuchs, 2009; Fung, 2003; Gilbert & Rasche, 2007; Graz, 2018; Papachristos & van de Kaa, 2021).

Such a power structure makes international rule-making susceptible to private interest influence or even capture (for instance, see Ogus, 2004) while putting the interests of marginalized stakeholders—such as environmental agencies, consumer associations, and women—at greater stake. In addition, standard-setters might behave protectively for their national interests, especially in case national standards existed at the time of developing international counterparts—as in the case of TV (Yates & Murphy, 2019b, p. 158-198).

Scholars repeatedly argued that the above issues undercut the legitimacy of GGOs (Cargill & Bolin, 2007; Simcoe, 2006). Indeed, substantial literature has been concerned with topics related to the GGOs' legitimacy, such as assessing it, the mechanisms by which it is generated, and the consequences in case it gets rejected by the underrepresented stakeholders (Alshadafan, 2020; Beisheim & Dingwerth, 2008; Bernstein & Cashore, 2007; Buchanan & Keohane, 2006; Dahl, 1999; Ogus & Carbonara, 2011; Tamm Hallström, 2004, 2006; Zürn, 2004). These topics remain hotly debated, with some scholars being optimistic about the ability of SDOs to achieve legitimacy (Bernstein & Cashore, 2007; Hahn & Weidtmann, 2016; Palazzo & Scherer, 2008; Ponte et al., 2011), and others being rather skeptical (Boström & Tamm Hallström, 2010; Dingwerth, 2005; Fuchs & Kalfagianni, 2010; Graz & Nölke, 2007; Tamm Hallström, 2006). Meanwhile, both camps of scholars consider legitimacy to be crucial for GGOs, not least because it helps these organizations obtain support from stakeholders and maintain their influential positions in global governance (Boli, 1999; Zürn, 2018).

Another related line of work recognized greater inclusivity as a source of legitimacy for SDOs (Bexell et al., 2010; Boström, 2006; Fransen & Kolk, 2007; Gulbrandsen, 2005; Kostova & Zaheer, 1999), ultimately leading to more effective standards (Cadman, 2009; DeMenno & Büthe, 2022). Boström and Tamm Hallström (2013) argued that in order for SDOs to survive, they should not only include more stakeholders but also strive to maintain a power balance among them. Meanwhile, marginalized stakeholders were calling to integrate their voices into international standard-setting (for instance, see Communication to the WTO, 2019; Delimatsis, 2018, p. 284; Ren & Peng, 2022).[15] Many scholars and policymakers have therefore agreed that GGOs need to offer participation mechanisms to improve inclusiveness and representation in their rule-making (Guay, 2022; Koenig-Archibugi, 2017; Koenig-Archibugi & Macdonald, 2017; Macdonald, 2008; Scholte, 2004, 2011; Stevenson, 2016; Stewart, 2014).

Against this backdrop, major SDOs introduced and implemented a variety of quasi-democratic procedures and measures in an attempt to open up for the underrepresented stakeholders (Grigorescu, 2015; Jönsson & Sommerer, 2013; Tallberg et al., 2014). Aiming at the same objective, major SDOs developed and implemented internal policies and measures such as the Guide 59 developed by the ISO and IEC (ISO/IEC, 2019).[16] Recent studies scrutinized, among others, the motivation and consequences of such opening moves in global governance (Pauwelyn et al., 2022; Weise, 2016).

[15] Associations representing consumers and other non-commercial interests, such as the environmental, have been particularly affected by this issue, including those based in countries with relatively greater economic and technical capabilities (for example, see Australian Government, 2006).

[16] The guideline is entitled: "ISO and IEC recommended practices for standardization by national bodies." (ISO/IEC, 2019). The ISO and IEC state that the purpose of the guideline is to provide "recommended standardization practices that are intended to support the application of the following: the WTO TBT Committee decision on principles for the development of international standards, guides and recommendations (G/TBT/9, 13 November 2000); and the WTO TBT Agreement's Code of Good Practice for the Preparation, Adoption, and Application of Standards (Annex 3 of the 1995 WTO TBT Agreement)."

While the preceding review of the literature shows a vibrant and growing literature on international standard-setting, a number of important issues and topics remain unresolved and/or understudied, to which I turn next.

1.3. Research Gap

First, despite the importance of the opening up movement in global governance, little (empirical) work has been done to examine the extent to which the opening up measures are actually implemented in SDOs' internal operations (see few recent studies, Delimatsis, 2018; Forsberg, 2012; Kanevskaia, 2020). There is a severe need for further (empirical) research at the SDOs' internal operations level, not least to help find mechanisms to increase the diversity of the participating stakeholders across lines of national origin, interests and gender. Some scholars attribute the scarcity of relevant studies to the strict access to various SDOs' data (Harmes-Liedtke, 2022).

Second, scholars are seeking to better understand the making of de jure standards empirically; however, such attempts remain rare. For instance, only a few analyses of countries'/stakeholders' participation in SDOs are based on empirical participation data, while many of these studies are limited in scope and/or time span. The complaint of Simcoe (2006) about this gap in the literature long ago is, therefore, still valid. An empirical approach to investigating participation in international standard-setting remains largely lacking in the literature (for a literature review on empirical studies, see Contreras, 2017).

Third, legitimacy presents itself as key in understanding, among others, how SDOs practice their influential role in global governance; accordingly, how legitimacy comes about is a central subject of inquiry, as evident by the literature review above. Existing studies offer little guidance on how SDOs can be institutionally designed to enhance the legitimacy of their decision-making processes. Arguably, assessing the extent to which SDOs' internal procedures comply with the noble principles demanded by the marginalized stakeholders and the international community contributes to resolving ongoing legitimacy-related debates.

Fourth, studies report inconclusive evidence about the effectiveness of the opening up movement in increasing the participation of traditionally marginalized stakeholders/countries in different global governance issue areas (Contreras, 2014; Lavenex et al., 2021b; Na-Young, 2019; Pauwelyn et al., 2022; Weise, 2016) creating uncertainty about the status of North-South imbalance issue in global governance. This becomes particularly puzzling in the wake of the recent shifts in the global economic power structure, such as the rise of emerging economies and its possible profound implications on GGOs (Higgins & Richards, 2019; Horner et al., 2018; Langford, 2019).

Fifth, recent evidence casts doubts about our understanding of countries' drivers to participate in GGOs. Indeed, scholars are arguing that the participation decision is largely driven by country-level conditions (for example, see Lavenex et al., 2021a), suggesting that the developing countries' low participation in SDOs will not be improved by altering the supply side of the international standard-setting system (Kanevskaia, 2020; Pauwelyn et al., 2022). More broadly, national participation in GGOs has rarely been treated as a subject of study in its own right, and even rarer has it been investigated within the international technical standard-setting.

Sixth, among the emerging economies, China has been showing an exceptional increase in its participation in different GGOs (Breslin, 2013, 2017; Kuang, 2018; Shambaugh, 2013; Webster et al., 2022). Despite the vibrant scholarly attention to this topic (for example, see Gao et al., 2021; Kim et al., 2020; Mearsheimer, 2014), China's status and the implications of its ascent into global governance remain hotly disputed in the literature (also in accordance with argument by Yates & Murphy, 2019b, Conclusion). Existing analyses of China's behavior show that it varies from one organization to another, warranting more empirical research that is sensitive to the regulatory issue area (for example, see Frick, 2021; Hopewell, 2021; Kastner et al., 2020; Kennedy, 2018; Križić, 2021; Weiss & Wallace, 2021)—as Lavenex et al. (2021a) argued, China's behavior in global governance needs to be analyzed issue area by issue area.

Last but not least, the vast majority of studies narrowly focus on environmental (de Vries et al., 2012), labor, and accounting standards (Bernstein & Cashore, 2012; Büthe, 2009; Cashore et al., 2004; Mattli & Büthe, 2005a, 2005b). Technical standards, in contrast, have received very little systematic scholarly attention (for exceptions, see Büthe & Mattli, 2011; Funk & Methe, 2001; Grigorescu, 2020). I differentiate between technical and nontechnical standards by drawing on the work of other scholars, such as Grigorescu who suggests that "standards that are easily understood by all, as in the case of the early standards for weight and length, or labor standards specifying the maximum number of hours of work, are not technical in nature. Technical standards, by contrast, such as those in the electrotechnical, chemical, or medical realms, involve a high degree of expertise and are difficult for the general public to assess" (Grigorescu, 2020, p. 154)—for an earlier work about this discussion, see Reck (1956).

2. DISSERTATION AIMS, QUESTIONS, AND STRUCTURE

Following this introduction, four empirical chapters take different approaches to address distinct but interrelated issues of international technical standard-setting. This research seeks to contribute to our knowledge of international technical standards by scrutinizing the process of developing them with a special focus on the participation of stakeholders. The overarching research question is how countries/stakeholders participate in international de jure technical standard-setting, especially in the wake of important recent events, such as shifts in the global power structure and the opening up of different global organizations. Through an analysis of several large (original) datasets and evidence collected from interviews, the dissertation attempts to offer a detailed look at the empirical reality of the participation of member countries in SDOs.[17]

The participation of stakeholders in international standard-setting is an important subject of inquiry for several reasons. First, the participating stakeholders—who typically have vested interests—often adopt a certain approach in standard-setting; being the main actors, they make choices/decisions that often lead the entire process down a certain route. Meanwhile, the literature shows that some standard-setting routes lead to inferior results (de Vries et al., 2011). For instance, Lei et al. (2017) showed how the choice of a given product testing method—which is typically described in technical standards—in the construction industry could influence the effectiveness of the standard in achieving its objective(s). Studying the participation of these stakeholders and the relevant dynamics is an important step towards improving both our understanding of international standard-setting and the chances of avoiding inferior results. In practice, the participating actors in SDOs are those responsible for implementing the Good Standardization principles and practices.[18] Second, among the principles of Good Standardization, the inclusion of developing countries in standard-setting is key for achieving the overarching goal, as greater participation promises better implementation of the other Good Standardization principles (Russel & Berger, 2020, p.33). Finally, in accordance with scholars such as Becker (1983), greater diversity in the interests presented in standard-setting counterbalances the dominant interest, which is typically the commercial/private.

This research focuses on a major organization setting international technical standards, namely the International Electrotechnical Commission. For a comprehensive approach, participation in the IEC is examined on multiple levels: first, at the basic building block level

[17] Participation in international SDOs is primarily country-based. I present more details in the following sections.

[18] The ISO established nine principles with the stated aim of developing international standards in the interest of global welfare (Kellermann, 2019).

of standard-setting, namely the Technical Committee;[19] second, at an institution level covering the participation of all members over time; finally, at the level of an individual member country over time.

Chapter 2 of this dissertation is a published paper seeking to achieve a better understanding of the SDOs' internal processes and practices by analyzing the case of developing the international technical standard for measuring the energy efficiency of Televisions (TVs), namely the IEC 62087. Particularly, I ask: How legitimate is the process of setting that international standard for TVs with respect to the principles of good standardization? The Good Standardization principles established by the ISO and WTO are considered a primary source of legitimacy for IEC standard-setting. Similar to other major SDOs, the IEC claims adherence to both guidelines. Accordingly, I examine the extent to which the IEC procedural safeguards to implement the Good Standardization principles articulated in the WTO's six principles and the ISO/IEC Guide 59 have been actually implemented by the participants in developing the IEC 62087 in the relevant IEC technical committee.

Chapter 3 of this dissertation aims to achieve two main objectives: the first is to assess the effect of the SDOs' opening up measures on the participation of developing countries in international technical standard-setting. In this chapter, I ask: Whether, and if yes, to what extent did the IEC's opening up measures improve the participation of developing countries in the organization? The second objective is to achieve a better understanding of what could explain the variation in member countries' participation in the same realm.

Chapter 4 seeks to provide a more nuanced picture of China's behavior in international technical standard-setting by analyzing it in the case of the IEC. Particularly, the chapter aims at two main objectives: first, to achieve a better understanding of how China exerts power, if

[19] At the Technical Committee level, key technical decision-making in standard-setting is carried out.

at all, in the IEC; second, to assess the likelihood of China acting in a disruptive manner in the organization.

Chapter 5 of this dissertation is part of an edited volume, which offers empirical case studies as well as theoretical insights into the evolution and resilience of SDOs through crises (Delimatsis et al., 2023).[20] In this chapter—co-authored with Tim Büthe, we seek to achieve a better understanding of how the IEC has responded to a variety of challenges—such as the recent technological change, the rise of competitor SDOs and new entrants of the Global South—to its role and legitimacy as the preeminent SDO for electrotechnology. We also problematize the notion of resilience as continuation with adaptability, suggesting that it requires specifying in advance the SDO's essential defining attributes, which would have to remain largely intact for adaptation to changing circumstances to count as resilience.

Chapter 6 concludes the dissertation by summarizing the main findings and contributions of the research, highlighting the limitations of the work, and pointing to avenues for future research.

3. RESEARCH DESIGN AND METHODOLOGY

In this section, I present the primary research design for this dissertation, address the underlying arguments for my methodological choices and broadly describe the data sources and collection. Further details on the individual methods employed in the four studies comprising this research (i.e., chapters 2, 3, 4 and 5) are presented in the respective chapters.

Motivated by a desire to improve our knowledge of international technical standard-setting through a thorough study of an individual SDO (i.e., the IEC), the overarching methodological approach guiding this research is a case study. A case study is "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context,

[20] Resilience in the sense of the SDO's ability to survive shocks and environmental changes, such that it still resembles its former state and functionality.

especially when the boundary between phenomenon and context are not clearly evident." (Yin, 2017, p.15).

The case study was deemed an appropriate research strategy essentially because its methodological strengths align well with the dissertation's questions and objectives. First, this dissertation aims to capture the complexities of a phenomenon grounded in real-life context by raising as well as addressing "how" questions (Yin, 2017, p.13). Second, different aspects of international technical standard-setting will be examined with an emphasis on the depth and breadth of the phenomenon (Creswell & Plano Clark, 2011; Yin, 2017). Third, the dissertation seeks to serve as "an intensive study of a single unit with an aim to generalize across a larger set of units,"[21] ultimately supporting relevant theory-building efforts. Fourth, the case study research design allows me to draw upon a variety of sources and types of evidence (Yin, 2017, p.115). Finally, given that our empirical knowledge of international standard-setting is scarce, the case study is particularly suitable for gathering such evidence (Yin, 2017, p.128).

While being aware of the inherent weaknesses of a case study approach, I follow lines of thought arguing against these weaknesses (among others, see Flyvbjerg, 2006). For instance, a common criticism of the case study is the limited generalizability of its findings (George & Bennett, 2005). Meanwhile, several scholars have shown that intensive case studies can still generate causal as well as descriptive inferences that are generalizable to comparable cases (for example, see King et al., 1994, p.44), including in the study of global governance organizations (Achen & Snidal, 1989).

In addition, the risks of embracing a case study approach are counteracted in this dissertation by triangulating a variety of sources and types of primary and secondary evidence, all of which I have verified for credibility (King et al., 1994, p.9; Patton, 1999; Punch, 1998, p. 191). Among the different forms of triangulation, I employ methodological and data

[21] In accordance with the case study definition by Gerring (2004, p. 342).

triangulation (Arksey & Knight, 1999, p.23). In this research, triangulation served as a means for complementarity to test a hypothesis and/or answer a question and check for evidence validity. In so doing, I incorporate different perspectives and evidence in interpreting international technical standard-setting, ultimately reducing the probability that the findings are affected by bias introduced by certain evidence or methods (Creswell et al., 2003; Denzin & Lincoln, 2005, p.5; Yin, 2017, p.245).

Accordingly, the research design of this dissertation is in part inductive and descriptive and, at the same time, relies on mixed research methods and evidence—qualitative and quantitative—as suits the research needs best (Tashakkori & Teddlie, 2010).[22] Mixed methods research "involves the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority and involve the integration of the data at one or more stages of the process of research." (Creswell et al., 2003, p.212). As further elaborated below, I approach the overarching research question from different methodological perspectives: I adopt a qualitative approach in Chapter 2, a quantitative deductive approach in Chapter 3, a mixed approach in Chapters 4 and 5. I employ different methods for data collection and analysis in each of the four chapters.

The mixed methods approach has its weaknesses (Creswell et al., 2003), which I strive to tackle. For instance, Ahmed and Sil (2012) argue that by using mixed-methods research, I might risk forfeiting some of the benefits of the individual methods. In addition, analyzing qualitative and quantitative evidence requires considerable resources such as time, money, and researcher expertise in both types of research approaches (Johnson & Onwuegbuzie, 2004, p.21).

[22] Inductive reasoning is "an approach to the relationship between theory and research in which the former is generated out of the latter." (Bryman, 2016, p. 691). Conversely, deductive reasoning is "an approach to the relationship between theory and research in which the latter is conducted with reference to hypothesis and ideas inferred from the former" (Bryman, 2016, p.690).

In addition, qualitative and quantitative approaches differ, at least methodologically (McKeown, 1999). While qualitative research involves systematic collection and interpretation of mostly textual evidence gathered from, among others, the analysis of documents and interviews (Creswell & Plano Clark, 2011), “quantitative research uses numbers and statistical methods. [Quantitative research] tends to be based on numerical measurements of specific aspects of phenomena.” (King et al., 1994, p.3). Nevertheless, both approaches and methods are deemed suitable for this research.

I follow lines of thoughts arguing that the conventional distinction between qualitative and quantitative approaches is diminishing and that they can be jointly utilized to generate knowledge (Creswell & Plano Clark, 2011, 2017; Harding & Seefeldt, 2013; King et al., 1994), not least because they complement each other’s weaknesses. Indeed, scholars argued that incorporating qualitative and quantitative evidence and methods enriches the research, enhances the validity and reliability of the interpretations made and reduces the effect of the methodological weaknesses introduced by the individual approaches (for instance, see Miles & Huberman, 1994).[23] Among other weaknesses, qualitative methods might introduce bias in evidence collection and/or interpretation (Miles & Huberman, 1994, p.10; Patton, 2002).

By employing pluralistic approaches, I adopt a pragmatic paradigm position, wherein I focus on addressing the research problems more than the selection of methods and use “what works” to achieve my research objectives (Creswell et al., 2003; Johnson & Onwuegbuzie, 2004; Morgan, 2007; Patton, 1990; Tashakkori & Teddlie, 2010).

Specifically, for Chapter 2, a qualitative research approach offered several advantages over its quantitative counterpart. The qualitative methods facilitated, among others, addressing the topic with flexibility and small sample size (Patton, 2002, p. 244). As the chapter aims to examine the extent to which the procedural safeguards of good standardization articulated in

[23] I discuss reliability and validity at the end of this section.

the WTO's six principles and the ISO/IEC Guide 59 have been actually implemented by the participants in developing the IEC 62087, it was necessary to interview participants/stakeholders as well as analyze relevant documents and records.

Through 12 semi-structured interviews/discussions, qualitative methods facilitated the understanding of how the interviewees make sense of their experiences of reality as well as exploring their perceptions (Miles & Huberman, 1994; Patton, 2002, p. 348; Tellis, 1997; Weiss, 1994) on participation in international technical standard-setting. Semi-structured interviews were considered particularly appropriate for evidence collection as I aim to develop detailed descriptions, integrate multiple perspectives and achieve a holistic understanding of the case under investigation (Patton, 2002, p. 348). More broadly, interviews proved to be effective in advancing knowledge in case studies (Gerring, 2017; Miles & Huberman, 1994).[24]

Potential interviewees were identified based on purposeful sampling (for a discussion, see Palinkas et al., 2015), wherein I focus on a "selected information-rich case whose study will illuminate the questions under investigation" (Patton, 2002, p.230). In the spirit of pragmatism, purposive sampling offers the freedom to focus on the best suitable interviewees/sample for the research. Some interviewees were also identified based on an analysis of relevant IEC documents and records.

In addition, around one hundred relevant public and internal documents and records were analyzed for acquiring additional evidence, which was triangulated with the evidence collected from the 12 semi-structured interviews. I complemented primary evidence with secondary evidence (Yin, 2017, p.126) because several topics could not be treated through interviews, and some data were unavailable due to strict access rules.

In order to achieve the two main objectives of Chapter 3 (i.e., assess the effect of the opening up measures to improve the participation of developing countries and achieve a better

[24] In semi-structured interviews, the researcher prepares a fixed protocol but maintains open-ended and flexible questions. Semi-structured interviews were deemed suitable for evidence collection in Chapter 4, too.

understanding of what could explain the variation in member countries' participation), a large amount of cross-national participation data were empirically analyzed within the context of the IEC. For that, quantitative methods are suitable as they measure phenomena in time and space and allow for comparison between variables. Quantitative methods measure relationships between relevant variables and isolate individual effects using statistics and analysis of objective evidence (Creswell, 2009). The quantitative analysis complemented the case study as the former is suitable for theory-testing and identifying causal inferences in large-N analysis. As stated by King, Keohane and Verba, quantitative research "abstracts from particular instances to seek general description or to test causal hypotheses" (King et al., 1994, p.3).

For the first research objective, the participation of IEC member countries has been analyzed through almost all of the participation mechanisms offered by the SDO with an aim to examine a potential increase in participation, as suggested by theory. For the second objective, a regression analysis has been carried out to examine the theoretical expectations of positive correlations between two country-level variables, namely economic power and the relevant industrial capability, and the likelihood of participation in SDOs. I supplement the analysis with two statistical methods for detecting and measuring the magnitude of positive trends in the participation of developing countries.

The statistical analysis was done using RStudio for macOS. Large datasets were analyzed using descriptive as well as inferential statistics. The regressions were used to determine the degree of correlation between the independent and dependent variables. The results of the quantitative analysis were presented in tables and different graphical formations.

Chapter 4 seeks to achieve two main objectives: first, to improve our understanding of how China exerts power, if at all, in the IEC; second, to assess the likelihood of China acting in a disruptive manner in the organization. For that, I analyze China's status and participation in the IEC through a number of participation mechanisms and assess the likelihood of disruptive behavior by China in each of the mechanisms, taking into account the IEC's internal governance rules and structure. I utilize a two-decade internal IEC dataset that includes numerous participation records for IEC member countries and qualitative evidence retrieved from six semi-structured interviews and public sources.

The rationale behind employing multi-methods (i.e., statistical inferences and semi-structured interviews) is largely in line with what has been presented above. These methods were deemed suitable because the chapter seeks "to assess trends and relationships with quantitative data but also be able to explain the mechanism or reasons behind the resultant trends." (Creswell & Plano Clark, 2011, p.82). Semi-structured offered an avenue for background information and flexibility. Meanwhile, purposeful sampling allowed me to select interviewees "who have experienced the central phenomenon or key concept being explored in the study" (Creswell & Plano Clark, 2017, p.173).

The interviews also followed relevant academic ethical norms and practices. In conducting interviews, relevant research objectives were communicated to the interviewees prior to the interviews. The interview questions were designed based on respective research objectives and questions. The interviewees remain anonymous and relevant materials, such as my notes, remain confidential.

Most of the interviews were conducted remotely essentially for two reasons. First, part of the interviews took place during the COVID-19 pandemic; consequently, remote interviews offered safer environments for the interviewees and me. Second, remote interviews offer relatively greater flexibility and eliminate relevant expenses, such as traveling costs.

In Chapter 5, we draw on the proto-theory of preeminence in global private governance by Büthe (2010a) to sketch a theoretical framework that underpins the analysis. The analysis, in turn, is based largely on various empirical evidence and the data presented above.

In conducting this research, I strived to overcome threats to the validity and reliability of the work. Reliability essentially "means that applying the same procedure in the same way will always produce the same measure." (King et al., 1994, p.25), and validity "refers to measuring what we think we are measuring." (King et al., 1994, p.25). For the quantitative part of this research, the data are available; therefore, the analyses are almost entirely replicable. Scholars argued that quantitative research "seeks measurements and analyses that are easily replicable by other researchers." (King et al., 1994, p.3). However, replicability of data may be difficult, if at all possible, in research that involves interviews (King et al., 1994, p.26). Achieving reliable and valid qualitative research remains a disputed issue in the literature (for instance, see Adler, 2022; Golafshani, 2003).

In addition to triangulation, I draw on my professional experience for evidence collection and interpretation—this has been considered important in following a pragmatic approach (Morgan, 2007). In addition to a number of years working for a global certification body as a Quality Manager, I have been involved in several standard-setting projects. In addition, at the time of writing this, I hold the position of Quality Process Analyst in a key private player in the semiconductor industry. Last but not least, throughout the writing of the dissertation, I presented my work and findings at numerous conferences for critics.

I chose to analyze the IEC because it is a representative, information-rich case, and relevant data were available for this research (Gerring, 2007, p. 91-97; Patton, 1987). First, despite its powerful position in global governance, the IEC remains one of the lesser-known SDOs and has only relatively recently been identified as an influential GGO in the IR literature (for the most recent studies, see Büthe, 2010a; Büthe & Alshadafan, 2023; Teichmann, 2010). Second, the IEC plays a prominent role in developing Information and Communication Technologies (ICT) standards, which are increasingly attracting scholarly controversy (according to data by Grillo et al., 2021). Third, over the past two decades, the IEC introduced numerous measures as well as policies that are geared to ensure the effective implementation of good standardization frameworks, such as the ISO/IEC Guide 59, with the ultimate aim of improving the legitimacy of its standard-setting. Finally, the IEC operates based on a set of rules and procedures commonly implemented in other major SDOs; consequently, the generalizability of the dissertation's findings is enhanced.

4. THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

4.1. History

The international standard-setting system we have today first emerged in the early twentieth century and is still evolving. The current complex system arose essentially from some national professional communities comprised of prominent engineers and businessmen, mostly from the then-industrialized world. These communities invented a novel decision-making process to reach a consensus among committees of stakeholders on various technical issues. The output of that process, in turn, often gets voluntarily adopted by all parties. Before going across borders, these mostly European communities sought to serve the public by promoting that decision-making process to improve the efficiency and interoperability of national manufacturing.

International standard-setting has been institutionalized in mostly non-governmental organizations that are still operating to this day in spite of the turbulent times they went through. Indeed, while two world wars and a Global Depression added burdens to efforts toward establishing an international standard-setting system, such events simultaneously introduced advancement opportunities (Grigorescu, 2020). For instance, the Second World War created tensions between the national professional communities of the battling parties—admitting Germany to the IEC was a multi-year challenge, with some countries, such as the Soviet Union, explicitly voting against granting Germany a membership (Yates & Murphy, 2019a, p. 153).

At the same time, military demands for standardization have fueled various standard-setting efforts. Indeed, since its early times, international standard-setting has been shaped by international politics (for a great and comprehensive historical review, see Yates & Murphy, 2019b).

The research presented in this dissertation was conducted on a prominent and one of the first established international SDOs, namely the IEC. At the turn of the twentieth century, national standard-setting activities intersected with scientific work that was carried out at the international level, notably in the then rapidly changing field of electrical engineering. Standardization needs arose to establish common technical measures and facilitate information exchange and scientific development on a global scale.

With tremendous efforts from two British "standardization entrepreneurs," namely Colonel Rookes Crompton and Charles Le Maistre, and support from the British and American national electrical standardization bodies, a proposal was made in an international electrical congress in 1904 in the city of St. Louis in the United States for setting up an international SDO with a restricted domain of issues related to electrical engineering. The original objective was to establish electrical units and the nomenclature and ratings of various electrical machines. The proposal of the influential individuals who planned and led that international congress, such as the two highly respected electrical engineers/businessmen Alexander Siemens and Elihu Thomson, was supported by a Chamber of Government Delegates representing 15 countries. The involvement of individuals with high statuses and interests gave the newly planted seed for international standardization a scientific essence as well as a sort of official support.

Two years later, precisely on June 26th, 1906, the IEC was officially established in a meeting in London by 33 attendees representing 13 relevant National Electrical Communities (NECs): the United States of America (Institute of Electrical Engineers), Austria

(Elektrotechnische Verein in Wien), Belgium (Société Belge des Électriciens), Canada (Standards Committee), Spain (Ministry of Commerce), Japan, Great Britain (Institution of Electrical Engineers), France (Société Internationale des Électriciens), Germany (Verband Deutscher Elektrotechniker), Holland (Koninklijk Instituut van Ingenieurs), Hungary (Ministry of Commerce), Italy (Associazione Elettrotecnica Italiana), and Switzerland (Société Suisse des Électriciens). Norway, Sweden, and Denmark showed an interest in obtaining memberships but did not attend the meeting (Ruppert, 1956, p. 1). Note that only three countries were non-European: Japan, Canada, and the United States. In 1908, the first IEC statute was drawn up almost entirely by the British NEC and remained unchanged for 41 years.

While the primary motivation behind establishing the Commission was, in a sense, global prosperity, the commercial interest was a prominent driving force behind the work (Büthe, 2010a; Yates & Murphy, 2007; Yates & Murphy, 2022). At the same time, numerous efforts were made to balance the (national) interests represented in IEC standard-setting. As Alexander Siemens, who chaired the 1906 meeting, put it: "[the founding Committee] had endeavored to place every country joining the Commission on an absolutely equal footing." In addition to portraying the IEC as a non-governmental organization, every national community representing a country was given one vote in decision-making. These policies and procedures served as countermeasures against the involvement of international politics in the operations of an SDO that is focused, at least at the outset, on purely technical matters (for an extended historical review of the IEC, see Yates & Murphy, 2019b, p. 53-81).

4.2. The Modern IEC

In the century since then, the IEC has become a "preeminent" international/transnational SDO in the form of a private authority (for a recent review of the evolution of the IEC, see Büthe, 2010a). The Commission, which started with a group of 33 individuals coming from 13 countries, grew to have today more than 20,000 people involved in its work from more than

170 countries. As of the end of 2021, the IEC has developed 11,200 international standards and standards-like documents (IEC Website, 2022, Understanding Standards). The scope of the IEC work has expanded far beyond the original focus of "standardizing ratings of electrical apparatus and machinery" (Ruppert, 1956, p.1) to include not only numerous electrotechnology-related issues but also to offer related Conformity Assessment services, ultimately shaping numerous societal aspects.[25] The IEC mentions on its website: "Our work facilitates technical innovation, affordable infrastructure development, efficient and sustainable energy access, smart urbanization and transportation systems, climate change mitigation, and increases the safety of people and the environment." (IEC Website, 2022, What we do).

The IEC has also secured an influential role in global governance despite the emergence of competing standard-setting forums over the past few decades (Büthe & Alshadafan, 2023). First, as a response to complaints about its standard-setting process as being bureaucratic and slow (Büthe & Witte, 2004; Cargill, 2002) as opposed to standard-setting through other mechanisms, such as the industry consortia (Büthe & Witte, 2004), the IEC introduced "fast-track paths" to develop standards. For instance, in case of sufficient/urgent market demand, the IEC can skip some of the time-demanding stages of the standard-setting process, which will be discussed later, to develop standards faster. The IEC also increased its efforts in "ratifying" standards developed by other forums as IEC standards, provided that these externally developed standards go through a shortened standard-setting process within the IEC.

Second, many (standardization) collaborations and partnerships aimed essentially at encouraging the implementation of IEC standards worldwide were established with other

[25] The IEC defines conformity assessment as "any activity that determines whether a product, system, service and sometimes people fulfill the requirements and characteristics described in a standard or specification. Conformity assessment is the activity of verifying that a standard or technical specification was applied in the design, manufacturing, installation, maintenance or repair of a device or system." (IEC Website, 2022, What is Conformity Assessment). In collaboration with the ISO, the IEC developed a number of international standards and guides—such as the ISO/IEC 17000 family—for the conformity assessment process itself.

international as well as regional organizations, such as the International Telecommunications Union, the Arab Industrial Development, Standardization and Mining Organization, the European Committee for Electrotechnical Standardization and the WTO.[26] Some of these collaborations led to a formal delegation of regulatory authority to the IEC (for a discussion, see Büthe, 2010a). One important standardization collaboration was established with the ISO in 1976. In addition to developing joint Directives to govern areas where their work overlaps, a Joint Technical Advisory Board and Joint standard-setting projects were established (ISO/IEC, 2021).[27]

Third, several measures were put in place with the stated aim of increasing the diversity of interests represented, especially via the participation of countries from the developing world. This was partly a response to critics of the IEC as being dominated by Western NECs—many of which host major market players. For instance, the IEC has been offering standardization-related training and numerous incentives for countries/stakeholders less active in its work—a presentation of these measures is available in Chapter 3.

Fourth, the IEC was successfully able to integrate potential "challengers" to its role in global governance, such as the Rising Powers, some of which might establish counter organizations—as in the case of China in establishing the Asian Infrastructure Investment Bank in the Global Finance issue area (Ren, 2016). Indeed, most of the emerging economies, such as Russia, Brazil, and India, have been IEC members for decades (Büthe, 2010a).

Fifth, thanks to their standardization of many essential electrical fundamentals and components, IEC standards preserve their key role in future technologies as well as products. One of the examples is the sensor, which has long been and continues to act as a vital part of

[26] For a list of these collaborations, see IEC Website (2022, List of IEC Partners).

[27] At the time of writing this, the joint directives (ISO/IEC Directives, Part 1:2022 Procedures for the Technical Work) has version number 18.0 and can be accessed on the IEC website (IEC Website, 2022, Reference Material). Another version of the directives was prepared to present relevant details specific to the IEC (ISO/IEC Directives, Part 1:2022 + IEC Supplement:2022 - Procedures for the Technical Work - Procedures Specific to IEC)—this document can be accessed on the IEC website.

devices ranging from traditional household appliances to complex smart manufacturing.[28] Sensors are integrated into wearable technologies used in, among others, the healthcare sector.[29] During the COVID-19 pandemic, sensors were utilized for the detection of coronavirus(es) in individuals.[30] Most of these sensors are designed and manufactured according to the IEC 60747-14 family of standards. Even in flying cars—a technology that is expected to become a reality as soon as 2030 (Kleinman, 2021)—the IEC already has standards for devices relevant to surround-view monitoring of such cars and the controversial issues of data protection and cyber-security, such as the IEC 62668 (Bogost, 2016; IEC News & Blogs, 2021). A final recent example of the IEC's ambition to standardize future technologies is the establishment of the Systems Evaluation Group to explore the standardization needs of the metaverse (IEC Editorial Team, 2022).

Last but not least, IEC standards continue to be widely integrated into national regulations. For instance, the EU Low Voltage Directive references IEC standards that include safety requirements for commonly used electrical equipment (European Commission, 2014). Under the EU New Approach, industry players need to meet these standards—though not explicitly mentioned in the directive—in order to comply with the directive (Delimatsis, 2016, p.9). Also, the recently revised Radio Equipment Directive requires manufacturers to adopt an IEC-based universal charging solution—the USB-C—for phones and other electronic devices (European Commission, 2021).

4.3. Structure and Governance

Since its founding, the IEC has been, and remains, structured in a decentralized fashion. While the overall operations of the Commission are coordinated by individuals based in a secretariat

[28] Sensors can interpret analog or electrical stimuli, including temperature, sound, motion, smell, and pressure.

[29] Such devices offer great promise for reducing relevant costs and improving patient care by (remotely) monitoring physiological processes and biomedical signals (Patel et al., 2012).

[30] Sensors installed in a wearable device can alert the user when changes in their metrics match those associated with COVID-19 or even track the stability and recovery of those infected.

office in Geneva, most of the technical work is carried out by NECs/stakeholders in meetings conducted all over the world.[31] In fact, these NECs provide almost all the resources required for standard-setting including but not limited to funding and technical human capital. Moreover, in 2021, the IEC generated its highest-ever total net operational income of CHF 30,88 million (IEC Annual Report, 2021), suggesting that the IEC work is rapidly growing.

The IEC central secretariat essentially ensures the proper implementation of rules and procedures and publishes standards. The individuals who coordinate the IEC work are recognized as officers—such as the President, a Deputy President (i.e., the Immediate Past President or the President-Elect), three Vice-Presidents, a Treasurer, and a Secretary General—some of whom are employed by the Commission. The IEC officers may take part in decision-making but do not have the right to vote, except for the president, who can vote on certain occasions.

Participation in the IEC work is open to any country with an established NEC, which, in principle, should represent all national stakeholders. National Electrical Commissions interested in joining the IEC need to apply for membership and pay annual fees, which is an amount calculated by the IEC based on Gross National Product, population, and national electricity consumption. If the calculated amount exceeds a certain threshold, the IEC obliges the candidate NEC to hold the membership type that has relatively greater participation rights and responsibilities in the IEC work, namely the Full Membership (IEC, 2021, p. 4). Otherwise, the NEC holds the so-called Associate Membership, which provides a sort of observer status with limited participation rights. Such participation and membership rules indicate that the IEC intentionally motivates wealthy countries to increase their participation in its standard-setting.

The IEC calculates the minimum fees necessary for acquiring a Full Membership annually in the form of a percentage of total fees planned to be collected from all members.

[31] The main IEC secretariat is in Geneva. Regional offices were established in Kenya, Singapore, Brazil and the United States. There are two additional secretariats for conformity assessment activities in Switzerland and Australia.

Based on the mentioned criterion, if the calculated fees for an Associate member exceed the minimum percentage required for the Full Membership in a given year, the membership of that NEC gets automatically upgraded to Full. In case an NEC refuses a Full Membership status, it might risk losing any status it bears at the IEC. At the same time, any NEC willing to pay the Full Membership fees, irrespective of its development level, can apply for that membership.

Full Membership provides its holder with the right to participate in all (technical) activities at the IEC through voting, commenting in decision-making, and appointing individuals to hold different positions in the Commission, including some of the officers. In contrast, Associate Members do not have the right to vote or participate except on a few occasions and are not entitled to hold any IEC position. Associate Members are still required to pay an annual fee averaging around 30,000 CHF. All IEC members are allowed to sell IEC standards/publications and gain a certain amount of commission. Note that such rules might force countries to join as Full Members, as the Associate Membership limits the ability of its holder to participate in most of the IEC activities.

Full Members are categorized according to the amount of financial and technical support they provide to the IEC into two groups: Financial Group A (FGA) members and those that are non-FGA members. According to a discussion with an IEC officer, Full Membership fees can amount to anywhere between 60,000 and 1,000,000 CHF—including the obligatory amount of fees—depending on the interest level of a given Full Member in the IEC work. Being part of the FGA requires not only paying the maximum value of fees but also offering substantial financial and technical support, which might take the form of "voluntary funding" to the Commission (for a discussion of different types of funds for international organizations, see Graham, 2015). For instance, in order to consider an application of a given NEC to become a member of the FGA, the applicant should have at least 200 experts involved in the IEC work and be holding a number of positions in different IEC decision-making organs (IEC, 2021, Appendix 5).

National Electrical Committees accepted as IEC members are internally called National Committees (NCs). An admitted NC needs to adhere to various IEC standard-setting principles, such as ensuring transparency and inclusiveness. For interactions with the IEC, each NC needs to establish a national mirror structure of stakeholders that is led by a president and a secretary. For example, the German NEC is the German Commission for Electrical, Electronic and Information Technologies—known as Deutsche Kommission Elektrotechnik Elektronik und Informationstechnik (DKE).[32] The DKE is composed of, and open for participation from, all German domestic stakeholders such as the government, industry, and consumer associations. In case the DKE is interested in a given standardization area at the IEC, a mirror committee needs to be established by interested national stakeholders. The DKE, specifically the national mirror committee, should consolidate different national interests into a single national position, which is ultimately represented at the IEC by the German NEC president with the help of the secretary.

Similar to other IEC NECs, the DKE is required to implement the IEC standardization principles in its standard-setting. In its main Directives, the IEC mentions: "The Commission will take appropriate measures to advance respect for transparency, diversity, inclusivity, and for equal opportunities—principles to which the Commission is committed." (IEC Website, 2022, Statutes and Rule of Procedure, p. 4). In addition, the Directive states: "Each Member undertakes: [among other points] to uphold the principles to which the Commission is committed, including through its policies on transparency, diversity, inclusivity, and equal opportunities." (IEC Website, 2022, Statutes and Rule of Procedure, p. 5).

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[32] The DKE constitutes a joint organization of the German Institute for Standardization (called in the German language: Deutsches Institut für Normung) and the Association for Electrical, Electronic & Information Technologies (called in the German language: Verband der Elektrotechnik, Elektronik und Informationstechnik (VDE)). The VDE is responsible for the daily operations of the DKE (DKE Website, 2022).

As an additional measure to open up, the IEC allowed stakeholders/organizations to participate in its standard-setting without being affiliated to a certain NC as so-called liaison organizations. After applying for such status, the stakeholder is provided with various participation rights depending on their nature, level of operation, and interest. Liaison organizations can generally access documents and submit comments on certain occasions but not vote.

The IEC has a supreme governing organ called the General Assembly, which consists essentially of all Full Members; Associate Members and other participating stakeholders are not considered part of it. In the General Assembly, decisions are primarily made by voting in meetings and are adopted by a simple majority (i.e., more for a given decision than against it while excluding the third type of voting, which is abstention). The General Assembly essentially approves proposals made by the IEC Board, such as proposals for the Commission's vision and mission, annual membership fees, statutes, and rules, and elects decision-makers in the organization.

The IEC Board is comprised of the main IEC officers—president, deputy president, vice-president, treasurer, secretary-general—and fifteen individuals elected from the General Assembly. At the same time, each member of the FGA automatically (i.e., without an election) has seats on the IEC board. While the individuals serving on the IEC Board are required to divest from their national affiliation and act in the interest of the IEC, they remain sponsored by the stakeholders they represent.

Despite being key decision-makers at the IEC, the Board members must submit an application in case they are interested in accessing certain internal information. According to the IEC rules, board members wishing to—what the IEC calls— "inspect books and files" need to submit a request to the Secretary-General, who can reject it and even escalate it for voting at the IEC Board level. Such rules raise doubts about the transparency of the IEC standard-setting, even towards the participating/internal actors. Commitment to the work is also expected from the IEC board members. For instance, an absence from two consecutive meetings is considered an intention to resign. Such rules provide more evidence of how the IEC obliges its members to be active in its work. A two-thirds majority generally adopts decisions in the IEC board.

The IEC Board delegates specific responsibilities to specialized managerial, executive, and advisory bodies. Among others, the Business Advisory Committee coordinates financial and commercial activities; the Market Strategy Board examines relevant technological trends and market needs with an aim to identify new standardization areas for the IEC and help the board to make strategic decisions; Conformity Assessment activities are delegated to the Conformity Assessment Board, the management of the (technical) standard-setting activities including the appointment of individuals leading the work is delegated to the Standardization Management Board. All of these bodies share more or less a certain structure. They are all comprised of a number of IEC officers and elected Full Members, some of which must come from the FGA members. The IEC has also established rules for preventing any of the bodies from being dominated by a certain interest and/or geographical region.

The IEC also has a number of advisory groups that are working on addressing specific matters. The IEC can even establish (short-term) advisory groups whenever the need arises. For example, the President Committee advises the IEC board on matters related to the promotion of IEC activities worldwide, and the Standardization Evaluation Group aims to enlarge the number of IEC stakeholders and, improve their participation, and evaluate the need for new standardization projects. Such operations show that the IEC, including its leading countries, is not only consciously promoting its standards but also striving to standardize new fields with its standards.

Conformity Assessment activities of the Commission are carried out by Conformity Assessment Systems—abbreviated by the Commission as IEC CA Systems—each of which has a certain issue area and a Management Committee. Participation in IEC CA Systems is open for both Full and Associate Members. Under certain conditions, even stakeholders from non-IEC member countries can participate in these activities. Any of these participating members can take part in relevant Management Committees, which are led by an Executive Secretary and a Chair.

The IEC Conformity Assessment activities cover numerous issues, such as the IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components (IECEE) and the International Electrotechnical Commission System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres (IECEx System),[33] the International Electrotechnical Commission Quality Assessment System for Electronic Components (IECQ), and the International Electrotechnical Commission for Certification to Standards Relating to Equipment for use in Renewable energy Application (IECRE).[34] While this aspect of the IEC operations is largely outside the scope of this dissertation, CA activities are important mechanisms for spreading IEC standards.

4.4. The Standard-Setting Process

As a recap, the actual technical work in the IEC is mostly carried out in meetings of committees of stakeholders from all over the world. These committees are established to work on a certain standardization project that arises as a response to market demand and/or proposals by a given Full Member. Depending on the nature of the work, IEC committees are classified into

[33] The IECEE Schemes address the safety, quality, efficiency and overall performance of 23 categories of electrical and electronic equipment (IECEE Website, 2022). The IECEx provides a means for manufacturers, regulators and users of equipment used in hazardous areas (IECEx System Website, 2022). In 2021, the IECEx began working on integrating international standards for the hydrogen economy.

[34] The IECQ is a global approval and certification system covering the supply of electronic components and associated materials and processes. The IECQ employs quality assessment specifications that are based on IEC standards (IECQ Website, 2022). The IECRE System aims to facilitate international trade and ensure the safety of equipment and services related to Renewable Energy Sectors (IECRE Website, 2022).

Technical Committees (TC), Sub-committees (SuC) and Systems Committees (SC), all of which are led and managed by two individuals from interested NCs. Technical Committees remain operating as long as there is a need for them; otherwise, they get disbanded by the Standardization Management Board. In case of (technical) disputes and/or a need for external (technical) advice, a given TC might decide to establish a so-called Working Group (WG). The WG handles a specific task of the overall work and is comprised of experts, who might be virtually anyone recognized by the parent TC as knowledgeable in the respective topic.

Among the key actors in IEC standard-setting are the leaders of the TCs, namely the secretariats and chairs. The secretariat of a TC is designated by the Standardization Management Board to an NC that has expressed its willingness to take on the role and provide all required technical and financial resources. The secretariat leads the technical work, prepares important documents for the NCs' review and acts as a coordinator between the Standardization Management Board and the TC members. The chair, in turn, is nominated by the TC secretariat and is responsible essentially for the management of the TC and ensuring that the IEC rules are implemented. While the IEC encourages NCs not to remain in these roles for more than nine years, analyses repeatedly showed that NCs could hold TC secretariates for longer periods of time. The IEC recommends that the secretariat and chair be from different NCs as a countermeasure against potential conflict of interests or dominance.

Participation in the committees' activities requires another type of membership, which can take one of two forms: first, the Participating membership that allows the holder (here referred to as P-member) to actively participate in all relevant standard-setting activities. In fact, the IEC obliges P-members to participate at a minimum by submitting votes on standard-setting.[35] Second, the Observing membership, which allows the holder (here referred to as O-

[35] Indeed, the IEC Directives clearly states that by failing to participate actively, a P-members risks downgrading its status to the lower membership. Failure to actively participate in TCs can be as simple as missing two successive committee meetings or failing to vote on a question circulated among the TC members.

member) to follow the work without the obligation to participate. O-members do not have the right to vote and can only access relevant documents but can submit comments on certain occasions. Note that Full Members can participate as P-members or O-members in any TC without any kind of limitations. Conversely, Associate Members can generally participate only as O-members in TCs and apply to act as P-members only in four TCs. Finally, a given NC may choose to be neither P-member nor O-member, in which case the NC will not be (obliged to get) involved in the work of that particular TC.

Standard-setting at the IEC is carried out in a process comprised of several stages, each involving stakeholders voting and commenting on a document that evolves from a simple outline for standardizing a given issue to an international standard. When a standard-setting need arises, for example, as a consequence of market and/or technology needs, a proposal can be submitted to initiate a project at the IEC virtually by anyone. Before a new standard-setting project is considered sufficiently mature for launch, the preceding proposal is set at a Preliminary Stage and recognized by the Commission as a Preliminary Work Item. After a review and a positive, simple majority vote by a relevant TC, a promising Preliminary Work Item is then transformed into a New Work Item Proposal, marking the beginning of the subsequent stage, which is called the Proposal Stage. In case a given proposal is sufficiently mature, it gets directly considered a New Work Item Proposal, and the Proposal Stage is initiated. A New Work Item Proposal can take the form of developing an entirely new standard, a new part of an existing standard, or another type of IEC publication called Technical Specification—further details below.

The proposer needs to accompany the New Work Item with a fairly written First Working Draft for discussion among stakeholders and nominate a Project Leader. The First Working Draft is then circulated among the IEC decision-makers for review and vote. Adopting a New Work Item Proposal requires not more than two-thirds majority voting among a few (4 to 5) P-members that expressed interest in the project. If needed, the IEC allows the adoption of a New Work Item Proposal that is supported by even a smaller number of P-members.[36] If adopted, P-members then appoint experts to carry out as well as lead the project, whereby the First Working Draft is advanced and renamed Working Draft, concluding the Proposal Stage.

In the next stage, the Preparatory Stage, the appointed experts establish a corresponding type of group—such as WG or SuC—where the experts work on advancing the Working Draft to have it in a shape ready for circulation among the parent TC. Most of the IEC principles do not apply to the operations of the groups. For instance, the participating experts act in a personal capacity with no restrictions on their affiliation or the interest they represent. Consequently, groups serve as spaces where stakeholders can exert extra influence in IEC standard-setting. The role of the groups' Project Leaders is mainly to ensure that experts arrive at a sort of consensus about the content of the Working Draft.

In case of sufficient demand from a key stakeholder for the standard, a given committee can skip several steps from the standard-setting process, relax some of the requirements, such as the voting threshold, and publish IEC standard-like documents based only on the Final Working Draft.[37] Examples of these publications are the so-called Technical Specifications, Publicly Available Specifications or Technical Reports, all of which are not officially recognized as IEC international standards.

The IEC also ratifies externally developed standards in the form of the so-called IEC Publicly Available Specifications (for example, see Büthe & Mattli, 2011, p. 46). For instance, the original USB 1.0 Specifications was introduced in 1996 outside the IEC. In 2014, the Specifications was ratified by the IEC within the IEC TC 100 as IEC 62680.

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[36] The multiple-years analysis of Büthe (2010a) shows that New Work Item Proposals hardly get rejected, suggesting that the Commission, including its members, is not hesitant about developing standards for new issue areas.

[37] As described above, the IEC has several measures in place to speed up the standard-setting process and publish standard-like documents within a period of time that is shorter than what an international standard typically requires.

The Preparatory Stage is completed once the new version of the Working Draft is ready, which is then renamed to First Committee Draft. This marks the start of the Committee Stage, whereby NCs get involved in the work by reviewing and commenting on the circulated First Committee Draft. According to the output of that review, and in consultation with the chair, the secretariat submits one of the following proposals for proceeding with the project: (1) discuss the First Committee Draft along with a compilation of submitted comments (if any) in another meeting; (2) circulate a revised—and hence not First—Committee Draft among the involved NCs for another round of review; (3) set the (revised, if applicable) Committee Draft to the subsequent stage, which is the Enquiry Stage.

In case two or more P-members disagree with the secretariat proposal and/or the content of the document, the Committee Draft is revised again and recirculated until consensus (on the technical content) among the P-members is achieved.[38] The IEC has a special approach to consensus and the secretariat and chair—and if necessary the Project Leader—play a key role in deciding whether consensus has been reached or not. For instance, the leadership is responsible for assessing—according to a certain IEC criterion—whether the opposition is "sustained opposition" as well as whether the opposer is "an important part of the concerned interest" or not (article 2.5.6 of the ISO/IEC Directives Part 1 + IEC Supplement). In case of no agreement among the committee members, the leadership can just document the dispute and proceed with the process. The leadership can even publish the draft as one of the above-mentioned non-standard publications despite the existence of (major) disagreement.

Once consensus is reached, if at all, the Committee Draft is transformed into the next form, which is the Committee Draft for Vote. This marks the end of the Committee Stage and the start of the Enquiry Stage. In the Enquiry Stage, the Committee Draft for Vote is circulated

[38] The Commission adopts the definition of ISO/IEC Guide 2:2004 for consensus, which is as follows: "General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. Consensus need not imply unanimity."

among all NCs and is adopted in case a two-thirds majority of the votes among P-members is in favor, and the number of negative votes does not exceed 25% of total votes. In case no technical changes are needed to the circulated Committee Draft for Vote, it can be directly published as a standard. Otherwise, the Committee Draft for Vote is amended to address the technical issues and then transformed into the next form, which is the Final Draft International Standard.

In case technical disputes have not been addressed, the Committee Draft for Vote can still be published but as a Technical Specification. Comments submitted at this stage by NCs are accepted if they are editorial only; otherwise, the leadership reviews them for decisions on "how to deal with them." (article 2.6.2 of the ISO/IEC Directives Part 1 + IEC Supplement).[39] Negative votes at this stage need to be accompanied by "technical reasons;" otherwise, they are dismissed. Such rules streamline the standard-setting process as well as reduce the chances of having it totally blocked. The Enquiry Stage is completed once the Committee Draft for Vote has been accepted and transformed into a Final Draft International Standard.

The last stage is the Approval Stage, which begins with the circulation of the Final Draft International Standard among the NCs. Approving a Final Draft International Standard requires the same threshold of votes cast for approving a Committee Draft for Vote. At this stage, editorial modifications are retained for future updates of the standard; meanwhile, technical changes are not allowed at all. In case of major disagreement, a revised Final Draft International Standard may get circulated for another round of review with the aim of achieving consensus among the P-members. The final stage of the process is the Publication Stage, whereby final processing is carried out, and the International Standard is published.

[39] The concept of sustained opposition is not applicable at the Final Draft International Standard stage. The IEC recommends a certain procedure to be followed by the leadership to address challenges in reaching a consensus. Meanwhile, the final decision is almost entirely in the hands of the leadership of a given Committee.

The IEC standards are maintained through a process that is similar to, but rather shorter than, the one for their development. Standards are regularly reviewed for a decision on whether maintenance is required or not. Each TC establishes a maintenance team, which is comprised of experts from the P-members, who are responsible for maintaining relevant standards up to date. The entire review process needs to be planned and completed before the end of the so-called stability period, which is the period of time whereby any given standard remains unchanged.

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Chapter 2 – Energy Efficiency Standards: The Struggle for Legitimacy[1]

1. INTRODUCTION

Over the past few decades, scholars have witnessed a part of regulatory power transference from national governments to various non-state transnational (private) actors (Cashore et al., 2011). Such transference has been most prominently observed in governance gaps[2] (Strange, 1995), whereby some of these actors integrate their rules into governmental regulations in the form of international technical standards. Despite being nominally voluntary in terms of adoption, these international standards often transform into mandatory requirements that shape national public policy and hence become authoritative.

Standards are often developed and promoted by international Standards Developing Organizations (SDOs). These SDOs operate based on practices and principles that are in tension with democratic principles commonly held by political organizations. International SDOs emphasize technical expertise and efficiency in their decision-making and, at the same time, are not held accountable to stakeholders (Brunsson & Jacobsson, 2000). Scholars have expressed concerns that such a technocratic decision-making process (Cafaggi, 2011) is ultimately causing uneven distributional gains among the stakeholders (Büthe & Mattli, 2011) as well as a legitimacy deficiency in the overarching global governance system (for recent extensive research, see Eliantonio & Cauffman, 2020). Indeed, scholars repeatedly reported evidence suggesting issues with various aspects of the legitimacy of international standard-setting, such as the marginalization of actors with less technical and financial capabilities in

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[2] Governance gaps are basically areas where governments are incapable of regulating due to the lack of different prerequisites.

decision-making (for example, see Büthe, 2010b; Forsberg, 2012; Fuchs et al., 2011; Hauert, 2010; Heß, 2020). Meanwhile, legitimacy remains crucial for SDOs—as a form of global governance organizations—to survive and obtain stakeholders' support.

Against this backdrop, the World Trade Organization (WTO) and major SDOs established guidelines and "procedural safeguards" in an attempt to achieve what has been termed as "Good Standardization" and ultimately legitimize standard-setting processes (as suggested by Kanevskaia, 2020). Within the Technical Barriers to Trade (TBT) agreement framework, the WTO established six principles for developing international standards (TBT Committee, 2000). Meanwhile, the International Standardization Organization (ISO) and the International Electrotechnical Commission (IEC) developed the ISO/IEC Guide 59:2019 (referred to here as Guide 59) to serve as an internal guideline for recommended practices for standardization (ISO/IEC, 2019). These guidelines and principles are meant to serve as procedural safeguards against various issues that could hinder the legitimacy of the standard-setting process, such as low transparency or the marginalization of certain stakeholders.

Despite the importance of this development, we know very little about the extent to which such guidelines and procedural safeguards are implemented in practice. Indeed, our knowledge about the internal operations and dynamics in SDOs is very limited. Arguably, this is due to the very reason behind the introduction of the Good Standardization guidelines, namely the strict access rules to SDOs. This chapter seeks to achieve a better understanding of SDOs' internal processes and practices by analyzing the case of developing the international standard describing the testing procedures for measuring the energy consumed by Television (TV).

The IEC developed this standard, numbered IEC 62087 and titled "Audio, video, and related equipment – Determination of power consumption." This is a case whereby an international standard plays a central role in the functionality of widely adopted public policies.

The standard has been integrated into television's energy efficiency labeling regulations in the United States and European Union (EU). The ultimate aim was to reduce the consumers' energy bill, and environmental footprint generated by the use of TVs and create market incentives for manufacturers to design more energy-efficient devices. Given the far-reaching consequences of the IEC 62087, at stake are not only governance procedural aspects but also the effectiveness of the overarching regulatory system in achieving its intended societal and environmental objectives. Therefore, examining the legitimacy of the embedded standard in such governmental regulations is warranted.

As the guidelines and principles referred to above aim to address relevant legitimacy deficiencies, this chapter asks: how legitimate the process of setting the international standard for TV is with respect to the principles of Good Standardization? To answer this question, the process of developing the IEC 62087 is analyzed against the procedural safeguards of Good Standardization articulated in the WTO's six principles and the Guide 59. These guidelines are viewed as rooted in the normative principles of democratic legitimacy (i.e., input, throughput and output) and collectively comprise an overarching framework that international standard-setting should adhere to in order to legitimize their processes. Similar to other major SDOs, the IEC claims to adhere to and implement these guidelines and procedural safeguards.

The IEC 62087 proves to be an interesting subject of study since it governs a globally used technology (i.e., Television) and has been integrated into regulations that were widely applied with far-reaching societal consequences. As I show in the analysis, since the standard was adopted, it has repeatedly been criticized for being ill-suited to achieve its objectives, making it an interesting case to analyze its output legitimacy. Finally, the IEC—as a subject of study—has been surprisingly overlooked in the literature despite the focal role it plays in international standard-setting (for a recent exception, see Büthe, 2010a). To my knowledge, only a handful of papers have conducted a similar analysis (Delimatsis, 2014; Forsberg, 2012;

Kanevskaia, 2020) and this work is the first to shed light on why such a standard might have failed to achieve its intended objectives.

As developing the standard followed typical IEC procedures, lessons from this chapter will allow us to broadly reflect on how the Good Standardization principles are implemented in practice at this SDO. While the generalizability of the findings might be limited—given the scope of the study—they can still provide preliminary knowledge about the standard-setting dynamics in other similar SDOs, such as the ISO. Additionally, this chapter also seeks to explore what can be learned from detailed tracking of a single standard-setting process and interviewing the involved actors. The chapter also supplements a shortage of empirical studies on the legitimacy of global governance organizations and contributes to this literature by advancing our understanding of the potential legitimacy of international standard-setting.

In this chapter, I argue that the standard-setting practices in developing the IEC 62087 are inadequate if the goal is not just to bundle technical expertise but also to meet the standards of democratic governance in filling the respective governance gap. The chapter points to several practices in developing the IEC 62087 that hinder the legitimacy of the IEC standard-setting process.

The remainder of this chapter is organized as follows: Section 2 presents the theoretical approach by showing how the procedural safeguards defined by WTO, ISO and IEC can be rooted in the principles of normative legitimacy. The output of Section 2 is a set of components that serve as a criterion for analyzing the legitimacy of the IEC 62087 development process. In Section 3, the methodology and the data employed for the analysis are introduced. This is followed by a brief background information presented in Section 4. In Section 5, the IEC 62087 development process is analyzed using the legitimacy criterion developed in the theory section. Section 6 concludes by arguing that this research's findings call into question the legitimacy of the standards developed by the IEC.

2. THEORETICAL FRAMEWORK

Legitimacy has been broadly defined as "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995, p. 574). In the realm of global governance—whereby legitimacy is not derived through traditional democratic sources—the concept is multidimensional and contains significant ambiguity. One of the primary sources of normative legitimacy for SDOs is the implementation of quasi-democratic mechanisms in their structures and decision-making processes (Cafaggi, 2014). Meanwhile, the literature tells us little about what these mechanisms might entail and even less about how they can be implemented in practice.

These mechanisms are articulated in SDOs' internal procedures and, in principle, grant international standards with their legal effect. To address the concerns of developing countries in developing standards, SDOs should adhere to six procedural safeguards required by the WTO: transparency, openness, impartiality and consensus, effectiveness and relevance, and coherence. For that, major SDOs have developed internal codes of conduct to ensure adherence to such principles. A key guideline is the Guide 59, first developed in 1994 and later updated in 2019. This guideline requires national participating actors to respect six principles in standard-setting: inclusiveness, consensus-building attitude and skills, compliance with the procedures, efficiency, impartiality, commitment to quality and dedication of personnel and experts. In principle, such guidelines offer "procedural safeguards" to address the democratic deficits in standard-setting (Kanevskaia, 2020), ultimately leading to "good" standardization.

A close examination of these guidelines shows that they are rooted in the democratic principles for legitimating global governance regimes. Such principles have been identified by scholars as they sought to establish a criterion for the evaluation of the normative legitimacy of non-state rule-making. Most of this research builds on the work of Scharpf (1999) and

Schmidt (2013) and distinguishes between three dimensions of legitimacy, namely input, throughput and output. This chapter considers the procedural guarantees articulated in the WTO's six principles and Guide 95 as inherent in the three dimensions of legitimacy and that they collectively comprise an overarching framework that international standard-setting should adhere to in order to achieve legitimacy. To make such a framework empirically tractable, I discuss its concepts and operationalization in the next section.

Input legitimacy refers to the participatory and deliberative qualities of the decision-making process in the organization as well as its accountability toward stakeholders (Bäckstrand, 2010, p.149). Studies have repeatedly provided evidence suggesting numerous deficiencies in SDOs' input legitimacy, such as the dominance of relevant industries and underrepresentation of developing countries, women and stakeholders representing non-commercial interests (Büthe, 2010b; Dingwerth, 2008; Forsberg, 2012; Fuchs et al., 2011; Hauert, 2010; Heß, 2020; Wilcock & Colina, 2007).

Procedural safeguards from the WTO's six principles and the Guide 59—such as openness, inclusiveness, and addressing the concerns of developing countries—are considered as a means to enhance input legitimacy. While the governance literature is unclear about what throughput legitimacy actually entails (for an extensive review, see Steffek, 2019), scholars emphasize transparency and the consideration of all stakeholders' interests in actual decision-making as means to enhance the legitimacy of the process. In order for the stakeholders to monitor how the organization performs with respect to such aspects, stakeholders should be able to access records/information relevant to the organization's decision-making processes (Bekkers & Edwards, 2011). Relatedly, Faure and Philipsen (2020) show that the confidentiality practices implemented in SDOs might serve the interests of the powerful stakeholders only. Accordingly, procedural safeguards from the WTO's six principles and the Guide 59—such as transparency, consensus, impartiality and, to a less extent, coherence, compliance with the procedures, building attitude and skills, commitment to quality and dedication of personnel—can enhance throughput legitimacy.

Output legitimacy, in turn, is associated with evaluating the effectiveness of regulations in fulfilling the intended objectives (Bäckstrand, 2010, p. 149). Studies on the legitimacy of international standard-setting have been so far reluctant to empirically assess the extent to which standards meet the criterion of output legitimacy. This has been attributed to the complexity of identifying a particular objective for the standard being assessed and the variable implementation time of the standard (Hahn & Weidtmann, 2016). As de Bakker et al. (2019, p. 366) put it, "evaluating problem-solving effectiveness is a complex exercise influenced by timing, measurement, and most of all, who is judging." The IEC 62087 has to date been in use for two decades, and its efficacy has been independently validated and perceived by a number of experts and studies. The following analysis of the output legitimacy of IEC 62087 builds on these evaluations. Procedural safeguards from the WTO's six principles and the Guide 59, such as effectiveness and relevance, are viewed to enhance the output legitimacy of the standard-setting process.

Mena and Palazzo (2012) operationalized the three dimensions to assess the legitimacy of global governance bodies exercising regulatory power. The authors define four criteria for assessing input legitimacy: inclusion, procedural fairness, consensual orientation, and transparency, and three to assess output legitimacy: efficacy, coverage and enforcement. This chapter builds on their operationalization for the analysis of the IEC 62087 setting process as it covers the main democratic principles identified in the literature as well as the procedural safeguards from the WTO six principles and the Guide 59 as conditions for a governance process to be considered legitimate. Despite not being classified as a separate criterion for assessing legitimacy, throughput legitimacy is inherent in the operationalization framework.

Following Schmidt and Wood (2019) and (DeMenno & Büthe, 2022), I view throughput legitimacy as being covered by the aspects of procedural fairness, consensual and transparency.

According to the operationalization of Mena and Palazzo (2012), the chances for a process to achieve high input legitimacy are strong if all relevant stakeholders participate (inclusion) and are considered equal partners in the decision-making process (procedural fairness). Regarding the throughput dimension, chances for a process to achieve high legitimacy is strong if the elaboration of a standard, the voting procedures, or the repartition of power are disclosed (transparency) and stakeholders are able to change their positions in a given discussion on the basis of convincing reasons (deliberative and consensual orientation). Finally, high output legitimacy can be achieved if the number of stakeholders implementing the standards is high (coverage), the problem-solving effectiveness of the process output is high (efficacy), and the SDOs ensure that their rules are followed and applied in practice (enforcement). Due to the difficulty in counting all the manufacturers that have implemented the standard, coverage is considered relatively less helpful in evaluating the legitimacy of IEC 62087.

Scholars have also applied different legitimacy assessment models to standard-setting processes, such as corporate social responsibility and nanotechnologies (Eliantonio & Cauffman, 2020; Forsberg, 2012; Hahn & Weidtmann, 2016). Most of this work concludes that SDOs need further refinement to fulfill the prerequisites for inputs and throughput legitimacy, such as inclusiveness, transparency and accountability. I expect to find similar legitimacy deficiencies in the process of setting IEC 62087 (i.e., low input and throughput legitimacy). Meanwhile, none of this work has analyzed how legitimate standards are in terms of achieving the intended regulatory objectives (i.e., output legitimacy). This chapter seeks to contribute to filling this gap in the literature as well as show the extent to which previous findings can be present in an SDO that governs commonly used electrical appliances. The chapter will also show how deficiencies in the legitimacy of such an international standard can ultimately contribute to a failure to safeguard the interests of certain stakeholders.

3. METHODS AND DATA

This chapter employs multiple qualitative methods to collect and analyze empirical data for a case study (Yin, 2017). The data were derived from several sources: (1) fifty-nine internal IEC documents comprised of different drafts of the IEC 62087, compilations of participants' comments and results of ballots; (2) dozens of public documents related to the development of the labeling policies in the United States and EU such as documents related to the ENERGY STAR program developed by the United States Department of Energy, environmental agencies' reports, verification studies and other documents related to the development of the European labeling policy; (3) I conducted semi-structured interviews with the actors who have been identified through the analysis of the documents. Additional actors were interviewed because they have specific experience in the field (e.g., performing energy testing or developing standards for TVs). See Appendix A for further details about the interview subjects.

Interview questions were focused mainly on the following aspects: (1) how the participants in developing the IEC 62087 have formed their respective national positions at the IEC and what interests they represented; (2) how the energy measurement procedure was designed; (3) how the participants coordinate with their domestic standardization body; and finally (4) how the principles of Good Standardization were implemented throughout the process.

4. BACKGROUND

In the early 2000s, the Television industry attracted the attention of policymakers worldwide due to an increase in the electricity consumption of TV users. This was mainly due to the introduction of advanced, ever-larger then-new Plasma and Liquid Crystal displays (Crosbie, 2008). In response, several policy efforts in, among other countries, the United States and EU attempted to limit or reverse that increase in energy consumption.

4.1. Setting the IEC 62087 Standard

An essential component of an energy efficiency regulation is a measurement procedure that reasonably estimates the energy consumption of the appliance(s) being regulated. Such a procedure needs to specify, among other elements, the conditions under which the energy measurement should be conducted (i.e., the testing environment). These conditions should reflect real-life use environments (as much as possible). Energy efficiency labels, which are often one outcome of the regulations, have been recognized as an effective instrument in helping consumers to compare the energy efficiency of appliances on a reasonable basis (Stadelmann & Schubert, 2018). Note that bearing an energy label highlights the TV's energy efficiency, ultimately leading to increased manufacturers' sales (Northwest Energy Efficiency Alliance, 2011).

Around the year 2005, three standards existed for measuring TVs' energy consumption with different technical approaches: the U.S. Department of Energy measurement procedure, a procedure developed by the Japan Electronics and Information Technology Industries Association and the first version of the IEC 62087 that was developed by the IEC in 2002. Industry players tested the consequences of applying the existing energy consumption measurement procedures to their newly developed displays. Based on their testing results, the leading actors from both dominating technologies—Plasma and Liquid Crystal Displays (LCD)—argued that the three procedures are applicable only for the old cathode ray tube TVs and that they all failed to control for an essential element later called the Average Picture Level (APL).[3] These actors claimed that this failure causes an exaggeration in the energy amounts

[3] The APL is a measure of the luminance content of the television signal. In simple terms, it equals 0% when the screen is totally black and increases with brighter signals to reach 100% when the screen is totally white. By that time, APL as a notion was almost unknown, with no available way to measure it.

measured (Stobbe, 2007). In other words, the industry experts believed that their displays consumed less energy than what the testing results showed. This created a deep concern for the industry, especially for manufacturers producing Plasma displays. The display manufacturers offered to help regulators from the United States and EU develop a new energy measurement procedure that would overcome the deficiencies present in the existing standards—specifically in the existing energy testing procedure. It was agreed to develop the new procedure within the IEC framework and include it in the subsequent version of the IEC 62087 (Stobbe, 2007, p. 22).

Due to different technical reasons, the APL played a greater role in determining the amount of energy consumed by the Plasma displays than the LCDs (Jones et al., 2007). Sponsors of the Plasma technology from the industry fear of the APL issue was reflected in the substantial amount of work done by the main Plasma promoter, namely Dr. Larry Weber. With the help of other market players, Dr. Larry Weber not only found a way to measure the APL but also estimated a global average level. In addition to developing this fundamental component, he edited the procedure's main testing component, which is basically a 10-minute dynamic broadcast-content video signal. It was claimed that the video contains a variety of TV fragments that match what people typically watch on their TVs and imitate the average APL level (LCD TV Association, 2008).

The resulting measurement procedure was an essential element of the IEC 62087:2008. In simple words, a meter will record the energy consumed by TVs while a video is playing, with all settings set to default (i.e., manufacturer-recommended or out-of-the-box settings). The industry advocated that the test be performed based on manufacturer-recommended settings (Fairhurst, 2009), later called Home Mode. While this was not a definite requirement in the standard, the labeling regulations explicitly required it. Performing the test while the TV is on default settings was based on the assumption that consumers never change the default settings of their TVs.

4.2. Developing the Labeling Regulations

IEC 62087:2008 and its three subsequent versions, 2008, 2011 and 2015, were integrated into TVs' energy labeling programs in the United States (versions 4.0, 5.0, 6.0, 7.0 and 8.0 of the ENERGY STAR specifications) and EU regulations (EC/642/2009, no. 801/2013, EU 2016/2282, no. 518/2014 and EU 2017/254). For a TV to bear an ENERGY STAR label in the United States, the amount of energy consumed—measured according to the testing procedure described in IEC 62087—should fall below a certain threshold. Major TV manufacturers and other industry players were extensively involved in developing the specifications for the program.

In the EU, the Commission adopted another approach, whereby an energy efficiency rating is estimated for a given TV—based on performing the energy measurement method included in the IEC 62087—then displayed on the label. The EU Commission conducted several preparatory studies based on market data provided by the industry and discussed drafts of the regulation with stakeholders within consultation forums (for further details, see Stobbe, 2007).

4.3. The IEC Standard-Setting in a Brief

In the century since it was established, the IEC has become one of the most important technical SDO for millions of electronic devices used around the world (Büthe, 2010a). The IEC basically consists of its' members, executive and advisory bodies and internal officers. Countries interested in participating in the IEC work need to have an established National Electrotechnical Committee (NEC), which upon admission, is called the National Committee (NC) of the respective country. Only one NC can participate per country, and it should participate in standard-setting based on a consolidated position representing all national stakeholders. In principle, domestic standardization bodies establish national mirror committees composed of national stakeholders who coordinate with the respective NC to form a consolidated national position at the international level. Arguably this aggregation principle is a major source of input legitimacy for the IEC standard-setting process.

Developing a new or revising an existing standard is carried out within groups of NCs – interested in standardizing a given electrotechnical area—under an overarching Technical Committee (TC) umbrella. For example, the IEC 62087—including its different versions—was developed by an IEC TC numbered 100. NCs can participate in TCs as P-members, who tend to take an active role by attending meetings and voting, or O-members, who are allowed to attend certain meetings as observers with no voting rights. A broader range of stakeholders—such as environmental and consumer associations—can also participate but only as liaison members with certain participation rights. Organizations representing citizens and environmentalists' interests in SDOs—such as the European Association for the Coordination of Consumer Representation in Standardization (ANEC)[4] and the European Environmental Citizen's Organization for Standardization (ECOS—can take part in the IEC work as "Category A Liaison" a non-voting membership that allows them to attend certain meetings only.

In case of (technical) disputes and/or a need for external (technical) advice, IEC TCs can establish so-called Working Groups. The Working Group handles a specific—mostly technical—task of the overall work and is comprised of experts, who could be anyone recognized by the parent TC as knowledgeable in the topic being discussed. While much of the (critical) technical work is done at the Working Group level, many IEC rules and principles are not implemented there. For example, and unlike TC level rules, the balance of interests

[4] This is an umbrella group for 44 independent consumer organizations from 32 European countries.

presented in the Working Group is not monitored against bias or dominance by certain interest(s).

5. THE SETTING OF THE IEC 62087 AND THE LEGITIMACY CHALLENGES THEREOF

Based on the framework introduced above, this section undertakes a detailed legitimacy analysis for the process of setting IEC 62087. Specifically, the analysis is structured along the three dimensions of legitimacy by focusing on the criteria of inclusion and procedural fairness (comprising input legitimacy), transparency and consensual orientation (comprising throughput legitimacy), coverage, enforcement and efficacy (comprising output legitimacy).

5.1. Inclusion and Process Fairness (Comprising Input Legitimacy)

The IEC internal documents show that the TC100 was comprised of 30 NCs who submitted a total of 471 comments. Seven P-members only representing industry-leading players and developed countries provided all comments. One of these NCs submitted around 50%, and another two NCs jointly submitted 40% of the total comments. Apart from these seven, no other NCs submitted any comments. When I asked about the reason behind this distribution of voting, interview subjects suggested that expertise plays an important role and that this situation is not unusual. For example, one interviewee responded to my question with: “From my several years of experience, a small number of people do most of the work in a given TC—the ones with expertise. The rest basically decide if they can live with the content” (interview subject no. 4).

Moreover, ANEC and ECOS were neither involved nor consulted in developing the standard. Several interviewees confirmed the absence of consumer and environmental representatives and interests. For example, interview subject no. 2 said: “Government was involved but not TV users. Consumers associations are usually worried about risky products but not TVs." Evidence suggests that a lack of funds is preventing such bodies from being present at the meeting. A former ANEC employee confirmed that and said: "We have experts, and I believe that if we could sit at the table, the industry would listen to us. Unfortunately, we do not have enough funds to participate in the meetings" (interview subject no. 11).[5] Finally, I had the chance to review the composition of one of the NCs that submitted a substantial amount of comments. The committee consisted of five producers and suppliers with no presence of consumer associations or environmentalists.

The above evidence suggests that several major (technical) assumptions regarding how TVs are typically used were made without (sufficient) consultation with consumers, such as the assumption that consumers never change default TVs' settings. Similarly, the global average APL level was estimated without consulting consumer associations or testing labs and based on data collected from a small number of countries.[6] This raises concerns about the interest(s) served when the actors from Plasma technology dominated the processes of measuring as well as estimating the global average level of APL. As the Plasma sponsors were relatively more concerned about the measurement method,[7] delegating the task of estimating a global average level APL level to them—with no consultations with consumer associations—increased the risk of biasing the data.

The industry is also able to increase its influence, when needed, in a given TC by "activating" NCs to increase their voting power effectively. When I asked about the interests represented in developing the IEC 62087, two interview subjects—who participate in several TCs—answered: "I try to convince my national mirror committee that the position of my sponsor will be best for the country. If I fail in doing that, my sponsor will most probably

[5] I tried to include more interview subjects from civil society organizations such as the European Association for the Co-ordination of Consumer Representation in Standardization and the European Environmental Citizen's Organization for Standardization. Unfortunately, they ignored/rejected my several invitations for an interview.

[6] The average APL was estimated based on data collected from the US, the UK, Australia, the Netherlands and Japan.

[7] This can be seen in letters submitted to the Environmental Protective Energy (EPA) by Dr. Larry Weber. Available at https://www.energystar.gov/index.cfm?c=archives.tv_vcr_spec

activate additional NCs to support our position" (interview subject no. 10). Interview subject no. 3 said as a reply to the same question: "Companies increase their influence, whenever needed, by increasing their voices in a given TC."

Moreover, some evidence points to insufficient implementation of the "aggregation principle." In setting IEC 62087:2008, there is a lack of—or insufficient—coordination between NCs and respective national mirror committees. Responses from interview subjects confirmed that NCs primarily consulted their employers—in this case, almost all of the participating actors were manufacturers—in the process of forming their national positions regarding different aspects of the IEC 62087. Several interview subjects confirmed this practice in IEC standard-setting: I list their response to my question about this issue in the following paragraph.

Interview subject no. 5 said: "I consult my company, as they are the ones paying me, you know." Interview subject no. 3 responded: "In setting the IEC 62087:2008, NCs were not able to consolidate inputs from mirror committees. For me, I consulted my manufacturer first." Similarly, interview subject no. 4 said: "NCs' inputs usually reflect manufacturers' opinions and/or their own expertise. In fact, mirror committees usually consist of manufacturers only," and interview subject no. 10 said: "I need to balance between three interests: of the manufacturer I am presenting, the national interest, and the IEC interest. I prioritize my sponsor interest; it's an industry-driven organization." The last interviewee added: "Members representing governments face issues in organizing their voice in a consolidated position, mainly due to bureaucracy and weak coordination with the industry. It is not the IEC job anyway to ensure balanced representation at the national level; it is the responsibility of the NCs. Finally, interview subject no. 9 responded as follows: "We do our best to ensure a balanced representation of interest in the national mirror committee; however, in this case, it was only the industry."

Concerning public access to IEC standard-setting, the main relevant tool introduced by the IEC to obtain public comments through their website proved to be ineffective. One of the interview subjects, who have access to performance data of this tool, said that the public commenting tool introduced a number of years ago on their website has—at the time of conducting the interview—registered a few records only (interview subject no. 9). Consequently, the public is left with little opportunity to participate in developing IEC standards.

In sum, the process of developing the IEC 62087 was dominated by a very small number of male industry representatives from developed countries. Consumer and environmental groups, as well as women, were absent. The process lacks an effective mechanism for public participation and does not provide all stakeholders with equal chances to obtain different participation rights. Finally, stakeholders' financial and technical capabilities are key to gaining greater participation rights in IEC standard-setting. All this, arguably, undermines the input legitimacy of the IEC standard-setting process.

5.2. Transparency and Consensual Orientation (Comprising Throughput Legitimacy)

Access to IEC meetings or documents is restricted to certain members. In fact, such access varies even amongst members of a given TC. For instance, NCs with O-membership cannot access all technical documents and meetings. For research purposes, I was able to access an internal IEC portal where—according to the IEC—all available documents related to developing the IEC 62087 were posted. In this regard, several findings should be highlighted.

First, important documents such as minutes of (technical) meetings were not available in the portal or even did not exist. Evidence from the interviews points to informal avenues of decision-making. Interview subject no. 3 said: "At TC100, we resolve conflicts (if any) based on technical negotiations. We try to avoid conflicts at the voting stage." When I asked about how agreements on different issues are achieved, interview subject no. 4 said: "Most of the agreements are concluded during coffee breaks." This suggests that technical agreements are reached, and potential conflicts are resolved without (sufficient) documentation. For example, in order to develop and estimate the global average APL that reflects what consumers experience while watching TV in real-life, TC100 had to rely on scientific data and expert opinions provided by certain participants—interview subject no. 1 confirmed that. Relatedly, I failed to find any relevant documentation even after asking several TC100 participants for them. The same applies to the assumption that consumers do not change their TVs' default settings, which had a considerable ultimate effect on how the measurement procedure should be designed. Many of the documents that I accessed were merely short summaries of discussions and drafts of the IEC 62087, showing almost no details about the rationale/data behind the (technical) decisions made.

Moreover, I failed to find documentation related to how the experts were identified to get involved in the work at the so-called Working Group level. These external experts invited by the TC100 can use their opinions as technical inputs to the work. These sub-committees have even stricter access rules. For example, O-members are not allowed to attend such meetings. Given that these participants are sponsored (in many cases employed) by their market players, transparency becomes crucial for maintaining impartiality in the work. The same applies to the members of the TC100. Identification details, such as names and affiliations of some participants, are not publicly available. I obtained such information from interview subjects and through public sources posting information about the TC100.

In the case of IEC 62087, stakeholders representing interests other than the commercial were almost entirely absent. Consequently, consensus had to be achieved among the participating manufacturers only. In fact, due to the lack of documentation, there was no way to review how disagreements (if any) among the participants were resolved despite the existence of against-votes in the ballots. Moreover, some NCs have rules that oblige their representatives to vote in favor by default unless there is a major issue that is not in the interest of the NC. Such practices exaggerate the acceptability of the standard, at least among the participating stakeholders. Several interview subjects confirmed this practice; for example, interview subject no. 4 said "Every NC has its' own rules for voting. Generally, if they can live with the content, there is no reason not to vote Yes."

In sum, the closed-door policy for conducting meetings and lack of documentation hinders the transparency and traceability of the process, especially for non-participating stakeholders. Almost all relevant information and documents are rarely disclosed, even for research purposes. All this made it difficult to analyze how agreements were reached, and disagreements were resolved (if any) in developing the standard. Consequently, and arguably, several aspects of the throughput legitimacy are undermined.

5.3. Efficacy, Coverage and Enforcement (Comprising Output Legitimacy)

Several recent testing studies and expert reports have found that the intended objectives of several versions of the IEC 62087—including the labeling regulations, whereby the standard was integrated—were insufficiently achieved (Hall, 2017; Neslen, 2016; Tinetti et al., 2015). Note that achieving the objectives of energy efficiency regulations depends upon how the end users interpret the information shown on the label (Stadelmann & Schubert, 2018). Indeed, many studies have found that the energy consumption amounts indicated on the labels overestimate the TVs' efficiency both in the United States and the EU. Verification tests and expert opinions presented below show that the energy measurement procedure was applied under unrealistic testing conditions, causing TVs to consume less energy during the testing. Consequently, the TVs' out-of-the-box settings left consumers unsatisfied with the brightness of their screens when first turned on. Consumers, in turn, had to modify the settings and increase the brightness of the screens to achieve reasonable pictures (DECO Proteste; Taub, 2009).

The above suggests that manufacturer-recommended settings repeatedly failed to reflect real-life use conditions—at least concerning the TVs' brightness levels that were unrealistically low. Evidence from my discussion with the Portuguese consumer association, which conducted one of the testing studies cited in this chapter, supports my finding. When I asked for further details about their testing, they said: "Unfortunately, through our tests done in 2014, we found a disturbing discovery. In many devices, in order to achieve a good energy label—more appealing to the consumer—manufacturers have begun to offer poor image quality with the default settings. On many TVs, the images are even darker and have less contrast than desired" (interview subject no. 12). Meanwhile, verification tests suggested that changing default settings causes a substantial increase in power consumption—sometimes up to 50% beyond the value declared on the label (Michel et al., 2013; Stiftung-Warentest, 2011).

Such a discrepancy in the energy testing procedures described in the IEC 62087 has even been described as a loophole in the energy efficiency regulations by ANEC and the Bureau Européen des Unions de Consommateurs in their comments on a discussion paper presented by the EU Commission in 2015 (Malizou, 2015). A loophole in the sense that manufacturers lowered their default settings to achieve higher energy efficiency ratings while taking advantage of the fluid requirements in both the IEC 62087 and the labeling regulations.

Evidence from the interviews also suggests that testing experts would have a different approach if they were present during the standard-setting. Interview subject no. 11 said: "If I was there, I would have set the TV to average using conditions and then applied the test. We normally inform the IEC when we find the testing procedure unrealistic." Consumer reports and verification studies at that time continued to suggest, among other issues, that testing conditions are not representative of real-life use conditions (Baton et al., 2017; Willcox, 2015). A study done by the Natural Resources Defense Council estimated the value of unpredicted energy consumed by TVs at $1.2 billion in the United States alone (Horowitz & Remick, 2016)

(Horowitz & Remick, 2016). In the EU, the regulation was amended in 2016 because the verification tolerances laid down in the implementing measures were exploited by some manufacturers to achieve higher energy efficiency ratings (EU Commission, 2016).[8]

Finally, updating the standard by the IEC took a number of years, causing the standard to be outdated—vis-à-vis existing technologies—at the time of its publication. Indeed, TV technologies developed faster than anticipated by regulators in the EU and the United States (Howard et al., 2012). Practitioners argue that this was partly due to the industry providing outdated data as part of their inputs to help design the energy efficiency regulations. In the EU, the predictions made by the regulations' preparatory study—to analyze the market status and technology progress—were far from what later materialized (Centre for Strategy and Evaluation Services and Oxford Research, 2011). Indeed, the majority of TVs met the requirements before the labeling regulation even entered into force (EU Commission, 2012; Michel et al., 2014). Meanwhile, critics suggested that the standard as well as the regulations were based on manufacturers' preferences and helped the manufacturers achieve exaggerated energy efficiency ratings for their TVs (Huulgaard & Remmen, 2012), ultimately hindering the regulations' intended positive impact (Christensen et al., 2019).

Concerning the coverage aspect, determining the number of IEC 62087 adopters is time-consuming, and the output of such a task would most probably not be informative. While the implementation of the IEC 62087 per se is voluntary and not legally binding, adherence to the overarching labeling regulations—and hence adopting the standard—is "inevitable" for TV manufacturers if they want to access the markets in the United States and the EU. The standard, therefore, was indeed adopted by many TV manufacturers and, in that sense, has high coverage.

[8] Verification tolerances are designed to allow for variations that emerge in the measurements taken during verification tests, which are due to the differences in the measurement equipment used by manufacturers and surveillance authorities (EU Commission, 2016).

However, this cannot be considered indicative of high output legitimacy, not least because compliance is—in a sense—obligatory.

In terms of enforcement, and similar to other major SDOs, the IEC neither monitor the implementation of nor the compliance with its standards. These tasks are left to different public and market verification/testing authorities. The IEC 62087, therefore, can be characterized as having low enforcement. As noted above, the standard has been repeatedly evaluated for its effectiveness in accurately measuring the energy consumed by TVs at different points in time and by a number of experts and verification studies. All of this work points to deficiencies in fulfilling the standard's intended objectives, further undermining the output legitimacy of the standard.

6. CONCLUSION

This chapter has sought to examine the legitimacy-seeking aspirations of the IEC by comparing its normative claims of implementing the Good Standardization principles with the actual practices of developing the IEC 62087. For that, a number of interviews with the actors who substantially shaped the standard were conducted, and dozens of relevant documents were analyzed. Based on the findings of this analysis, I argue that the practices of developing the IEC 62087 is inadequate if the goal is not just to bundle technical expertise but also to meet the standards of democratic governance in filling various governance gaps at the interface of technology and society. This deficiency has ultimately contributed to a failure to safeguard the interests of consumers and environmentalists. Arguably, addressing such issues can enhance the overall legitimacy of IEC standard-setting.

First, while achieving full representation of all stakeholders in IEC standard-setting might be impractical, the evidence of this analysis shows a severe imbalance in the representation of stakeholders' interests, resulting in a bias in the distribution of power among the stakeholders. A small number of male actors representing developed countries and associated with commercial interests dominated almost the entire process. The most important (technical) aspects of the standard were designed based on the preferences of the participating actors while paying little attention to the interests of the stakeholders who were not present. Additionally, actors equipped with relatively greater financial and technical capabilities have greater opportunities to patriciate as well as intensify their voices in IEC standard-setting. Meanwhile, (female) actors representing non-commercial interests and developing countries were almost absent throughout the entire process. All this considerably undermines the input legitimacy of the process.

Second, while the technical expertise—offered by the experts who joined the Working Group—utilized in developing the IEC 62087 was supposed to act as a source of legitimacy to the process, insufficient transparency regarding how such expertise eventually shaped the TC decision-making undermined the throughput legitimacy. The analysis provides evidence suggesting insufficient monitoring by the IEC to how the Working Groups' experts get nominated to join the work and how valid their technical opinions are. In addition, the non-participating stakeholders at the TC level did not have the opportunity to verify whether their preferences were included in the IEC 62087 or not before it got published. Consequently, the ability to participate and influence IEC standard-setting is distributed unequally amongst stakeholders. All this further hinders the accountability of the IEC as a global SDO for electrotechnology as well as the participating actors toward the absent stakeholders.

Finally, many expert reports and verification studies have criticized the ability of the standard—and ultimately the labeling regulations—to fulfill the intended objectives. The unexpected increase in the amount of energy consumed by TVs caused a rise in both consumer energy bills and potentially the respective environmental footprint. This has been—at least partly—caused by TC 100 members making inaccurate assumptions about how users watch

TVs in real-life environments. Output legitimacy has been further undermined by the IEC's inability to ensure proper compliance with the standard by the official testing authorities and industry players. The evidence of this analysis suggests that industry players exploited loopholes in the standard—as well as the labeling regulations—and official testing implemented the energy testing procedure literally with less attention to its usefulness. Meanwhile, and despite the many complaints raised by consumer and environmental associations about the issues in the standard, no serious actions were taken by the IEC—such as presenting procedural safeguards to mitigate similar future risks—beyond updating the standard through a process that took a number of years to be completed.

This chapter offers important avenues for future studies: first, further research should verify the presence of legitimacy deficiencies (similar to those presented in this chapter) in other international standard-setting areas. Second, scholars should establish a—or improve the existing—criterion for assessing the legitimacy of international standard-setting processes; the vagueness of such criterion has weakened the findings presented in this chapter. Finally, both scholars and practitioners should suggest ways to enhance the transparency of the standard-setting process without jeopardizing the confidentiality of the technical dimension of the work.

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Chapter 3 – Opening up International Standard-Setting: More or More of the Same?

1. INTRODUCTION

Over the past century, developed and industrialized countries from the Global North have been establishing and dominating various Global Governance Organizations (GGOs), such as the organizations developing international standards.[1] The influence of these Standards Developing Organizations (SDOs) has been meanwhile growing, sometimes to a level that it impinges upon national policymaking (Kingsbury et al., 2005; Morais, 2002). Such structure of the global system has triggered backlashes, largely from the Global South, calling for more democratic and representative global governance (Stewart, 2014; Zürn, 2004), including international standard-setting (Communication to the WTO, 2019). Meanwhile, scholars have been warning that the continued existence of a North-South imbalance in global governance could eventually hinder the legitimacy of its organizations as well as threaten their role in maintaining the existing international order (for example, see Graz & Nölke, 2007).

Against this backdrop, a number of GGOs have introduced various opening up measures and reforms geared towards integrating the voice of traditionally marginalized stakeholders in their rule-making (Grigorescu, 2015; Jönsson & Sommerer, 2013; Tallberg et al., 2014).[2] Aiming at the same objective, major SDOs, such as the International Standardization Organization (ISO) and International Electrotechnical Commission (IEC) followed other organizations and implemented numerous measures for achieving the so-called

[1] The focus of this chapter is international standard-setting, which is—including its organizations—viewed as part of the global (private) governance. Private global governance is defined essentially as “the decision-making processes and the binding decisions of private groups that affect the quality of life and opportunities of a larger public.” (Rudder, 2008, p. 901)

[2] As I show in the following section, developing countries and stakeholders representing non-commercial interests have long been considered marginalized in GGOs, including SDOs.

Good Standardization Practices (Kellermann, 2019).[3] Such opening up movement was reinforced by the Technical Barriers to Trade (TBT) Committee that developed the Code of Good Practice, which also came as a response to external calls for greater inclusiveness in international standard-setting (Delimatsis, 2018, p. 284). The TBT Committee agreed on six principles that international SDOs should implement in their processes in order to develop standards that, among others, include the preferences as well as serve the needs of all stakeholders (Committee on Technical Barriers to Trade, 2000).[4]

Despite being in force for more than two decades, very little has been done to empirically investigate the effectiveness of the SDOs' opening up measures in achieving their goals (for recent exceptions, see Kanevskaia, 2020; Pauwelyn et al., 2022). My first objective in this chapter is to contribute to closing this gap in the literature by asking whether, and if yes, to what extent, international SDOs' opening up measures improved the participation of developing countries in the organizations?[5]

While the opening up movement has long been viewed as key for integrating the less-developed world into international standard-setting (Delimatsis, 2018; Delimatsis et al., 2021; Stevenson, 2016; von Bogdandy, 2012), relevant studies puzzlingly show that cross-national reactions—what was expected to be a general increase in participation—have considerably differed (Contreras, 2014; Lavenex et al., 2021b; Na-Young, 2019; Pauwelyn et al., 2022). At the same time, literature is providing inconclusive evidence about the status of the North-South

[3] Among others, the ISO/IEC Guide 59 was developed. The guideline is entitled: "ISO and IEC recommended practices for standardization by national bodies." (ISO/IEC, 2019).

[4] The six principles are articulated in Articles 2, 3 and Annex 3 of "Decision of the Committee on Principles for the development of International Standards, Guides and Recommendations." The principles are transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and the development dimension. See also G/TBT/9, 13 November 2000, para. 20 and Annex 4.

[5] This is my first question. I define participation broadly to include countries' utilization of different participation mechanisms offered by SDOs to take part in international standard-setting. While participation in SDOs is country-based, the delegates at the international level are often non-state actors. Regardless of their actual affiliation (such as industry-sponsored, environmental organization representative, or consumer association representative), the participating actors are required—at least by the major SDOs—to represent all national stakeholders/interests.

imbalance in SDOs (for example, see Hanegraaff & Poletti, 2021; Peña, 2014).[6] Moreover and relatedly, scholars are arguing that the participation decision of a given country is driven largely by domestic conditions (for example, see Lavenex et al., 2021a), suggesting that the developing countries' low participation in SDOs will not be improved by altering the supply side of the international standard-setting system (Kanevskaia, 2020; Pauwelyn et al., 2022). Indeed, in contrast to the predominant emphasis on economic capabilities (Bartley, 2018; Uhre, 2014), recent studies are showing a host of other factors driving countries to participate in SDOs (for example, see Blind & von Laer, 2021; Lavenex et al., 2021b, p. 109).

All this makes my first question more central and casts doubts about our knowledge of countries' drivers to participate in GGOs/SDOs. My second objective in this chapter is to achieve a better understanding of the above-interrelated issues by raising the following question: what could explain the variation in countries' participation in international standard-setting?

Drawing on the literature on global governance and Power Transition Theory, I derive three theoretical expectations: for the first question I raise in this chapter, studies led me to expect that if a given SDO introduces opening up measures, then the likelihood of developing countries' participation in that SDO will increase. For my second question, theory suggests that the greater a country's economic power, the greater the likelihood of its participation in a given SDO; I also expect that the greater a country's industrial capability of products governed by an SDO, the greater the likelihood of its participation in that SDO.[7]

This research focuses on international technical standards, as opposed to previous analyses of other global regulatory issue areas (for instance, see Pauwelyn et al., 2022, on

[6] For instance, Hanegraaff and Poletti (2021) argue that wealthier countries—relative to their economic size—are actually underrepresented in the World Trade Organization (WTO) and the United Nations Climate Summits.

[7] As I explain in the following section, a country's relevant industrial capability is essentially viewed as the country-level export volume of relevant products. In the case of IEC, relevant products are electrical and electronics regulated by its standards.

global finance and health). Specifically, I empirically investigate my questions within the context of the IEC.[8] The IEC is an important as well as an interesting case for several reasons: First, its substantive importance in global governance as the focal point for setting electrical and electronics standards that regulate a wide range of products and components used in everyday life. Second, the IEC is one of the SDOs that has introduced numerous measures geared to increasing the participation of traditionally marginalized stakeholders over the past two decades. Third, given the relatively narrow scope of the products regulated by its standards, the IEC serves as a specific standard-setting issue area. Consequently, by studying this case, the chapter responds to calls for theoretical explanations and empirical analyses—of countries' participation in GGOs—that are sensitive to issue-specific differences (Lavenex et al., 2021a). And finally, data availability.

To test my hypotheses, I leverage a number of datasets retrieved from different sources. For the first hypothesis, I analyze internal and public IEC data containing various information about the participation of its member countries over the past two decades with an aim to examine observable implications generated by the hypothesis. Particularly, I analyze the participation of IEC member countries through six participation mechanisms offered by the organization for countries to influence its standards.[9]

However, doing that alone is insufficient to draw final conclusions, not least due to the lack of a benchmark to assess the significance of the increase, if any, in developing countries' participation in the IEC. Therefore, I supplement the analysis with two additional methods for detecting and measuring the magnitude of positive trends in developing countries' participation, as presented in section 5.4. In this part of the analysis, I focus on member

[8] Unlike typical GGOs that develop rules for addressing global issues such as climate change, SDOs often develop standards that are highly technical with narrow scopes.

[9] Participation in the IEC is primarily country-based. Meanwhile, member countries' utilization of these mechanisms does not guarantee influence in IEC standard-setting. I provide more details in the analysis.

countries' participation through voting, as it is one of the main participation mechanisms in the IEC.

For the assessment of the second and third hypotheses, I use a regression model to examine the relationships between the two variables suggested by the literature and countries' participation in the IEC. For that, I leverage data retrieved from relevant public sources to construct my independent variable and IEC's internal data for member countries voting to construct my dependent variable.

The analysis provides evidence showing that the opening up measures taken by the IEC to improve the participation of the developing countries in its standard-setting have been, at best, only slightly effective in achieving their objectives. If these measures had any effect, they benefited only a small group of member countries, mostly experiencing growing economic and industrial capabilities. In addition, the analysis shows that national participation in the IEC is largely driven by these capabilities. Arguably the opening up measures contributed to strengthening the IEC by increasing the number of its member countries and the diffusion of its standards globally.

The contribution of this research consists of several folds: first, by analyzing the power structure of a prominent global SDO, the analysis of this chapter brings much-needed empirical evidence to ongoing debates on inclusiveness and the North-South imbalance in international technical standard-setting; second, this work contributes to debates on the behavior of emerging economies in SDOs by identifying as well as studying the participation of the countries increasing their roles in the IEC; third, my findings advance our understanding of patterns in countries' participation in SDOs, as well as the factors influencing such patterns; fourth, the findings of this analysis have implications for legitimacy and bias in international technical standard-setting for the electrotechnology; finally, I hope to advance debates over dynamism in countries capabilities and how it can shape the existing global order and future global technology markets.

The chapter proceeds as follows. In Section 2, I review pertinent literature, outline the puzzle and derive my hypotheses. I introduce the IEC in Section 3. In Section 4, I describe the datasets and empirical strategy. In Sections 5 and 6, I present my empirical analysis and assessments of hypotheses. In Section 7, I interpret the results in light of the theoretical expectations. I conclude and suggest avenues for further research in Section 8.

2. THEORY

Evidence from literature is increasingly showing that participation in international standard-setting is beneficial both at the micro (e.g., Wakke et al., 2016; Wu & de Vries, 2022) and macro levels (e.g., Blind & Jungmittag, 2008). At the same time, marginalized and other non-participating stakeholders in this area of global governance face different negative consequences. For commercial stakeholders, failing to keep up with standard-setting could lead to a loss of market share (Büthe & Mattli, 2011; Swann, 2010). As international standards do not automatically conform to domestic conditions (Glasbergen, 2018), nations absent from standard-setting might end up with nonfunctioning and/or high-priced products (David, 1986; Malkin, 2007).

Given the high stakes, scholars repeatedly asked: who set international standards? The reported evidence is, meanwhile, becoming increasingly inconclusive. On the one hand, many studies show that the developing countries—which are of utmost need to the benefits of participation in international standard-setting—are critically underrepresented in SDOs (Büthe & Mattli, 2011; Dingwerth, 2008; Fuchs et al., 2011; Schleifer et al., 2019; Tamm Hallström, 2000). Graz (2018) argues that even the industry players—which are typically best positioned to participate in SDOs—from developing countries are struggling to obtain a seat at the table.

Even countries such as South Korea—which is known as an active late-joiner to several international SDOs—its participation proved to be lower than expected (as shown in an analysis of Na-Young, 2019, in the ISO and IEC). Similar evidence has been reported after the opening up movement in SDOs. Renckens and Auld (2019) provided evidence showing the persistence of the North-South imbalance in the Marine Stewardship Council despite introducing opening up measures.[10] Louis and Ruwet show that despite implementing different opening up measures, the ISO membership remains "too Eurocentric and too industry-oriented" (Louis & Ruwet, 2017, p. 11).

On the other hand, other studies are witnessing an increase in the participation of some developing countries, such as South Africa, India, Indonesia and Malaysia (Horner et al., 2018; Hughes et al., 2012; Parizek & Stephen, 2020; Schouten & Bitzer, 2015; Tallberg et al., 2013, 2014) in setting numerous global standards (for several analyses in different issue areas, see Pauwelyn et al., 2022). Peña (2014) argues that many developing countries are not as disadvantaged in SDOs as theory suggests and highlights Brazil's growing role in the making of the international standard for social responsibility, namely ISO 26000. Similarly, Rohitratana (2022) showed that the development of SA 8000 standard was an inclusive process. Among others, Contreras (2014) and Gamito (2021) show a rapid increase in China's participation and probably influence in the Internet Engineering Task Force and the International Telecommunication Union (ITU). It should be noted that the countries driving most of the participation improvement reported in the literature were those countries experiencing growing financial and probably industrial capabilities—referred to by scholars as the Rising Powers or BRICS.[11]

[10] The Marine Stewardship Council is a global certification scheme for sustainable fisheries.

[11] The most prominent Rising Powers are the so-called BRICS countries—referring to Brazil, Russia, India, China and South Africa. The term BRICS was coined in a 2001 Goldman Sachs report entitled "Building Better Global Economic BRICs" by Jim O'Neill. Much of the literature has focused on these countries only, especially on the first four among them, leaving many other developing countries with very little attention.

These findings warrant an up-to-date examination of the players setting international standards. Importantly, literature tells us very little about who is setting international standards that regulate different technical aspects of products we use in everyday life. These standards are often highly technical compared to standards regulating other regulatory issue areas, making participation in developing the former a challenge for stakeholders who do not have sufficient technical capabilities. Many technical standards are developed in major international SDOs, such as the ISO and ITU, that serve as platforms for stakeholders to set these “de jure” standards. It should be noted that scholars are still struggling to develop a universal framework for definitions and types of international standards.

Besides the scarce and inconclusive evidence, literature on national participation in SDOs contains little empirical investigations of (what could explain) patterns in countries’ participation (for a recent exception, see Baron, 2020).[12] The few existing empirical analyses focus narrowly on a certain standard or utilize highly aggregated or indirect measures of participation (for recent study utilizing a large participation dataset, see Winzen & Weyrauch, 2019).[13] All this warrants further empirical and longitudinal analysis aimed at depicting a more nuanced picture of cross-national participation in international technical standard-setting.

Moreover, we know rather little about why some countries participate in SDOs more than others in the first place. Recent studies on different types of GGOs suggest that participation is largely a country-level decision to “develop requisite—fundamentally political and issue-specific—capabilities” (for a discussion, see Lavenex et al., 2021a). Some scholars put less emphasis on economic capabilities (Tallberg et al., 2018), while others argue for disentangling relative economic power from wealth (Hanegraaff & Poletti, 2021).[14] Villarreal

[12] Uhre (2014) finds that available financial resources and proximity to meeting avenues can explain participation in the United Nations Framework Convention on Climate Change and the United Nations Convention on Biological Diversity.

[13] Andonova et al. (2017) find a relationship between ambitious national public policies and participation in internet standard-setting.

[14] Hanegraaff and Poletti (2021) call for establishing a relative measure of density that places patterns of participation in GGOs in relation to countries’ economic power.

(2018) argues that the dominance of the commercial interest in the ISO and IEC is making it difficult for these SDOs to increase the participation of developing countries in the organizations, suggesting that the commercial interest is what drives participation. Henry et al. (2019) show that the design of the organization itself plays a role in explaining countries' participation in it. The bulk of the literature, meanwhile, remains focused on transnational climate governance (Andonova & Sun, 2019; Cao & Ward, 2017; Kahler, 2017; Leiponen, 2006) while paying little attention to organizations developing technical standards.

Studies on SDOs report evidence in line with the above while suggesting a more complex account of countries' drivers to participate in these organizations. Green (2017) shows that greater number and activity of local Non-Governmental Organizations increase the likelihood of countries' participation in developing carbon standards. Winzen and Weyrauch (2019) link variation in countries' participation in the Internet Engineering Task Force to the distribution of transnational leadership positions and information patronage. Some scholars report a correlation between the distance to the standard-setting meeting avenue and stakeholders' participation (for example, see Waguespack & Fleming, 2009); however, the recent digitalization of the standard-setting processes raises doubts about the continued validity of these findings.[15] Despite the prominent role played by the relevant industries in international technical standard-setting, the relationship between countries' industrial power and the likelihood of participation in SDOs has been severely underappreciated in the literature (for exceptions, see Blind, 2006; Blind & Mangelsdorf, 2013).

All this raises doubts about the effectiveness of, or even the need for, the opening up measures carried by SDOs (for a discussion, see Büthe et al., 2022). Relatedly, Kanevskaia (2020) finds that SDOs implement due process requirements, such as the six principles of the

[15] As different participation-related costs have been repeatedly highlighted as major barriers facing developing countries (Villarreal, 2018, p.54), many of these measures have been geared to reduce these costs. This includes introducing numerous digital tools to facilitate remote voting and the circulation of relevant documents.

TBT Committee, only to the extent acceptable by the concerned member countries. Last but not least, the primary focus of the stream of studies on SDOs has been on commercial actors (from the developed world) or company-level participation in different standard-setting forums (Aggarwal et al., 2011; Bar & Leiponen, 2014; Baron et al., 2019; Blind & Thumm, 2004; Büthe & Mattli, 2011; Hsueh, 2017; Ranganathan et al., 2018; Waguespack & Fleming, 2009), leaving developing countries and their stakeholders with very relatively little attention. Having reviewed the literature, I derive my theoretical hypotheses in the following two subsections.

2.1. The Opening up of International Standard-setting

I draw on Power Transition Theory literature to derive the first hypothesis. Early works suggest that countries experiencing internal growth in different capabilities can rise in the global power structure and eventually replace dominating/established countries (Organski, 1958). In this perspective, developing countries might be able to peacefully, or through war, take over a rigid global system.

Conversely, more recent studies emphasize the adaptation of GGOs to power shifts among countries as opposed to the total replacement of the established powers by new powers. Responding to the integration demands by the marginalized stakeholders is key against the rise of challengers to the system, especially from the Rising Powers, as they are best positioned for that among the developing countries. China's establishment of the Asian Infrastructure Investment Bank as a counter organization in the global finance is a form of "peaceful" challenging behavior (He & Feng, 2019).

Scholars argue that the organizational adaptation to power shifts might take place essentially through one of two approaches: accommodation or integration (for conceptualization, see Dany & Freistein, 2016). Both of these approaches emphasize, among others, the agency and incentives of GGOs' leadership to increase, at least quantitatively, the participation of developing countries. For instance, Tamm Hallström (2006) argues that the

ISO is not merely a platform for its standard-setting but an actor with certain contribution. First, GGOs might adapt by accommodating developing countries' demands in the form of organizational reforms that ultimately further enhance the power of the established countries (Auld et al., 2015; Kirshner, 2012; Paul, 2016). Kruck and Zangl (2019) termed such an accommodation approach "strategic co-optation." The authors argue that the established countries can obtain the potential challengers' support to the organization by offering mechanisms geared to increase the latter's quantitative participation (also, see Smith et al., 2017). In the same vein, Shelton (2021) and Delimatsis et al. (2021) argue that a restructure of GGOs reflecting the (recent) shifts in the global economic power structure is inventible, otherwise many GGOs will not survive. Second, optimistic scholars argue that GGOs might offer mechanisms that allow marginalized countries to be genuinely integrated into the rule-making process, not least because this will ultimately strengthen the organization as a whole (Ikenberry, 2011; Kahler, 2013).

Regardless of the intention for opening up, whether it be accommodation, integration (or strategic co-optation) of the developing countries in GGOs, the above strands of thinking suggest that developing countries—especially Rising Powers—will eventually increase their participation at least quantitively.[16] According to this line of argumentation, I derive the first hypothesis:

H1: If a given SDO introduces opening up measures, then the likelihood of developing countries' participation in that SDO will increase.

2.2. Potential Drivers of Countries' Participation in SDOs

I rely on realist theories of international politics to derive my second hypothesis. For realists, GGOs are viewed as reflections of the global structure of power (Mearsheimer, 1994), which

[16] Whether such an increase in participation will be translated into actual influence or not remains an unresolved issue in the literature and beyond the scope of this analysis.

is measured essentially in terms of domestic economic capabilities (Kennedy, 1987). Such capabilities determine a given country's position within the global system (Organski, 1958). In addition, it is expected that shifts in the distribution of economic power among countries to eventually be reflected in GGOs' power structure. Ikenberry (2011) argues that countries growing in power will eventually be integrated into the existing system, suggesting that they will behave as the established power and increase their participation in GGOs. For instance, over the past two decades, South Korea claimed positions among the established powers in several global issue areas (for example, see Cho & Büthe, 2021). Accordingly, economic power is considered a primary variable for explaining countries' behavior in the international sphere (Krasner, 1991). Indeed, the literature contains no lack of accounts of how different economic-related variables affect countries' participation in GGOs, including SDOs (Kahler, 2017; Louis & Ruwet, 2017; Petersson, 2019; Uhre, 2014).

The above perspectives provide reasons to expect countries' participation in international standard-setting to be largely shaped by relative economic capabilities. My expectation is, therefore, to find a positive correlation between the economic power of a given member country and the likelihood of its participation in an SDO. This leads to my second hypothesis:

H2: The greater a member country's economic power, the greater the likelihood of its participation in a given SDO.

Conversely, other scholars are increasingly raising doubts about the economic power as the best predictor of countries' participation in GGOs, and at the same time, suggesting additional explanatory variables. Anderl et al. (2021) and Tallberg et al. (2018) show that economic capabilities do not appear to matter systematically in explaining countries' participation in a number of GGOs. Parizek and Stephen (2021) and Blind and von Laer (2021) find no relationship between a specific participation mechanism—namely, holding decision-making positions in organizations—and the (growing) economic power of member countries in the ISO, the International Monetary Fund, the WTO, and the United Nations. In case the economic power does not sufficiently explain the variation in countries' participation in SDOs, what then could it be?

For deriving my third hypothesis, I draw on a stream of studies noting another domestic capability that could derive countries' participation in SDOs, namely industrial power (for example, see Organski, 1958). Given the nature of the IEC—a private GGO publishing highly technical standards governing thousands of products—it comes as no surprise that relevant industries have substantial incentives to participate in setting its standards (de Vries & Veurink, 2017). Blind and Mangelsdorf (2016) argue that firms have strong interests in ensuring that governmental regulations referencing international technical standards are "industry-friendly." Firms, therefore, vigorously seek to shape the outcome of the standard-setting process in their own needs and preferences (Sherif, 2015; Wen et al., 2020). Empirical evidence repeatedly showed that countries are often represented by market players that have local presence (Baron, 2020; Baron & Spulber, 2018).

Moreover, in developing an analytical framework for understanding the consequences of power transition in the global economy, Lavenex et al. (2021a) argue that industries act as domestic forces in support of building requisite(s) for effective participation—conceptualized as strong regulatory state—giving the country leverage in GGOs. Serrano (2016) shows how the domestic electronics industry shaped China's behavior in the Intellectual Property regime. Scholars also inconclusively noted firm size and export volume as key variables for explaining participation in standard-setting (Blind, 2006; Blind & Mangelsdorf, 2013; Riillo, 2014), suggesting that economies of scale matter.[17] Assuming that countries' participation in SDOs is

[17] While both studies by Mangelsdorf and Denkler (2013) and Blind (2006) find a positive correlation between export volumes and the likelihood of participation, (Blind, 2006) shows that this relationship is true only to a certain level and that companies with very high export volumes are less interested in participating in SDOs.

influenced by the issue area governed by a given organization, it is plausible to expect that the above perspectives will be most applicable for industries relevant to a given issue area. In other words, a country's participation in an SDO governing a given issue area will be influenced by the industrial capability relevant to that issue area.

All this makes me expect a country's industrial capability of products regulated by a given SDO to positively correlate with the likelihood of that country's participation in that SDO. On these premises, I derive the third hypothesis:

H3: The greater a member country's industrial capability of products regulated by a given SDO, the greater the likelihood of the member country's participation in that SDO.

3. THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

3.1. Structure and Standard-setting

The IEC was founded in 1906 by 33 prominent engineers and businessmen representing 13 countries from the then developed world: Austria, Belgium, Canada, Germany, Hungary, France, Italy, Japan, Spain, the Netherlands, Switzerland, the United Kingdom, and the United States (for a historical review, see Yates & Murphy, 2019, chapter 2). In the century since then, the IEC has become one of the most important international SDOs (Büthe, 2010), with additional member countries joining from all over the world. As of the end of 2021, thousands of IEC experts have developed 11,200 international technical standards governing numerous aspects of thousands of electrical products, electronics and systems.

Countries interested in participating in the IEC work need to have an established domestic National Electrotechnical Committee (NEC) as well as apply for membership. Once admitted, member countries can participate in a given IEC standard-setting area by delegating individuals who are called within the IEC National Committees (NCs). The IEC requires these NCs to be representative of all domestic interests—by forming a single national consolidated position from the respective standard-setting area—such as governments, relevant industries, environmental agencies and other civil society organizations.

Depending on the level of its economic activity[18] and willingness to pay dues, a country can be admitted either as a Full member or as an Associate member. Paying Full membership dues provides the member country with the right to be involved in the IEC work through all available participation mechanisms, as well as hold technical and strategic decision-making positions. Associate members, in contrast, cannot hold positions at the IEC and the consideration of their inputs—they can vote and submit comments on certain occasions only—is not obligatory for other (Full) members. Generally, technical and managerial decisions in the IEC are adopted by a two-thirds majority of voting members—voting can take three forms: in-favor, abstain or against.[19]

Developing a new or revising an existing IEC standard is carried out within groups of NCs called Technical Committees (TC). In case an NC is interested in a given IEC standard-setting area, certain delegates are assigned to participate in the respective TC. Depending on the membership held by the country they represent, NCs act either as a Participating (P) or an Observing (O) member in a given TC.[20] While P-members are, to a large extent, obliged by the IEC to participate through attending meetings and voting in TCs, O-members are not. Observing members do not have the right to vote, and it is not obligatory to consider their inputs. Moving forward with the standard-setting process or a given decision is essentially conditioned by the approval of a certain percentage of P-members.

The work in TCs is led mainly by secretariats, who typically come from developed countries' industries.[21] While Full members can occupy the secretariat as well as other

[18] The IEC measures economic activity according to the gross national product and annual electricity consumption per capita.

[19] Abstain votes are not considered when the votes are tallied.

[20] Associate members can request to hold a P-member seat at up to four TCs from all existing IEC TCs.

[21] In its annual report for the year 2000 the IEC mentions that 81% of the secretariats are experts from the industry (IEC Website, 2000, p.10).

decision-making positions, the Associate members cannot do that. Several studies suggested that these positions provide opportunities to exert considerable influence through the ability to influence the standard-setting process (Büthe, 2010; Dokko & Rosenkopf, 2010; Morikawa & Morrison, 2004; Murphy & Yates, 2009).

Standards developed at the IEC go through six main stages, each involving drafts being circulated among the concerned TC members for voting and commenting. The submission of a New Proposal launches the process of setting a standard for a standard-setting project by any IEC member country or stakeholder.[22] The New Proposal is voted upon by the concerned TC/SC P-members in the first stage, which is called Proposal Stage. In order for the New Proposal to be passed to the next stage, a two-thirds majority of P-members should vote in-favor of it. The New Proposal gets transformed into the so-called Working Draft in the second stage, which is called Preparatory Stage. By the end of the second stage, the Working Draft needs to be improved to take its next shape that is called First Committee Draft. In case of urgent market demand, the draft can be adopted as a Publicly Available Specification with no further work.[23] This is followed by the Committee Stage, whereby the First Committee Draft gets circulated among all member countries for comments. This marks the end of the Committee Stage and the start of the Inquiry Stage, wherein a Committee Draft for Vote is generated and submitted for voting. The Committee Draft for Vote is approved if two-thirds of the votes cast by P-members are in-favor and the number of negative votes submitted by all NCs is not more than one-quarter of the total votes. In case there is a need for technical changes, the Committee Draft for Vote is directly published as an IEC standard. Otherwise, the Committee Draft for Vote is transformed to its next shape, which is Final Draft International Standard, and gets circulated for further voting. If approved, the Final Draft International

[22] The IEC maintains potential standard-setting projects in stage zero, which is called the Preliminary Stage. Typically, the need for a standard is expressed by the relevant industry and then communicated to the respective NC.

[23] Such exercise reflects how influential the market/industry could be for the IEC work.

Standard or Committee Draft for Vote in case of no technical changes needed, the IEC standard gets published (for further details, see ISO/IEC, 2022).

3.2. Having the South and Other Marginalized Stakeholders Aboard

For many years, the commercial interest was dominant in the IEC (Yates & Murphy, 2007), and the organization appeared to be content with a small group of developed and industrialized member countries (Büthe, 2010). In combination with a growing role in global governance, such a structure soon presented the IEC with several challenges. Importantly, the legitimacy of the IEC as an influential global rule-maker was increasingly being questioned due to its biased internal power structure. The demand for, as well as influence of, IEC standards has substantially increased due to the signing of the WTO agreement on TBT in 1995.[24] The adoption of the six principles—transparency, openness, impartiality and consensus, relevance and effectiveness, coherence, and developing dimension—by the TBT committee in 2000 made these challenges more prominent. Despite the IEC's formal adherence to the principles in the ISO/IEC Guide 59,[25] the participation of the developing countries did not significantly improve. As a response, the IEC introduced numerous measures and incentives to attract more (developing) countries to participate in its standard-setting. Büthe (2010) argues that the IEC was eager to increase developing countries' participation to protect its preeminence as a global rule-maker.

First, the Affiliate Country Programme was introduced in 2001 to overcome different burdens—such as the lack of required technical and financial resources—hindering the

[24] While IEC standards are legally merely norms in technical language that are voluntary, they often become de facto or formally obligatory for governments, market players and other stakeholders.

[25] The ISO states on its website: "The guideline provides different practices that are intended to support the application of the WTO TBT Committee decision on principles for the development of international standards, guides and recommendations (G/TBT/9, 13 November 2000) and the WTO TBT Agreement's Code of Good Practice for the Preparation, Adoption and Application of Standards (Annex 3 of the 1995 WTO TBT Agreement)." The guideline was updated in 2019 (ISO/IEC, 2019).

participation of developing countries.[26] At no cost and without the need for an NEC, taking part in this program grants access to a number of IEC standards, some technical meetings, and very limited participation rights. Affiliate countries can access 200 IEC standards, which the country can adopt at the national level. They also have the right to nominate up to 5 experts to have access to working documents, attend certain meetings of 10 selected TCs and submit comments. Affiliate countries also receive training and mentoring in IEC standard-setting. The programme's ultimate objective is to help the affiliate countries obtain Full memberships and increase their activity at the IEC. For some years, the programme proved to be less fruitful than expected (Villarreal, 2018, p.54). As a response, the IEC introduced incentives for Affiliate countries to be more engaged in its work. For instance, once an Affiliate country shows sufficient commitment to the programme, the member can be upgraded to the so-called Affiliate Plus status, which grants higher participation privileges.[27]

Second, the IEC introduced a number of digital tools in its system to reduce the financial resources required for participation that requires personal presence (IEC Website, 2022). Such tools offered stakeholders remote access to numerous standard-setting activities and documents. Since 2001, the IEC has made it mandatory that all comments and voting on technical work be made by electronic means. Recently, the Online Authoring Tool and Experts Management System were integrated into the IEC system to enhance the process by enabling simultaneous work, communication and other standards editing features. During the COVID pandemic, such tools were effective in preventing the IEC operations from slowing down, despite that most of the work depends on meetings. Indeed, as shown in the IEC Annual Report for the year 2020 (IEC Website, 2020), different aspects of IEC operations ran almost normally.

[26] The underrepresentation of certain stakeholders has been attributed largely to the lack of necessary technical and financial capabilities (Büthe & Mattli, 2011, p. 42-59; Tamm Hallström, 2000).

[27] Holders of this status have access to 400 standards for national adoption and are provided with IEC mentoring programs to advance their standard-setting capabilities.

Finally, in response to criticisms of the underrepresentation of noncommercial stakeholders, such as NGOs and women, in the IEC work, several policies and measures were introduced to tackle this issue. In collaboration with the ISO, a policy statement was developed in 2001 to promote the participation of underrepresented stakeholders. After their commitment to enhance the consumers' participation, the Committee on Consumer Policy was established as an implementation measure (ISO Website, 2022). IEC members were also asked to work in close liaison with national stakeholders representing noncommercial interests. Additional mechanisms and tools were introduced to increase participation, such as liaisons organizations and online public commenting (IEC Website, 2022). Regarding gender equality in TCs, the Joint Strategic Advisory Group and another Task Force were established to help TCs improve the participation of women as well as ensure that the IEC is developing gender-responsive standards (IEC Website, 2021). Moreover, the IEC sought to increase its reach to the developing world by establishing there offices and collaborations with regional standard-setting bodies, such as the one with the African Electrotechnical Standardization Commission.

4. DATA AND METHODS

In order to test my hypotheses, I utilize two original internal IEC datasets and retrieve additional data from other (public) sources. I employ longitudinal designs with the main focus on the period of the past two decades; meanwhile, I operate with shorter timelines in certain parts of the analysis according to data availability.

I use multiple methods for the assessment of the three hypotheses. For H1, I first analyze the participation of all member countries based on different participation mechanisms offered by the IEC (presented in section 5). In this part of the analysis, I assess the effectiveness of the opening up measures in terms of increasing the participation of developing countries. I then supplement the analysis with two methods for detecting and measuring the magnitude of positive trends, if any, in participation, namely the Mann-Kendall Test and Sen's Slope Estimator (presented in subsection 5.4). For the assessment of H2 and H3, I use a Negative Binomial Regression model to examine the two relationships as follows: (1) the relationship between the economic power—operationalized as GDP PER CAPITA—and the likelihood of participation; (2) the relationship between the relevant industrial capability—operationalized as EXPORT VOLUME of relevant products—and the likelihood of participation (presented in section 6).

The first internal IEC dataset contains all votes submitted by member countries over the period of January 2000 – August 2019.[28] The original dataset includes relevant information such as the TC whereby a given vote was submitted, vote reference ID, country of the voting NC, types of membership (P or O) held by the voting NC in the respective TC, vote (in-favor, against or abstain) and start and end dates of the voting period. I consider voting as one of the main participation mechanisms and, therefore I use this data in several parts of the assessment of the three hypotheses. Specifically, I use the voting data in the analysis in subsections 5.2, 5.3 and 5.4 and in the empirical model (as the main dependent variable) in section 6.

The second internal IEC dataset contains records of Affiliate countries' engagement in the Affiliate Country Programme. This dataset includes the annual number of comments submitted by Affiliate countries over the period between 2004 and 2019. While the records do not show the contents of these comments, the commenting Affiliate country can be identified, and the submission dates are also available. This data is used in the analysis in subsection 5.1.

[28] The voting dataset does not show non-voters (i.e., member country attending a meeting without submitting a vote). However, I assume that these are rare cases, and therefore, will not have a (significant) effect on the analysis. I address this issue, to a large extent, by conducting the analysis on votes submitted by P-members only. This is according to my understanding of the IEC voting policy, whereby P-members are obliged to vote; otherwise, they will have to face the risk of downgrading their membership (ISO/IEC, 2022, Clause 1.7.4). Note also that member countries voting per se does not necessarily indicate actual influence. Amending a given aspect of an IEC standard requires participating through additional channels, such as commenting and participation in Working Groups. To reduce the effect of this limitation, I include other forms of participation in the analysis.

Additional data required for the analysis of that section, such as the number of standards adopted nationally, were retrieved from the IEC website.

Additional data required for the analysis in the other parts of section 5 were retrieved from the IEC website and other sources. More details are available in respective subsections. Finally, data required for the empirical model in section 6 were retrieved from several public databases. I collected country-level data to construct my variables: the two main independent (GDP PER CAPITA and EXPORT VOLUME) and control variables (POPULATION SIZE, OECD MEMBERSHIP and DEMOCRACY INDEX). More details about these variables are available in Appendix B.

5. THE IMPACT OF IEC OPENING UP MEASURES ON THE PARTICIPATION OF DEVELOPING COUNTRIES

In this section, I assess the effectiveness of the IEC opening up measures in achieving their objectives by analyzing the participation of member and Affiliate countries through almost all of the participation mechanisms offered by the IEC to influence its standard-setting. Note that member countries' utilization of different participation mechanisms does not guarantee influence. Arguably, the greater a given member country utilizes IEC participation mechanisms, the greater the potential influence that member country can secure in IEC standard-setting.

In my analysis, I focus on participation mechanisms that, if utilized, provide the participating member countries with the greatest potential influence. Accordingly, I consider the following six mechanisms: (1) Engaging in the Affiliate Country Programme;[29] (2) Submitting votes in decision-making; (3) Submitting against-votes in decision-making; (4) Taking part in technical committees as participating-members; (5) Holding Full memberships;

[29] As further described in the following section, I do not view taking part in the Affiliate Country Programme as equivalent to regular participation and hence the term engaging.

(6) Holding secretariat positions.[30] For each of these mechanisms, I examine the observable implications generated by the first hypothesis, namely an improvement in the participation of developing countries in the IEC work.

The mechanisms I focus on in my analysis are ascendingly ordered according to the relative technical and financial resources required by member countries willing to utilize a given mechanism. For instance, in order for a given member country to be able to hold secretariat positions in IEC TCs, the country should hold a Full membership—which can cost 60,000 USD in annual dues—as well as have substantial relevant technical capabilities (as required by the IEC, see ISO/IEC, 2022, p. 16). In contrast, taking part in the Affiliate Country Programme is virtually free of charge and does not require almost any technical capabilities.

In order to classify IEC member countries based on level of development, I group them according to four GNI levels: high-; upper-middle-; lower-middle-; and low- income.[31] I consider member countries from the lower three GNI levels (i.e., upper-middle-, lower-middle- and low- income) as developing countries. Developed countries, in turn, are those from the high-income level only.

It should be noted that the major shifts in economic power experienced by a number of member countries distorted the results of multiple parts of the analysis. Particularly, my preliminary analysis shows that the shifts of some emerging economies from lower GNI levels to higher levels understate the effect of the IEC's opening up measures—more details in respective sections. I reduce this effect by conducting the affected parts of the analysis without consideration of the economic shifts. For instance, Brazil was classified by the World Bank as an upper-middle-income country in 2000. In my analysis, Brazil remains classified as an upper-

[30] The IEC member countries can also participate through the so-called Working Groups level. Despite the high potential influence offered by this mechanism, it was not included in this analysis due to the lack of relevant data.

[31] For the 2020 fiscal year, low-income economies are defined as those with a GNI per capita, calculated using the World Bank Atlas method, of $1,025 or less in 2018; lower-middle-income countries are those with a GNI per capita between $1,026 and $3,995; upper-middle-income countries are those with a GNI per capita between $3,996 and $12,375; finally, high-income countries are those with a GNI per capita of $12,376 or more.

middle-income member country throughout the concerned period of time without consideration of shifts (if any) in its GNI status.

5.1. Engaging in the Affiliate Country Programme

Given the minimal potential influence provided for countries taking part in the Affiliate Country Programme to influence IEC standard-setting, this mechanism is not considered equivalent to regular participation through other mechanisms. By offering the Programme, the IEC aims at, among others, encouraging developing and Affiliate countries to hold IEC memberships and increase their voice in its standard-setting. At the same time, the Programme is designed to motivate Affiliate countries to adopt IEC standards nationally, ultimately enhancing the global diffusion of these standards. Note that although the latter objective is relatively less relevant to improving the participation of Affiliate countries, analyzing it remains insightful for the main arguments of the chapter.

In this subsection, I analyze data relevant to the engagement of the Affiliate countries in the programme to assess its effectiveness in achieving the IEC's three objectives above. For that, I first analyze countries' engagement globally in the programme. Second, I trace the Affiliate countries' status from the programme's introduction in 2001 to the year 2021 with the aim of examining the development in holding IEC memberships. Third, I analyze the internal IEC dataset that includes all comments submitted by Affiliate countries between 2004 – 2019.[32] According to my first hypothesis, I expect to find evidence of improvement in the engagement of the Affiliate countries in the IEC work. Finally, I analyze the national adoption of IEC standards by the Affiliate countries to assess the diffusion of these standards in the developing world.

[32] While the Affiliate Country Programme was first introduced in 2001, the IEC first started registering comments submitted by the Affiliate countries in 2004.

At the time of writing this, the IEC has 88 Full and Associate members, leaving 107 countries without any IEC membership globally. According to data posted on the IEC website, 102 countries have taken part in the Affiliate Country Programme since it was introduced in 2001.[33] Attracting 102 out of the 107 countries that do not have any IEC membership from all over the world is arguably beneficial for the organization on several levels. Importantly, by engaging more countries in the programme, the IEC establishes a form of a connection between countries that are presumably less knowledgeable about the organization from all over the world and its work. In doing so, the IEC ultimately improves the diffusion of its standards as well as its role in international standard-setting. Based on this analysis, it is fair to argue that the Affiliate Country Programme has been effective in engaging countries to hold Affiliate status in the IEC.

Regarding the development in the Affiliate countries' statuses, analyzing relevant data shows that only three countries have upgraded to Full membership and 14 countries to Associate membership throughout the period 2004 – 2019. Given that obtaining an Associate membership provides the member country with relatively small potential influence in IEC standard-setting, I consider upgrading to Full membership as a more meaningful measure of the programme's effectiveness in achieving its objective. Accordingly, three Affiliate countries upgrading to Full memberships suggests that the programme has been only modestly effective in increasing the participation of the developing countries. The programme, meanwhile, was effective in increasing the number of member countries provided with relatively fewer participation privileges in the IEC.

The internal IEC dataset that includes the comments submitted by the Affiliate countries between 2004 – 2019 shows a total of 58 comments. Analyzing the data shows that an average of 4 comments per year were submitted by all Affiliate countries throughout the

[33] Data were retrieved from https://www.iec.ch/acp during the year 2022

entire period without any sign of increase, suggesting that they have not improved their inputs in the IEC work. Such performance in submitting comments by the Affiliate countries further supports the finding that the programme was only modestly effective in enhancing the Affiliate countries’ engagement in the IEC work.

Finally, and as mentioned, I have retrieved from the IEC website data relevant to the national adoption of its standards by the Affiliate countries. For the analysis of this dataset, I have identified the total number of IEC standards nationally adopted by Affiliate countries since taking part in the programme. I present the analysis in a scatter graph, as shown in Figure 1 below.

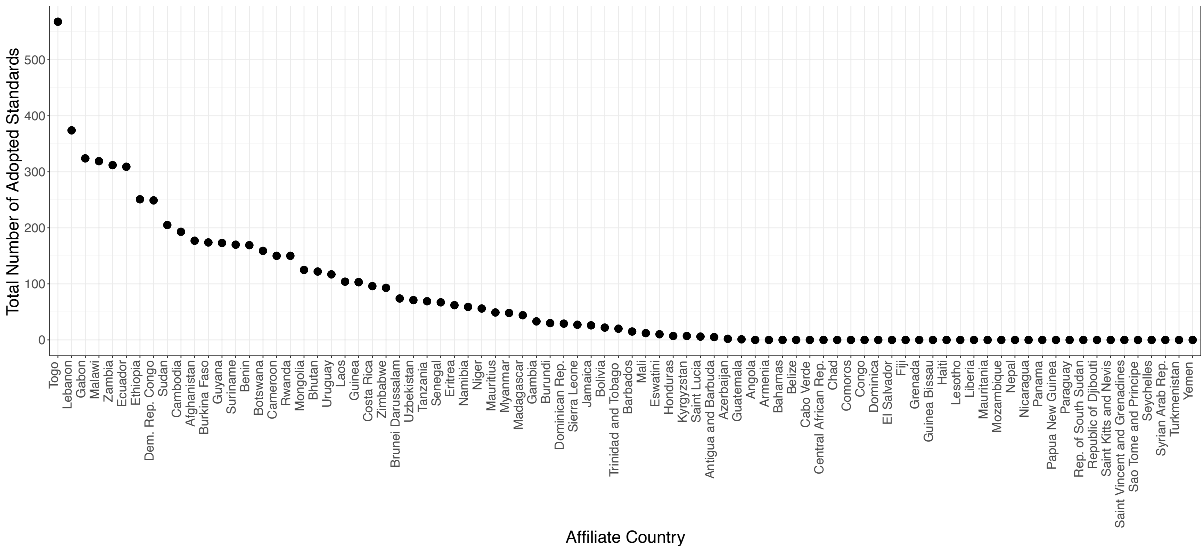

Figure 1 National Adoption of IEC standards by the Affiliate Countries Between 2001 and 2021

As illustrated, the analysis shows that out of the 85 active participants in the programme at the time of writing this chapter, 52 Affiliate countries have adopted tens, sometimes hundreds, of IEC standards since 2001. The IEC annual report for the year 2021 mentions that over 9000 IEC Standards have been adopted nationally by affiliate countries (IEC Annual Report, 2021, p. 28). Unfortunately, the lack of a threshold makes it challenging to assess the programme’s effectiveness in enhancing the diffusion of IEC standards among developing countries. It is, nevertheless, fair to consider the data presented in Figure 1 as demonstrating a good level of interest by the Affiliate countries towards adopting IEC standards. This suggests that the programme has been fairly effective in increasing the diffusion of IEC standards in the developing world.

The analysis of this subsection provides evidence showing that the Affiliate Country Programme has been largely inadequate in achieving its objective of increasing the participation of developing/Affiliate countries in IEC's standard-setting. The evidence shows that the Affiliate countries were generally uneager to obtain Full memberships or even to provide comments on IEC standard-setting. The programme, meanwhile, has been generally effective in terms of attracting countries without any IEC membership to hold Affiliate statuses as well as motivating many of them to adopt IEC standards nationally. Consequently, and arguably, the programme has been relatively more effective in terms of enhancing the diffusion of IEC standards globally and increasing the number of its member countries that are provided with fewer participation privileges. Given that the theoretical expectation of Hypothesis 1 is focused on participation—that provides member countries with potential influence in IEC standard-setting—the analysis above provides evidence against the Hypothesis.

5.2. Submitting Votes in Decision-making

Submitting votes in IEC TCs is one of the main participation mechanisms that provide member countries with potential influence in standard-setting (Weiss & Sirbu, 1990).[34] In this subsection, I assess the effectiveness of the IEC opening up measures in increasing the number of annual votes submitted by the developing countries over the period 2000 – 2018.[35] I focus on P-members' voting only in the analysis, not least because their votes offer substantially greater potential influence in IEC standards-setting than O-members' voting. In addition, my

[34] Weiss and Sirbu (1990) showed that submitting "written contributions" was an effective participation mechanism. Unfortunately, I could not access data showing the number of comments submitted by IEC member countries. I assume that member countries that are active in voting are more willing to submit comments than member countries that are less active in voting.

[35] The dataset covers only eight months of the year 2019. As the focus of the analysis is the number of votes submitted annually, I discount the year 2019 as the data is incomplete for the full year.

preliminary analysis shows that including O-members' votes has no significant effect on the final results; this is because they submit far fewer votes than P-members.[36] Leveraging the internal IEC dataset that includes all member countries voting, I conduct the analysis in different ways in order to achieve greater certainty of the final results. According to the first hypothesis, I expect to find evidence of an increase in the number of votes submitted by developing countries over the eighteen years period covered in the analysis.

As the first step in this part of the analysis, I explore the voting dataset by presenting it graphically using annual box plots—see Figure 2 below. Each data point on the graph represents the total number of annual votes submitted by a given P-member in all IEC TCs. The first information to be gleaned from the Figure is the decreasing trend in the data. In order to examine this trend, I calculate two values for each year, as shown at the top of the Figure. The upper row of values—represented with the "n" letters—shows the total number of P-members who voted annually. The lower row of values—represented with the "$\bar{x}$" symbols—shows the average number of votes submitted per year. A given $\bar{x}$ value is calculated by dividing the total number of votes submitted in the respective year by the number of all P-members who voted in that year. The data puzzlingly show that despite the increase in the number of P-members submitting votes (illustrated in the increasing n values), the average number of annual votes decreased (illustrated in the decreasing $\bar{x}$ values) over time. This is puzzling because one assumes that an increase in the number of voting members should generally result in an increase in the average number of submitted votes.

The analysis shown in the box plot suggests significant inequality in submitting votes among the IEC P-members. Particularly, the data shows that while the total number of voting P-members in IEC TCs has been increasing, the number of votes submitted by some of them has remained relatively very low over time. At the same time, the number of these relatively

[36] Recall that O-members are allowed to vote on certain occasions only.

less-active P-members in IEC voting has been increasing. This can be seen by merely observing the increasing number of data points at the bottom of the boxes. I further examine this finding below.

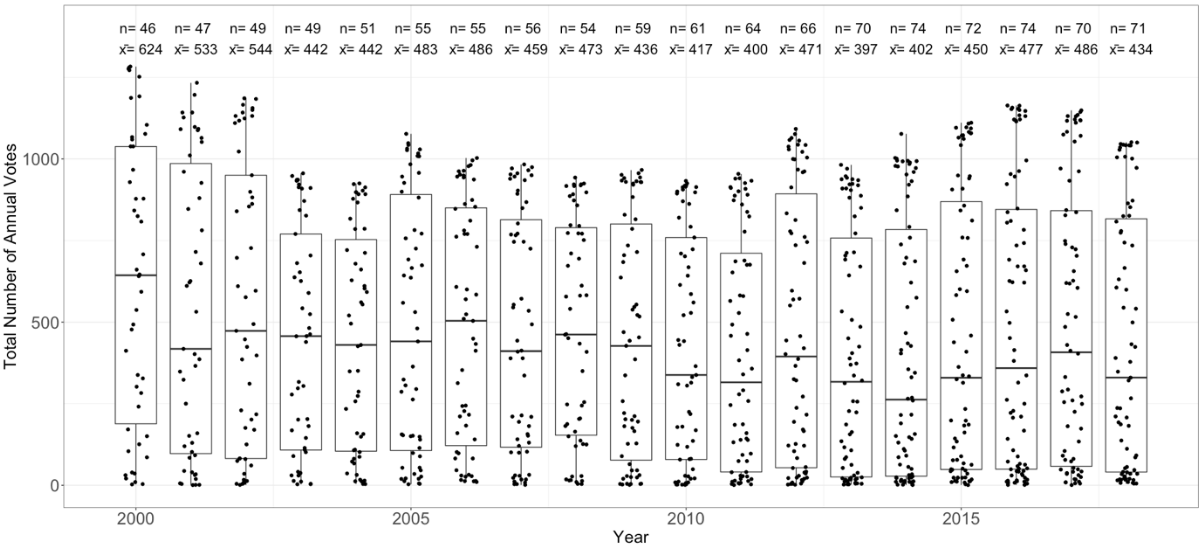

Figure 2 Annual Votes by P-members in all IEC TCs between 2000 - 2018

In order to assess the effect of the IEC opening up measures on the voting of the developing countries, I further analyze the same dataset. This time, I trace the number of annual votes submitted by IEC P-members over the period 2000 – 2018. Then, I identify the level of development for each member country based on the respective GNI level in the year 2000 and group them accordingly.[37] Finally, I aggregate member countries' annual votes over the mentioned period of time and present the data graphically in a line chart in Figure 3 below. For a better reading of the data, I show the annual number of member countries from different GNI levels in Table 1. By constructing the analysis in this way, I was able to assess the effect of the opening up measures on voting as well as identify the GNI level of the voting members responsible for the decrease in the average number of annual votes observed in Figure 2.

[37] Recall that my preliminary analysis shows that considering the change in annual GNI levels of member countries renders the increase in their participation invisible. Therefore, the classification of member countries based on GNI level is fixed to their statuses in the year 2000. I present my preliminary analysis graphically in a line chart in Figure C1 in Appendix C. As illustrated, the number of votes submitted by the developing countries generally remained low throughout the entire period. Beyond a slight increase in the number of annual votes submitted by countries from the upper-middle income class, there is almost no observed improvement. One can even observe a slight descent in the lines for member countries from the low- and lower-middle income classes.

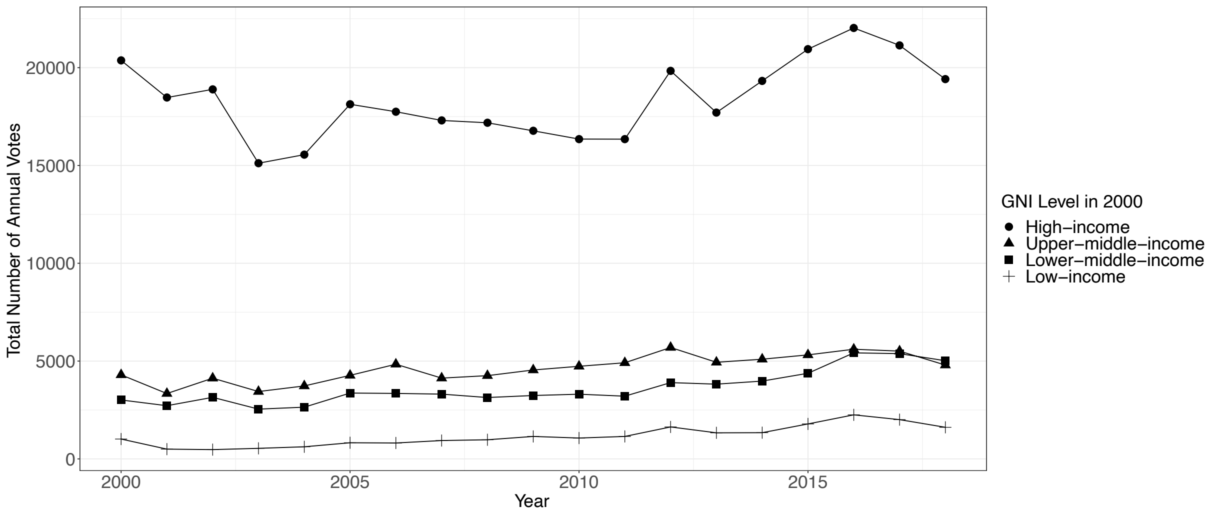

Figure 3 Change in Total Number of Annual Votes Submitted by Member Countries From Different GNI Levels Between 2000 and 2018

Table 1 Annual Number of Voting Member Countries From Different GNI Levels

GNI \ Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
High-inc.	24	25	25	25	25	27	27	27	27	28	28	29	29	29	29	29	29	28	28
Upper-middle-inc.	10	11	12	13	13	13	13	13	13	13	14	14	14	15	16	15	15	15	16
Lower-middle-inc.	7	7	7	7	8	9	9	9	8	10	12	14	14	18	19	18	19	17	18
Low-inc.	5	4	5	4	5	6	6	7	6	8	7	7	9	8	10	10	11	10	9

As illustrated in Figure 3, the data show increasing trends in annual votes submitted by member countries from all three GNI levels representing the developing countries. For instance, countries from the upper-middle-income level have increased the total number of annual votes they submit roughly by 1000. It should be noted that a closer look at the data shows that a small group of member countries has shown exceptionally high participation, consequently driving most of the observed increase in votes—I further analyze this finding in subsection 5.4. Such an increase suggests that the opening up measures taken by the IEC have been effective in improving the developing countries' voting in its standard-setting. Accordingly, this analysis provides evidence supporting the theoretical expectation of Hypothesis 1.

The analysis in Figure 3 and Table 1 provides several additional interesting findings. First, regarding the issue of inequality in submitting votes among the P-members observed in Figure 2, the analysis shows that member countries that submitted relatively fewer annual votes—member countries that appeared at the bottom of the boxes—are mostly developing countries. The analysis shows that half of the member countries that joined the IEC after the year 2000 held Associate memberships, limiting their ability to increase their voting. As these developing countries continue to join the IEC, the number of member countries with low voting grows over the years. Second, the number of votes submitted by member countries is largely associated with the ranking of GNI levels (i.e., the higher the GNI level of a given group of member countries, the greater the number of votes submitted by them and vice versa). Last but not least, despite the increasing number of member countries from the developing world—as shown in Table 1—the total number of votes they jointly submitted remained significantly lower than the number of votes submitted by member countries from the high-income level throughout the entire period of time. These additional findings are further discussed in Section 7.

5.3. Submitting Against-Votes in Decision-making

Voting in opposition to other member countries' preferences and inputs in IEC decision-making is an important participation mechanism that requires relatively greater financial and technical resources than submitting other types of votes. Recall that the IEC requires member countries to submit scientific/technical justification along with their against-votes. Studies show that member countries often do not have the required technical capabilities (Büthe, 2010; Forsberg, 2012). Arguably, member countries that submit against-votes more often are equipped with relatively greater financial and technical capabilities and interest in influencing IEC decision-making.

In this subsection, I assess the effectiveness of the IEC opening up measures in increasing the number of against-votes submitted by the developing countries between the years 2000 and 2018. For that, I identify the number of annual against-votes submitted by each member country. My preliminary analysis shows that while P-members rarely submit against-votes, O-members almost never do that. Next, I classify member countries based on respective GNI levels in the year 2000. Then, I aggregate the total annual number of against-votes submitted by each GNI level for the period 2000 - 2018. Finally, I present the analysis in a line chart, as shown in Figure 4 below. According to Hypothesis 1, I expect to find an increase in the number of against-votes submitted by member countries from the developing world.

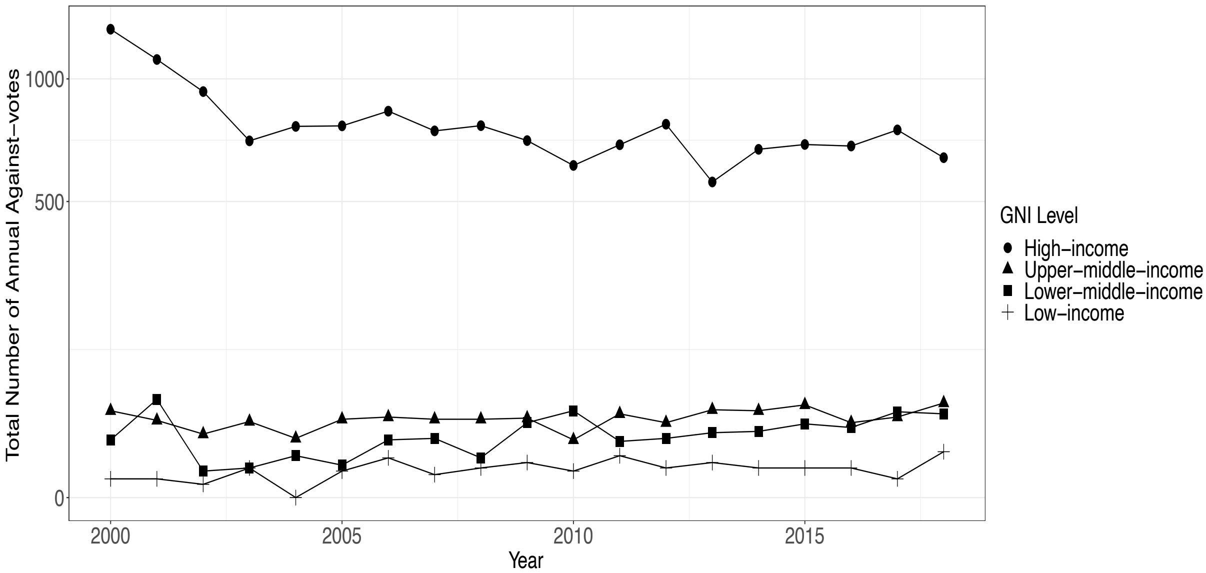

Figure 4 Change in Total Number of Annual Against−votes Submitted by Member Countries From Different GNI Levels Between 2000 – 2018

As illustrated in Figure 4, the data show that member countries from the lower three GNI levels have maintained very low participation through the mechanism of submitting against-votes with very little sign of improvement. Note that in the Figure, the Y-axis scale has been modified in order to highlight this slight increasing trend. While most developing countries never submitted any against-votes, a few countries from the upper-middle-income GNI group submitted a very small number of votes throughout the 18 years covered in the analysis. Particularly, the developed countries submitted 95% of all against-votes; meanwhile, the remaining 5% of the total votes were submitted by a small group of member countries showing exceptional participation among the developing countries. This group is comprised of China, Russia, South Africa, Mexico, Brazil and India.

In sum, this analysis provides evidence showing minimal improvement in the participation of developing countries through the mechanism of submitting against-votes in IEC TCs; accordingly, I find weak support for the theoretical expectation of Hypothesis 1.

5.4. Further Analysis of Submitting Votes in Decision-making

In this subsection, I supplement the previous analysis with two statistical methods for detecting and measuring increasing trends, if any, in developing countries' voting in IEC TCs. The two methods will also help me identify the member countries that have increased their voting in the IEC. Specifically, I test for the detection of significant positive trends in the number of votes submitted monthly by P-members from January 2000 through August 2019. By focusing on monthly—instead of annual—voting, I achieved an optimal sensitivity of the test as well as a larger number of data points, ultimately enhancing the accuracy of the tests. Recall that according to my first hypothesis, I expect to find evidence of increasing trends in developing countries' voting. In what follows, I introduce the methods I am utilizing for this subsection of the analysis.

The two methods that I utilize help me detect significant positive trends as well as quantify their magnitudes. As the voting data is non-parametric, commonly used trend tests are unsuitable. Therefore, I consider the following two non-parametric methods: (1) the rank-based Mann-Kendall (MK) test to assess the significance of any monotonic positive trend in the number of votes (Kendall & Gibbons, 1990; Mann, 1945),[38] and (2) Sen's slope estimator to quantify the magnitude of the trend, if any (Sen, 1968). Both are widely used in other disciplines (for example, see Gocic & Trajkovic, 2013).

For the MK test, each individual member country's voting over the above-mentioned period is evaluated as a time series. Monthly votes are ranked and represented as x_i where $i =$

[38] The data do not need to conform to any particular distribution for this test. The null hypothesis assumes that a value can always be declared less than, greater than, or equal to another value, the sequence of data is independent, and that the respective distribution remains constant.

$1,2,3 \ldots n-1$ and x_j where $j = i+1,2,3 \ldots n$ —where n equals to 236.[39] The monthly number of votes is successively treated as a reference data point and is compared to all data points that follow in time. The initial value of the MK statistic, S, is assumed to be zero (i.e., no trend). S is incremented/decremented by 1, if the number of votes from a later/earlier month is larger than from an earlier/later month.

$$sign(x_j - x_i) = \begin{cases} 1, & x_j - x_i > 0 \\ 0, & x_j - x_i = 0 \\ -1, & x_j - x_i < 0 \end{cases}$$

The net result of summing all increments and decrements yields the final value of S.

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sign(x_j - x_i)$$

Positive value of S is an indicator of an increasing trend, and negative values indicate a decreasing trend. In order to statistically quantify the significance, it is necessary to compute the probability associated with S. In this case, $n \geq 10$, the test is conducted using a normal approximation (Z statistic):

$$Z_{MK} = \begin{cases} \dfrac{S-1}{\sqrt{var(S)}}, & S > 0 \\ 0, & S = 0 \\ \dfrac{S+1}{\sqrt{var(S)}}, & S < 0 \end{cases}$$

with a mean equals to 0, and the variance is given by:

$$var(S) = \frac{n(n-1)(2n+5) - \sum_{i=1}^{m} t_i(t_i-1)(2t_i+5)}{18}$$

[39] The number of months from January 2000 to August 2019.

where m is the number of tied groups (a tied group is a set of sample data having the same value[40]) and t_i denotes the number of ties of extent i. In case of no tied data, the summation part can be skipped.

The null hypothesis H_0 states that there is no significant monotonic trend in a series of monthly votes. The alternative hypothesis H_1, in contrast, indicates the presence of a positive or negative or non-null trend. I test with adopted significance level α = 0.05. When $|Z_{MK}| > Z_{1-\alpha/2}$, where $Z_{1-\alpha/2}$ equals to 1.96 as obtained from the standard normal distribution table, the null hypothesis is rejected.

For Sen's slope estimator, using the same time series approach above, I quantify the magnitude of trends found in the MK test as:

$$\text{Sen's slope} = Median\left\{\frac{x_j - x_i}{j - i}\right.$$

The results of performing the MK test show that 38 member countries have experienced significant positive trends in their monthly voting throughout the mentioned period of time. As I have analyzed the voting of 49 developing countries in total, the results suggest that 78% of the developing countries have increased the number of votes they submit monthly. Considering this finding alone provides evidence of a positive effect of the IEC opening up measures on member countries' voting.

However, a closer look at the data shows that the MK test has exaggerated the significance of some of the positive trends detected. The analysis shows that more than half of the positive trends recognized by the MK test as significant were in the voting of countries that have generally submitted small numbers of votes, and at the same time, increased their voting by submitting additional few votes per month. For different inherent reasons in the MK test, an

[40] For instance, if the time series values were 13, 57, 23, 13, 66, 41, 57 and 57, we would have two tie groups for the measurements 13 and 57 (i.e., m=2), and the number of data points in these groups would be $t_i = 2$ for the tie group with 13, and $t_i = 3$ for the tie group with 57.

increase of just a few additional votes per month has been recognized as a significant positive trend in the voting of member countries with generally low voting. In order to reduce the effect of such exaggeration on the final results, the Sen's slope estimator and the average number of monthly votes were added to the analysis, as shown in Figure 5 below.

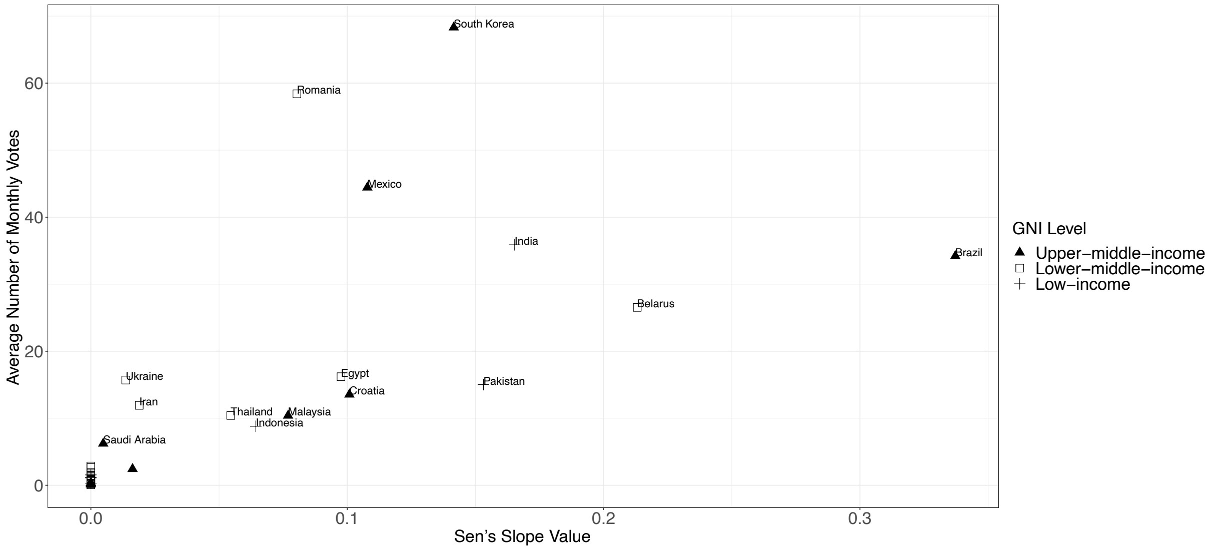

Figure 5 Map of Positive Trends in the Monthly Voting of Developing Countries

Figure 5 shows all the developing countries that—according to the MK test—have significantly increased the number of monthly votes they submitted between January 2000 and August 2019. The horizontal axis shows Sen's estimator values, which are the magnitudes of positive trends. The further the member country is positioned horizontally away from the vertical axis, the greater the magnitude of the positive trend in its monthly voting and vice versa.[41] The vertical axis shows the average number of monthly votes submitted by the member countries. For example, while Belarus and Mexico have both experienced significant positive trends in their monthly voting, the trend Belarus has experienced was greater in magnitude than the trend of Mexico. At the same time, the average number of votes per month submitted by Mexico was greater than this of Belarus. Finally, member countries are classified according to the respective GNI level of the year 2000.

[41] For example, the magnitude of the positive trend for the values 10, 25, 59, 102 is greater than the one for the values 102, 105, 110, 118.

As shown in Figure 5, the cases I highlight above (i.e., member countries showing significant positive trends in their monthly voting and relatively small values of averages of monthly votes) appear as stacked very close to the origin of the Figure (i.e., the point with 0,0 as x,y values). For these cases, the average number of votes per month has been less than 10 votes throughout the mentioned period, and at the same time, the magnitudes of the positive trends in their voting were relatively very small. Given the large size of IEC activities that require the participation of its member countries, the minimal increase detected in the voting of these member countries should not be viewed as evidence of improvement in the voting of developing countries in the organization. I now turn to the rest of the member countries appearing on the Figure (somewhat) far from the origin.

The analysis shows that a small group of member countries have relatively high values of both positive trends in their monthly voting (i.e., relatively high Sen's slope values) and averages of monthly voting. For instance, Brazil increased the average number of monthly votes submitted from almost zero in the year 2000 to 66 in the year 2018. Note that many of these member countries are recognized in the literature as Rising Powers, such as India, Thailand, Malaysia, and Pakistan. In addition, two developing countries showed exceptionally high voting, namely China and Russia. While these two member countries did not increase their already high number of monthly votes—and therefore were not captured by the MK test—they maintained a voting level as high as the most active member countries in the IEC. This provides further support to the finding that member countries that have increased their voting in the IEC are mostly countries experiencing growing economic and industrial capabilities.

In sum, the analysis of this subsection provides evidence supporting Hypothesis 1. The IEC opening up measures have been generally effective in increasing the number of votes submitted by member countries from the developing world. Meanwhile, member countries with growing economic and industrial capabilities benefited the most from these opening up measures.

5.5. Taking Part in Technical Committees as Participating-members

As a recap, member countries taking part in TCs as P-members are provided with the right to exercise substantial influence in IEC standard-setting. Arguably, the greater the presence of a given member country in IEC TCs as a P-member, the greater its participation in the organization. In this section, I analyze relevant data to assess the effectiveness of the IEC opening up measures in increasing the number of P-memberships held by developing countries in its TCs between 2010 and 2022. For that, I first identify the number of P-memberships held by member countries in all IEC TCs in two points of time, namely the years 2010 and 2022.[42] Then, for each of these member countries, I identify the respective GNI level in the year 2000. Finally, I aggregate the number of P-memberships by GNI level and present the results in a bar chart, as shown in Figure 6 below. According to Hypothesis 1, I expect to find evidence of an increase in the number of P-memberships held by developing countries from 2010 to 2022.

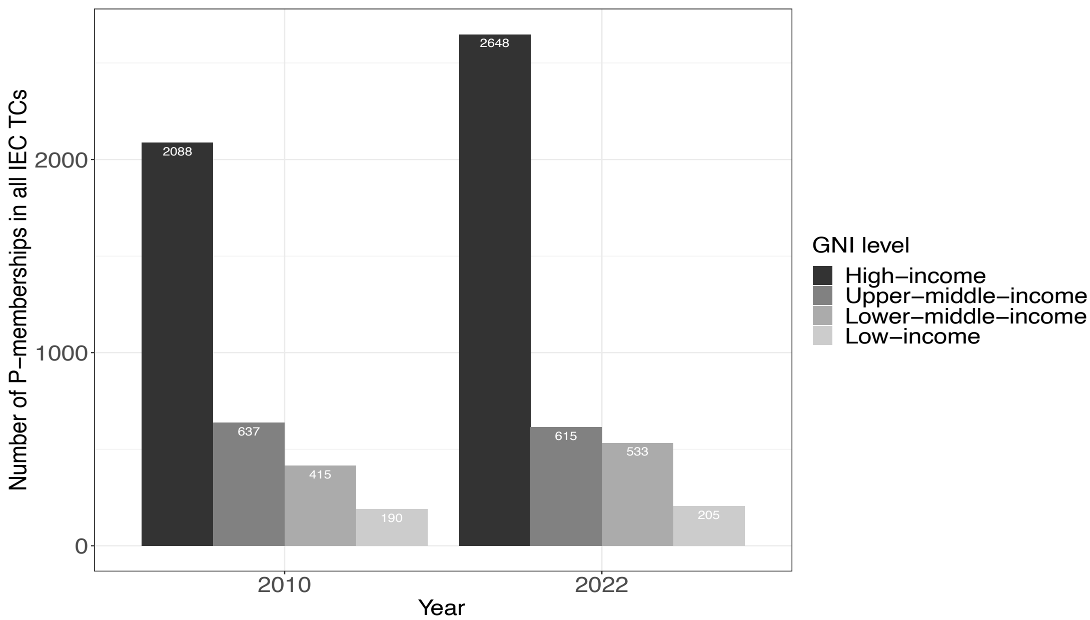

Figure 6 Distribution of P−memberships by GNI Level for the Years 2010 and 2022

[42] The IEC website publishes current data only. Therefore, I compiled the data for the year 2010 from the work by Büthe (2010). For the year 2022, I used the data as posted on the IEC website at the time of writing this–during the year 2022.

Before discussing the analysis, it should be noted that the general increase in the number of P-memberships observed in Figure 6 is partly a function of an increase in the number of IEC TCs over time. As the scope of the IEC expands to new standard-setting areas, additional TCs are constantly being established to serve as platforms for the technical work. Meanwhile, member countries continue to join these new TCs according to their preferences—as P- or O-members. In 2010, the IEC had a total of 174 committees (including the so-called subcommittees); this number has increased to 213 committees at the time of writing this.

As illustrated in Figure 6, the number of P-memberships held by the developing countries over the period 2010 – 2022 has only slightly increased. Particularly, member countries from the lower-middle-income level have increased the number of P-memberships they hold by 118, and member countries from the low-income level have done the same only by 15 memberships. Meanwhile, the number of P-memberships held by the member countries from the upper-middle-income level has decreased by 22 memberships. In comparison, member countries from the high-income level have increased the number of P-memberships they hold by 560 memberships. Note that the analysis includes a total of 58 member countries from the lower three GNI levels and only 31 member countries from the high-income level; meaning, despite the fact that the number of developing countries is almost twice the number of the developed, the participation of the former was substantially lower than the latter.

This part of the analysis also shows exceptionally high performance by a group of developing countries that are mostly Rising Powers. While most developing countries have little presence in TCs as P-members, China, Russia, India, Brazil and Pakistan are participating as actively as the developed countries.

In sum, this part of the analysis provides evidence showing that the IEC opening up measures have been only modestly effective in improving the participation of developing countries as P-members in its TCs. At best, this analysis provides only weak evidence supporting Hypothesis 1.

5.6. Holding Full Memberships

As a recap, member countries with Full memberships are provided with substantial participation privileges to exercise influence in IEC standard-setting. Conversely, the influence of member countries with Associate memberships is limited or, at best, conditioned by the agreement of Full members. Accordingly, increasing the participation of the developing countries in the IEC entails improving their presence as Full members. In this section, I assess the effectiveness of the IEC opening up measures in improving the participation of the developing countries through holding Full memberships in the organization between the years 2000 and 2022.[43] According to Hypothesis 1, I expect to find evidence of an increase in the number of IEC Full memberships held by the developing countries.

To construct this analysis, I first identify the membership type held by each IEC member country at the beginning and end of the period 2000 – 2022. Then, I classify member countries according to the respective GNI level in the year 2000. Finally, I aggregate the data according to GNI level and membership type for both years. The data is presented in bar charts in Figure 7 below.

[43] The IEC website only publishes current data; therefore, historical data were unavailable there. I compiled the data for the year 2000 from the work by Büthe (2010). For the year 2022, I used the data as posted on the IEC website at the time of writing this.

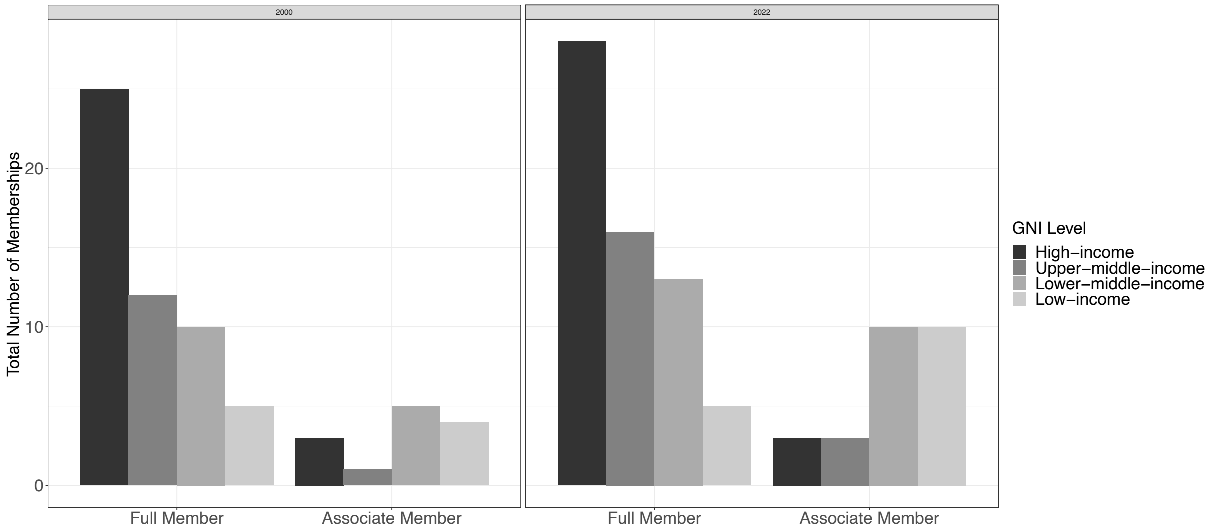

Figure 7 Number and Type of Memberships Held by Each GNI Level in 2000 and 2022

The data shows a general increase of 23 memberships in the total number of IEC memberships between the years 2000 and 2022. Particularly, the IEC had a total of 65 member countries in 2000, of which 52 held Full memberships and 13 held Associate memberships; and at the time of writing this (i.e., during the year 2022), the total number of IEC member countries is 88, of which 62 held Full memberships and 26 held Associate memberships.

The analysis presented in Figure 7 shows that most of the member countries that joined the IEC after the year 2000 were from the lower three GNI levels, and more than half of them joined as Associate members. The developing countries increased the total number of memberships they held in the IEC by 20, of which 13 were Associate memberships, and 7 were Full memberships. In contrast, member countries from the high-income level have increased the number of Full memberships they held by 3 memberships. It should also be noted that the developing countries are well represented as Full members in the IEC. The total number of developing countries—from the three lower GNI levels—holding Full memberships is greater than the number of member countries from the high-income level.

This analysis shows that although the larger proportion of developing countries has joined the IEC as Associate members, they have generally improved their already well-presence in the IEC, including the number of Full memberships they hold. This provides fair evidence supporting Hypothesis 1 (i.e., the IEC opening up measures have been effective in increasing the participation of developing countries). Meanwhile, the presence of developing countries in the IEC—in terms of memberships they hold—makes their limited utilization of IEC participation mechanisms more puzzling. Put differently, although they generally have the required participation privileges, the developing countries participate substantially less than the developed.

5.7. Holding Secretariat Positions

Given the central role played by the TC secretariats in IEC standard-setting, I consider holding such positions a very important participation mechanism in the IEC. Studies repeatedly suggested that member countries holding secretariat positions can exercise greater influence than other participants in a given TC (Büthe, 2010). Meanwhile, member countries interested in holding such positions should be equipped with substantial financial and technical capabilities. Increasing the participation of the developing countries in the IEC entails improving the share of secretariat positions they hold in its TCs. In this section, I assess the effectiveness of the IEC opening up measures in improving the developing countries' participation through holding secretariat positions in IEC TCs between the years 2000 and 2022. Recall that Hypothesis 1 makes me expect to find evidence of an increase in the number of secretariate positions held by the IEC member countries from the developing world.

To construct this part of the analysis, I identify the number of secretariat positions held by each IEC member country at the beginning and end of the period 2000 – 2022.[44] Then, I classify member countries based on respective GNI levels for the year 2000. Next, I aggregate

[44] Similar to previous parts of the analysis, relevant historical data are unavailable on the IEC website. I compiled the data for the year 2000 from the work by Büthe (2010). For the year 2022, I used the data posted on the IEC website at the time of writing this.

the number of secretariats held by member countries according to GNI levels for both points in time. Finally, I present the analysis in bar charts, as shown in Figure 8 below.

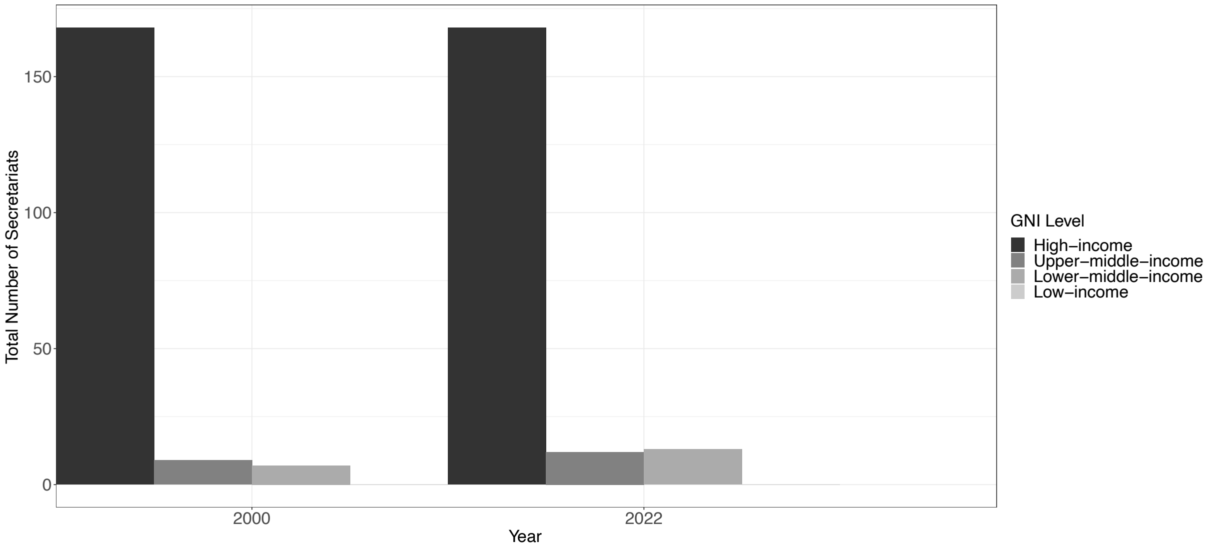

Figure 8 Distribution of IEC Secretariat Positions Among GNI Levels for the years 2000 and 2022

As illustrated in Figure 8, the analysis shows that the number of secretariat positions held by the developing countries in IEC TCs has only slightly improved since the year 2000. While member countries from the low-income level remain without secretariat positions, member countries with upper-middle- and lower-middle- income levels have increased their shares by a few positions only, 3 and 6 respectively. Most of the secretariat positions at the IEC have been, and remain, held by the developed countries—specifically, 168 positions.

The analysis of this section provides additional evidence suggesting that the measures taken by the IEC to improve the participation of the developing countries has been only modestly effective in achieving their objectives.

6. EMPIRICAL MODEL AND ASSESSMENT OF HYPOTHESES 2 AND 3

In this section, I present my empirical model, its variables and results for the assessment of hypotheses 2 and 3. Recall that I seek to explain the variation in member countries' participation in the IEC over the course of the past two decades. I hypothesize that economic power and the relevant industrial capability of member countries act as two main explanatory variables for national participation in the IEC.

My dependent variable is non-negative discrete count data that is strongly skewed to the right—as shown in the Histogram plot in Figure C2 in Appendix C. For analyzing time series consisting of counts, nonlinear models—such as the Poisson, Negative Binomial or Zero-inflated—are usually considered. At the same time, linear regressions, such as the Ordinary Least Squares, assume normally distributed error terms and may result in negative predicted values. These conditions are not applicable and theoretically impossible (i.e., minus number of votes) for the case here. The Poisson regression model was considered a poor choice due to the underlying assumption of the equality of the mean and variance of the dependent variable. A likelihood ratio test confirmed the presence of overdispersion in the data (Cameron & Trivedi, 2013, pp. 69 - 110). I find the negative binomial regression model as the most appropriate as it allows for excess variability (overdispersion) among event counts (i.e., assumes the dependent variable's conditional variance to be equal to the conditional mean (Long, 1997, pp. 216-240). The absence of zeros values in the dependent variable suggested that I should not use zero-inflated models. All these factors led to using a negative binomial regression model, which estimates a functional relationship between a response/dependent variable, that is a count of the number of times an event occurs and a metric predictor.

The main dependent variable NUMBER OF VOTES is operationalized as the discrete count of the number of votes submitted by a given P-member in all TCs per YEAR.[45] Values are then aggregated accordingly. My unit of analysis is, therefore, country-year. The output of this operationalization is presented in Figure C2 in Appendix C, demonstrating large variations in participation across countries.

[45] For a comprehensive picture, I aggregate all technical votes regardless of the standard-setting stage for which a given vote was submitted. Such technical votes comprise most of the dataset, leaving a small share of votes for strategic decisions.

According to H2 and H3, my model includes two variables acting as the main independent variables of interest. The first is the economic power of member countries. This is operationalized as the GDP PER CAPITA—in constant U.S. dollars—of a given member country in a given year.[46] The second independent variable is the relevant industrial capability of member countries. This is operationalized as EXPORT VOLUME of electrical and electronics products governed by the IEC for a member country in a given year. I identify such products by filtering the relevant dataset from the United Nations Comtrade Database for Harmonized System codes of chapter 85. This chapter includes electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles—IEC standards are very relevant to such product groups. Both of the main independent variables are logged in the model.[47]

In order to account for potential alternative explanatory variables, the model also includes several covariates that measure the influence of domestic factors on participation in the IEC. I consider the possibility that POPULATION SIZE, DEMOCRACY INDEX and OECD MEMBERSHIP may (partly) explain the variation in member countries' participation in the IEC. I expect countries with relatively larger populations to be, ceteris paribus, more likely to have more experts who might be able to participate in standard-setting. The POPULATION SIZE variable is logged in the model. Political characteristics are relevant because they may influence how countries represent their interests at the international level (Lavenex et al., 2021a). For example, there is a significant correlation between democracy and participation in WTO decision-making (Guzman & Simmons, 2005). It is plausible, therefore, to expect democratic countries to be better represented in SDOs. For this variable, I adopt the V-Dem Participatory Democracy Index, which is measured on a scale of 1 (as the lowest) to 10 (as the

[46] GDP per capita has been considered as a reliable measurement of countries' economic size in a number of previous studies. For example, see (Hanegraaff & Poletti, 2021).

[47] Log-transforming several variables in the model helped me reduce the effects of extreme observations, tighten the distribution, and include data points that acted as outliers.

highest).[48] In order to account for the development level, I include the Economic Co-operation and Development (OECD) membership as a dummy variable. The OECD members are considered developed and take values of 1; otherwise, they are considered developing and take values of 0.

Table 2 below provides descriptive statistics for the variables used in the empirical model. The data forms an unbalanced panel consisting of 1143 observations. This imbalance is due to differences in membership starting dates (i.e., countries joined the IEC at different points in time). I also investigate the possibility of multicollinearity by calculating the Variance Inflation Factor (VIF) for each variable and present the results in Table 3 in Appendix C. Values for all variables are less than 5, suggesting that multicollinearity is of little concern in biasing the model results. I provide further details about the definitions and sources of my variables in Table 4 in Appendix B.

Table 2 Summary Statistics of Variables

Variable	Mean	Std. Dev.	Min.	Max.
NUMBER OF VOTES	461.15	388.36	1	1283
log GDP PER CAPITA	9.61	1.19	6.16	11.63
log EXPORT VOLUME	22.15	2.28	11.51	27.22
DEMOCRACY INDEX	46.71	21.27	1.60	80.80
log POPULATION SIZE	16.86	1.66	12.60	21.05
OECD MEMBERSHIP (dummy)	0.55	0.50	0	1
YEAR	2009	5.40	2000	2018

6.1. Results

Table 5 below presents the analysis results estimated by Negative Binomial regression to explain the variation in member countries' participation in the IEC. Model 1 is the baseline, which includes only the control variables: DEMOCRACY INDEX, the log of POPULATION SIZE and dummy OECD MEMBERSHIP. In Models 2 and 3, I introduce the two main independent

[48] My results were robust when I replicated the analysis using the data of the Polity5 Project (The Center for Systemic Peace. https://www.systemicpeace.org/mission.html).

variables, one at a time to the baseline model. The first independent variable GDP PER CAPITA is included in Model 2, and the second EXPORT VOLUME is added in Model 3. I focus Models 4 and 5 on one independent variable at a time—GDP PER CAPITA and EXPORT VOLUME, respectively—and exclude the rest of the variables. Lastly, Model 6 contains the main independent and control variables and therefore represents the full model. Looking at the Akaike Information Criterion, adding the variables across the models increases the overall model fit. I consider Model 6 as the base for examining my theoretical expectations.

Regarding the control variables, while POPULATION SIZE and OECD MEMBERSHIP show significance across all models, DEMOCRACY INDEX is insignificant in Models 1, and even has a negative coefficient in Model 3. For the models where the coefficient is significant, the results indicate that member countries with larger populations, more democratic and among the OECD members (i.e., developed) are generally more likely to participate in international standard-setting. This is consistent with earlier findings in the literature about the importance of population size (Carroll & Rasmussen, 2017), democracy level (Uhre, 2014) and level of development (Hanegraaff & Poletti, 2021) in predicting countries' participation in GGOs.

Including the first independent variable GDP PER CAPITA to the baseline, resulting in Model 2 has notably improved the fit of the model. In this model, all variables are significant and positively associated with countries' participation in the IEC. The coefficient of the independent variable GDP PER CAPITA is large and positive. In Model 3, including the second independent variable EXPORT VOLUME had a smaller improvement in the fit of the model than in the previous case. Meanwhile, except for the DEMOCRACY INDEX—that has an insignificant negative coefficient—all variables have a significant positive impact on countries' participation in the IEC. Models 4 and 5 have the first and second worst values of Akaike Information Criterion. As described, these two models concentrate on GDP PER CAPITA and EXPORT VOLUME respectively, and exclude the rest of the variables. This suggests that none of the two independent variables should be solely considered as a predictor for countries' participation in international standard-setting. Meanwhile, both variables in the two models are highly significant (at the 0.001 level) and have positive effects on countries' participation in the IEC. While the coefficient of the GDP PER CAPITA in Model 4 remains relatively large (0.4190), the coefficient of EXPORT VOLUME in Model 5 is not much smaller in value (0.2967).

Hypothesis 2 postulates a positive relationship between countries' economic power and the likelihood of participation, and I indeed find that GDP PER CAPITA is positively and robustly correlated with the number of annual votes submitted by IEC member countries. The respective coefficient in Model 6 remains relatively large (0.5285). This is consistent with Hanegraaff and Poletti (2021) emphasis on the importance of economic power in predicting member countries' participation in GGOs. Meanwhile, the results show that the relevant EXPORT VOLUME also plays a role. This provides evidence supporting Hypothesis number 3, which predicts a positive relationship between the relevant industrial capability and countries' participation in SDOs.

Table 5 Regression Results

	Dependent variable: NUMBER OF ANNUAL VOTES					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.7494** (0.3492)	-6.9891*** (0.5731)	-0.6684* (0.3894)	1.9996*** (0.2664)	-0.6045** (0.3076)	-7.0032*** (0.5720)
log GDP PER CAPITA		0.5805*** (0.0386)		0.4190*** (0.0275)		0.5285*** (0.0427)
log EXPORT VOLUME			0.1487*** (0.0160)		0.2967*** (0.0138)	0.0659*** (0.0169)
DEMOCRACY INDEX	0.1347 (0.2177)	0.4430** (0.2052)	-0.0162 (0.2141)			0.3759* (0.2045)
log POPULATION SIZE	0.2630*** (0.0192)	0.4074*** (0.0198)	0.1649*** (0.0209)			0.3550*** (0.0238)
OECD MEMBERSHIP (dummy)	1.2390*** (0.0925)	0.3459*** (0.1035)	0.9278*** (0.0974)			0.2824*** (0.1036)
Observations	1,143	1,143	1,143	1,143	1,143	1,143
Log Likelihood	-7,926	-7,838	-7,902	-8,016	-7,960	-7,833
theta	0.9280*** (0.0346)	1.0495*** (0.0397)	0.9596*** (0.0359)	0.8202*** (0.0301)	0.8856*** (0.0328)	1.0570*** (0.0400)
Akaike Inf. Crit.	15,860	15,687	15,814	16,037	15,924	15,679

*Note: Robust standard errors are in parentheses; ***p < 0.001; **p < 0.01; *p < 0.05*

7. DISCUSSION

The analysis of this chapter provides evidence showing that the opening up measures taken by the IEC to improve the participation of the developing countries in its standard-setting have been, at best, only slightly effective in achieving their objectives. If these measures had any effect, they benefited only a small group of member countries, mostly experiencing growing economic and industrial capabilities. Such evidence has been found across almost all the participation mechanisms analyzed in this research and was persistent over the concerned periods of time.

First, the Affiliate Country Programme has been largely inadequate in increasing the number of IEC Full memberships among the Affiliate countries. Most of the countries that took part in the programme maintained their statuses as Affiliates, and only some upgraded to Associate members. Moreover, the inputs of the Affiliate countries to IEC standard-setting has been minimal since the launch of the programme and remained at a low level until the year 2019 without any sign of improvement.

The Affiliate Country Program has been, meanwhile, generally effective in terms of attracting countries without any IEC membership to hold Affiliate statuses, consequently increasing the number of IEC member countries with relatively fewer participation privileges as well as motivating many of them to adopt IEC standards nationally. Arguably, the programme has been relatively more effective in terms of enhancing the diffusion of IEC standards globally and its role in international standard-setting.

Second, the analysis of all votes submitted by IEC member countries between the years 2000 and 2019 shows a notable increase in the total number of annual votes submitted by the developing countries. Meanwhile, this improvement has been almost entirely driven by a small group of member countries, some of which have increased their voting so much that their participation became comparable/equivalent to the most active IEC member countries, which are mostly developed countries. Beyond this improvement, there was almost no sign of an increase in the voting of the developing countries from lower GNI levels throughout the entire period of time. Further analysis of the same dataset provided evidence of a significant North-South imbalance and identified the member countries that significantly increased their voting between 2000 and 2019.

Third, while a number of member countries from the developed world submitted the majority of the against-votes between the years 2000 and 2019, the developing countries submitted very few votes of this type with little sign of improvement throughout the concerned period. In addition, most the few against-votes recorded from the developing countries were made by the small group of member countries experiencing growing economic and industrial capabilities.

Fourth, the number of P-memberships held by the developing countries in IEC TCs between the years 2010 and 2022 has only slightly increased; meanwhile, this improvement has been driven largely by the same group of member countries highlighted above.

Fifth, the analysis of IEC memberships shows an increase in the number of memberships held by the developing countries in the IEC between the year 2000 and the time of writing this, albeit more than half of these later-joiners held Associate memberships. In doing so, they have generally improved their already well-presence in the IEC as well as increased the number of Full memberships they hold.

Sixth, the small number of IEC secretariat positions held by the developing countries over the past two decades has hardly increased. In terms of holding secretariat positions in the IEC, the participation of the developing countries has remained a far cry from the participation of the developed countries throughout the entire concerned period of time.

Regarding the drivers of countries' participation in the IEC, the regression analysis shows a significant positive correlation between countries' economic power and the number of annual votes submitted to the IEC between 2000 and 2018. The analysis also shows a similar correlation between the relevant industrial capability and the likelihood of voting in the IEC. Such findings are robust across various models as well as after controlling for several other domestic variables. Particularly, the analysis shows relatively large estimated coefficients of economic power, suggesting a strong impact of this variable on member countries' voting (this is consistent with what has been found by other scholars, for instance, see Hanegraaff & Poletti, 2021). While the relevant industrial capability has a relatively less positive impact, the analysis shows that this variable remains significant across different models, suggesting that it matters too.

The strong correlation between the two domestic variables—economic power and the relevant industrial capability—and the likelihood of participation in international standard-setting provides support to hypotheses suggesting that the participation decision is largely a country-level decision that depends on different domestic conditions (for example, see Lavenex et al., 2021a). While scholars have already emphasized numerous domestic variables—above all economic power (Bartley, 2018)—as drivers of participation at the international level, I argue that the relevant industrial capability should also be considered. Such an argument is most relevant in the realm of international technical standard-setting, not least because of the relatively greater technical capabilities required for participation. I view economic power as a necessary condition for participation in international standard-setting; meanwhile, it should not be considered alone in predicting the likelihood of countries' participation in SDOs. Instead, the commercial interest—which is likely to be driven by the industry interested in the rules being developed in a given SDO—should also act as an additional explanatory variable. Theory should, therefore, lead us to expect greater importance of domestic industrial power than is commonly recognized.

The findings of the analysis are in line with previous evidence showing that the North-South imbalance issue has not yet been addressed (Renckens & Auld, 2019) and that altering the supply side of international standard-setting will not provide sufficent incentives for developing countries to participate (for example, see Büthe et al., 2022; Kanevskaia, 2020). While the focus of this chapter is primarily on SDOs, the findings could still provide insights into the broader literature on global governance. For studies seeking to better understand the implications of the emerging economies' rise in GGOs (for example, see Lavenex & Jurje, 2021), the findings of this analysis reaffirm that these countries are playing a growing role in SDOs.

The findings also lend support to hypotheses suggesting that GGOs reflect the global power structure (Mearsheimer, 1994). The analysis provides evidence suggesting that the opening up measures strengthened the positions of member countries experiencing growing economic and industrial powers. At the same time, the originally targeted countries—presumably those with relatively low economic and industrial capabilities—have benefited the least from these measures. In the case of the IEC, many of the late-joiners—member and Affiliate countries—are increasingly being engaged in one form or another in its standard-setting; meanwhile, they are provided with few privileges to exercise influence. In addition to a notable increase in the number of member/Affiliate countries, many countries are adopting IEC standards nationally while being engaged very little in the process of developing these standards. These findings suggest that late-joiners of the IEC have been, at least so far, contributing to a greater diffusion of its standards, ultimately enhancing the IEC's role in global governance. I view such findings as in line with theories suggesting that GGOs' leaders, or established powers, will co-opt emerging economies by introducing various measures geared to prevent the rise of challengers (Auld et al., 2015; Kirshner, 2012; Kruck & Zangl, 2019; Paul, 2016).

This research has two limitations worth noting: First, the narrow focus (i.e., an individual SDO) of the analysis might limit the generalizability of the findings to SDOs that are similar to the IEC—with respect to internal governance system and power structure—and have introduced opening up measures, such as the ISO; second, due to a lack of a threshold, assessing the effectiveness of the IEC opening up measures in achieving their objective was done largely based on a relative evaluation between the participation of the developing and developed member countries.

8. CONCLUSION

This chapter has sought to achieve two main objectives: the first is to assess the effect of the opening up measures taken by SDOs to improve the participation of developing countries in international technical standard-setting, and the second is to achieve a better understanding of what could explain the variation in member countries' participation in the same realm. For that, a large amount of cross-national participation data has been empirically analyzed within the context of the IEC. For the first research objective, the participation of IEC member countries has been analyzed through almost all of the participation mechanisms offered by the SDO with an aim to examine a potential increase in participation, as suggested by theory. For the second objective, a regression analysis has been carried out to examine the theoretical expectations of positive correlations between two country-level variables, namely economic power and the relevant industrial capability, and the likelihood of participation in SDOs.

The findings of this chapter suggest that the IEC opening up measures have been, at best, only slightly effective in achieving their objectives. If these measures had any effect, they benefited member countries experiencing growing economic and industrial capabilities. In addition, the analysis shows that national participation in the IEC is largely driven by these capabilities. Arguably the opening up measures contributed to strengthening the IEC by increasing the number of its member countries and the diffusion of its standards globally.

That is not to say that the opening up measures do not help in increasing the participation at all, but that their positive effect should not be overestimated, especially for countries equipped with less economic and industrial capabilities. This might also suggest that the IEC bears only part of the responsibility for the participation imbalance among its member countries. Note that the participation dynamics observed in the analysis of this chapter could also exist in other SDOs similar to the IEC, such as the ISO. As emerging economies gain more power in these organizations, we should expect to witness an emergence of new actors in shaping future technology markets as well as products—which can already be observed in the case of China.

There are multiple important issues that I could not fully address in this chapter but which offer interesting avenues for further research. First, although the different participation mechanisms analyzed in this chapter are important for gaining potential influence in IEC standard-setting, analyzing relevant participation data does not allow me to draw firm conclusions on influence. Therefore, more efforts should be devoted to identifying participation mechanisms that guarantee influence and/or conduct analysis based on actual influence data. Second, further research could follow the developments in participation over the coming years and observe if similar/different dynamics occur. For instance, the recent global-wide digitalization of meetings—due to the Corona pandemic—could result in a general increase in member countries' participation in different GGOs/SDOs, consequently introducing new participation dynamics. Finally, the analysis of this chapter should be replicated in other SDOs or different issue areas, such as the ITU, in order to reach more conclusive findings.

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Chapter 4 – China: a Disruptive Power in International Standard-Setting?

1. INTRODUCTION

China's rise as a major power in Global Governance Organizations (GGOs) is not being questioned anymore (Breslin, 2017). Scholars are increasingly showing that China has become not only a proactive participant in numerous GGOs (for example, see Frick, 2021; Hopewell, 2021) but also an organization-builder in several regulatory issue areas (Paradise, 2016), such as in the cases of the Asian Infrastructure Investment Bank (Ren, 2016) or the Shanghai Cooperation Organization (Chin & Thakur, 2010).

Meanwhile, the implications of such a rise for GGOs are being hotly debated in the literature (Breslin, 2013; Kuang, 2018; Shambaugh, 2013; Webster et al., 2022). While some scholars expect China's ascent in the global economy to result in a hegemonic transition in power or at least instability in the existing global governance order (for example, see Gao et al., 2021; Kim et al., 2020; Mearsheimer, 2014), others are expecting insignificant or even a positive impact (for example, see Breslin, 2009; Ikenberry, 2011). In order to make more robust predictions, scholars continue to analyze China's behavior in various GGOs, but the reported evidence remains inconclusive. Analyses of China's behavior show that it varies from one GGO to another as well as over time, making understanding it a real challenge (for example, see Frick, 2021; Hopewell, 2021; Kastner et al., 2020; Kennedy, 2018; Križić, 2021; Weiss & Wallace, 2021).

While a fair scholarly attention has been paid to China's ascent in GGOs, an important type of these organizations, namely the international Standard Developing Organizations

(SDOs), remain puzzlingly understudied (for an exception, see Contreras, 2014).[1] Existing studies tell us little about how China is behaving/rising in international standard-setting and even less about how SDOs could be consequently shaped, if at all. This is unfortunate not least because SDOs promote global rules governing numerous aspects of our lives beyond merely technical, such as societal and environmental.

Several reasons warrant considering China in international standard-setting as an object of study in its own right. First, being the most prominent emergent economy (Güven, 2017; Kahler, 2013)—if not already a high income country (Bruton et al., 2021)[2]—China is playing a rapidly growing role in developing numerous technologies, making it inevitable to consider its preferences in setting respective international standards. Despite being developed in international SDOs, these standards can bear political preferences and values, allowing them to be strategically employed by China in its own favor (Seaman, 2020). Second, China's supply of domestic standards at the international level will eventually result in a redistribution of gains among holders of Intellectual Property Rights (IPRs)—who typically come from the West—as well as hindrance of interoperability, which is a major objective of setting international standards. Indeed, differences between Chinese and international standards gave rise to numerous challenges in front of stakeholders (Lei et al., 2017; You et al., 2022). Third, analyzing China's behavior in international standards-setting serves as a step further toward achieving a better understanding of China's approach to privacy-related issues in the development of various technologies.[3] Finally, China's recent reforms of its standardization policy proved to be fruitful in developing a "latent capacity" to influence the existing global order (Malkin, 2022), making studying such policy more important.

[1] The main focus of this chapter is international standard-setting, which is—including its organizations—viewed as being part of (private) global governance organizations.

[2] For instance, while China's Gross Domestic Product (GDP) in the year 2021 was 16.86 trillion U.S. dollars, all other BRICS countries' GDPs were below three trillions (O'Neill, 2021). Such economic growth has been repeatedly hailed as China's miracle (Lin et al., 2004).

[3] As they often regulate technical as well as non-technical aspects of technologies, standards can have an ultimate effect on how strict a given technology is with respect to privacy-related issues.

In this chapter, I seek to contribute to filling the above interrelated gaps in the literature by asking whether and how China exerts power in international standard-setting. And in case China is effectively exerting power in SDOs, how likely is it that it will act in a disruptive manner? I view the pessimistic scenario (i.e., China's behavior to be disruptive in SDOs) as both more intriguing and pressing to study than the optimistic, not least because the former is more likely to cause a transformation in these organizations. Due to the limited literature on SDOs, I draw on studies analyzing China's behavior in GGOs for theoretical expectations and insights.

The analysis of this chapter is conducted within the context of the most important international SDO for developing electrotechnology standards, namely the International Electrotechnical Commission (IEC). The IEC is considered a distinct regulatory issue area—standards related to electrical and electronic technologies, which are collectively called electrotechnology—and hence serves as an important as well as an interesting case study.[4] Standards developed at the IEC do not only govern thousands of everyday products/devices but also have an ultimate effect on numerous environmental and societal aspects of our lives. For instance, the IEC develops standards governing different safety and performance aspects of hundreds of commonly used household appliances, such as washing machines, dishwashers, and refrigerators. Despite its vital role in international standard-setting, the IEC is strikingly underappreciated in the literature. Last but not least, the ongoing controversy surrounding setting international standards for Artificial Intelligence technologies (Gamito, 2021; Schmitt, 2021) and 5G—both of which are partly governed by IEC standards—make studying China's role in this SDO/realm more important.[5]

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[4] As I show in the subsequent section, scholars suggest that China's behavior in GGOs shall be analyzed issue area by issue area.

[5] See Lemstra (2018) for a discussion on competition between powerful countries over the 5G. Such competition has recently become more fierce due to the global COVID-19 pandemic (Fish, 2020).

To answer my questions, I empirically analyze China's status and participation in the IEC throughout the past two decades with respect to two aspects: first, China's utilization of several mechanisms through which member countries can (access opportunities to) participate in the operations of the IEC both at the strategic and technical levels;[6] and second, the likelihood of disruptive behavior by China in the IEC. For the former aspect, I consider the following participation mechanisms as most suitable for the analysis: (1) Taking part in committees as a participating-member; (2) Voting in technical and strategic decision-making; (3) Voting in opposition in technical and strategic decision-making; (4) Holding decision-making positions; (5) Providing voluntary funds.[7] These participation mechanisms are ordered in an ascending fashion according to the respective potential effectiveness in achieving influence in the IEC.

Note that I distinguish between actual participation and opportunities for participation.[8] The strategic aspect is understood as IEC work-related matters that are beyond technical and might influence the overall strategic direction of the organization. I view the IEC as being led by relevant, powerful industries represented by national standardization bodies from the developed world (i.e., established powers). Member countries are also viewed as largely self-interest-seeking in the IEC and, therefore, will oppose technical/strategic proposals that are not in line with their interests. As I show in the analysis, a small number of industrialized countries show exceptionally high participation across all mechanisms in the IEC.

[6] As I describe in the following sections, participation at the IEC is country-based. The entity that actually participates and represents the national interests at the IEC is the respective national electrotechnology standardization body. This body should be established prior a country applies for an IEC membership and is comprised of—in principle—all national stakeholders. Typically, the national electrotechnology standardization bodies are largely comprised of industry stakeholders. The term member country used in this chapter refers to the respective national electrotechnology standardization body.

[7] The list that I propose is by no means conclusive. I view the identified participation mechanisms as the most effective mechanisms offered by IEC for member countries to influence the organization both at the technical and strategic levels. For instance, the number of patents submitted by a country has also been considered by scholars as a good indicator of participation in standard-setting (Baron & Kanevskaia, 2021); however, collecting data related to the number of patents China submitted for all standards developed by the IEC is, if at all possible, a challenging task. In addition, many standards do not include patents. Therefore, patent submission was not considered for this analysis. At the same time, the focus of this analysis is China's participation within the IEC—patent submission is made outside of the organization.

[8] Further details are presented in the analysis section.

For the second aspect of the analysis, I assess the likelihood of China behaving in a disruptive manner through each of the above participation mechanisms. Disruptive behavior in IEC decision-making can take place in a situation whereby China is able to introduce strategic/technical preferences in a way that cannot be blocked by other powerful member countries even if they want to. Specifically, the likelihood of China acting disruptively through a given participation mechanism is greater when two conditions are met: (1) the participation of China is significantly higher than the participation of the other powerful member countries; and (2) the opportunities for participation that China can access are larger than the opportunities that the other member countries can access while taking into account the internal governance rules of the IEC.

To conduct the analysis of this chapter, I collect qualitative as well as quantitative data from several sources: first, I leverage an original internal IEC dataset that includes numerous participation records of all IEC members over the course of the past two decades. Second, I retrieve additional data from the IEC website, other public sources, and previous (un)published research. Finally, I supplement the quantitative analysis with evidence from six semi-structured interviews with IEC decision-makers and experts in China's standardization policy.

The analysis of this chapter provides evidence showing that China has been increasingly exerting power in the IEC through effective utilization of all of the participation mechanisms analyzed, securing high potential influence in the organization. Such utilization, meanwhile, was less in mechanisms requiring relatively greater technical capabilities. Despite the substantial increase in China's participation in the IEC, the organization remains largely dominated by powerful Western member countries and Japan. Such participation, combined with a level playing field maintained by the IEC rules, reduce China's chances of behaving in a disruptive manner in the short term. That said, China can still act disruptively in the IEC, especially if its voice has gained sufficient support from other (powerful) member countries.

The contribution of this chapter is threefold. First, the analysis advances our knowledge about both the international standard-setting and the broader literature on global governance by adding a substantively important case to contrast with other recent analyses of regulatory issue-specific cases (for example, Lavenex et al., 2021). Second, the findings contribute to several debates, above all, those seeking to predict how China behaves in, and could shape, international SDOs. In so doing, this research serves as an additional step toward solving the "techno-nationalist" and "techno-globalist" tension in the literature.[9] Finally, the chapter provides original empirical evidence on the power structure as well as patterns of participation of the most powerful member countries at a major international SDO. To my knowledge, this research is the first to analyze China's behavior in the IEC.

The chapter proceeds as follows: In Section 2, I present China's recent efforts to strengthen its role in international standard-setting and review the literature for insights and theoretical expectations. I describe the data and methods in Section 3. In Section 4, I present my empirical analysis. In Section 5, I summarize and discuss the findings of the research. Finally, I conclude in Section 6 and highlight avenues for further research.

2. UNDERSTANDING CHINA'S BEHAVIOUR IN GLOBAL GOVERNANCE AND THE CHALLENGES THEREOF

2.1. The Rise of China in International Standard-Setting

Despite being a major global manufacturing powerhouse, China was placed in low positions in the Global Value Chain for many years, offering its industries low profits (Murphree & Breznitz, 2013). This was partly due to core technologies—integrated into many of the products manufactured by China—mostly being developed by Western companies and protected by IPRs, many of which were included in international standards. During the early 1970s, the

[9] More details will be provided in the next section.

Chinese government recognized this drawback and decided to reform its approach to international standard-setting (for a discussion, see Pusceddu, 2020). Among other reform measures, China introduced what has been termed by Ernst (2011) as the "two-track approach to standardization."[10] As part of this new standardization approach, China invested numerous resources to strengthen its role in international standard-setting by targeting the influence of both de jure and de facto standards (Russel & Berger, 2020).[11] In the following discussion, I elaborate on this approach.

Within the international standard-setting system, the "China Standards 2035" project was launched in 2021 by China's State Council with an aim to, among others, increase China's participation in SDOs. This objective was later repeatedly stated in many policy documents, such as the recent National Standardization Development outline document (Gargeyas & Pardhi, 2022).[12] The project is transforming China's behavior in international standard-setting from passive learning to substantive participation in numerous SDOs. Studies show that China is increasingly holding key decision-making positions, and has become among the most active actors, in a number of SDOs (Breznitz & Murphree, 2013; Contreras, 2014; Gamito, 2021; Hoffmann et al., 2020; Liu, 2018; Taylor, 2022). China has learned how to avoid the reoccurrence of its unsuccessful attempt to internationalize its indigenous Wireless Local Area Network – Authentication and Privacy Infrastructure (WAPI) standard for wireless communication (DeLacey et al., 2006). This can be seen in the recent integration of a number

[10] The author mentions: "By including Chinese technology into global standards, China seeks to strengthen its bargaining power and to reduce its exposure to high royalty fees. At the same time, however, China seeks to use its increasing geopolitical influence to promote new sets of rules for international standardization, and hence to transform the international standards system itself." (Ernst, 2011, p.5).

[11] While there are no universal definitions, I adopt a simple distinction between the two types of standards for the purpose of this research. In a sense, de facto standards are those privately developed without consensus among stakeholders but end up achieving adoption through different mechanisms, such as standard wars. De jure standards, in contrast, are those developed by reaching a sort of a consensus among stakeholders in a standardization body, which typically handles the promotion of these standards (for a discussion, see Stango, 2004).

[12] The national standardization body of China is the Standardization Administration of China (SAC). It is responsible for the management, supervision and coordination of standardization in China.

of Chinese standards at the international level, such as the Intelligent Grouping and Resource Sharing (GlobeNewswire, 2014).[13]

In parallel and outside SDOs, the Belt and Road Initiative (BRI) and the Digital Silk Road (DSR) have been introduced with an aim to, among others, promote China's domestic technical standards in the developing world (Arcesati, 2019; Rühlig & ten Brink, 2021; Russel & Berger, 2020). Since the introduction of BRI in 2013, more than one hundred countries have signed billions of dollars worth of (standardization) agreements for infrastructure development and connectivity such as railways, roads and power plants under labels such as Smart or Safe Cities. Additionally, China has been increasingly initiating technical standards dialogues through different GGOs such as the Shanghai Cooperation Organization. Meanwhile, It has been suggested that China is utilizing its geopolitical influence to extract political benefits from the signatories by deepening economic and political ties (Bondaz, 2021; Byrnes, 2020; Larmer, 2017). In so doing, China could gain further support for its indigenous standards and/or standardization interests at the international level (Chen et al., 2018, p. 52), ultimately intensifying unwanted geopolitical competition in what is intended to be a technical process that serves the global welfare. This become particularly critical in case Chinese standards significantly diverge from the international standards while creating a lock-in effect in the BRI signatories (for a discussion, see Rühlig, 2020).[14]

Relatedly, many scholars are warning that China's standardization practices are considered in conflict with the procedures and principles developed by the major international SDOs—such as the ISO, IEC and ITU—and confirmed by the WTO for international standard-setting. Rühlig (2020) argues that state-led standardization hinders the transparency as well as the integrity of international standards, not least because governments can influence the

[13] The Intelligent Grouping and Resource Sharing (IGRS) Standard is a Chinese industry association that developed the standard for advanced message and data-based exchange technology framework.

[14]

decision of their delegates (Harcourt et al., 2020) as well as integrate political views into standards (Cantero Gamito, 2018). For instance, in Internet standards, it has been feared that the Chinese government could restrict access to certain information or free speech (Russel & Berger, 2020). Hoffmann et al. (2020) report evidence suggesting China is seeking to reconfigure fundamental components of the Internet, such as the Domain Name System, in an attempt to centralize the control of networks and users' data in the hands of governments. Similar privacy-related concerns are being raised in surveillance standards, in which China is playing a growing role (Gross & Murgia, 2019).

All this has stoked much concerns among the Western world, ultimately leading to the launch of counter initiatives and reforms of standardization approaches, such as the Build Back Better World by the G7 as a counter initiative to the BRI (Adam et al., 2021),[15] the EU's updated standardization strategy (European Commission, 2022) and the Quad Principles on Technology Design, Development, Governance, and Use initiative by a number of Western countries (White House Briefing Room, 2021).[16]

In sum, China's recent reforms of standardization approach are geared to improving China's role in international standard-setting essentially by achieving two interconnected objectives: first, increase its participation within SDOs with an ultimate aim to increase the supply of indigenous standards internationally; and second, gain greater support for its interests, presented in SDOs, from other member countries by utilizing geopolitical projects outside the organizations. Literature, meanwhile, tells us very little about how effective China's recent efforts in enhancing its role in international standard-setting are.

[15] The initiative aims to provide an equitable and greener alternative to BRI for infrastructure development in developing countries with 40 trillion dollars by 2035.

[16] A commitment by the Quad countries (Australia, India, Japan, and the United States) to design, develop, govern, and use technology according to democratic values and respect for universal human rights. Technology is viewed as a way to make the people lives more secure, prosperous, and rewarding.

2.2. How is China Behaving in International SDOs?

While China's behavior in GGOs has attracted fair scholarly attention, SDOs remain severely underappreciated in this literature. At the same time, much of the reported evidence on this topic remains mixed and/or inconclusive. Studies show that China's behavior varies from "symbolic" to "substantive" at different times as well as in regulatory issue areas (Kennedy, 2018), largely depending on the strategic context (Kastner et al., 2020). Weiss and Wallace (2021) and Frick (2021) argue that China is investing in influencing issue areas that are crucial to its interest and is more willing to be less active in issue areas that it considers peripheral. Such variation in approaches makes it difficult to summarize China's rise to the GGOs as either entirely disruptive or status-quo-oriented (as rightly suggested by Johnston, 2019).

Similarly, mixed evidence has been reported in the scarce literature on SDOs while labeling China's shifting behavior as either a techno-nationalist or a techno-globalist.[17] For instance, in the development of the 3G mobile telecommunications standard—known as the Time Division-Synchronous Code Division Multiple Access (TD-SCDMA)—the core technology was combined with non-Chinese technology, and many international companies joined the development of the standard. The TD-SCDMA was eventually adopted as an international standard by the International Telecommunication Union (ITU). China's approach in developing the TD-SCDMA was considered techno-globalist (Han, 2009; Kim et al., 2014; Kwak et al., 2012). In contrast, Lee et al. (2009) report that the WAPI standard was based on indigenous technology, and China restricted the participation in setting the standard to Chinese companies—such an approach is viewed as techno-nationalist. Naughton and Segal (2003)

[17] Techno-nationalism refers to "a subset of mercantilist thinking that, in its extreme form, restricts most exports of technology, innovation, and scientific knowledge to maximize geopolitical advantages, technological self-reliance, and state power." (Xing et al., 2021, p.136). In countries adopting such an approach, a central role is played by governments, which work on maintaining innovation policies focused on national interests even if domestic industries are seeking international cooperation (Ostry & Nelson, 1995). Some scholars termed an extreme case of this approach neo-techno-nationalism (Yamada, 2000; Yao & Suttmeier, 2004). See also Delios et al. (2021, p.5). Techno-globalism refers to the view that "technology development is not a zero-sum game, but a plus-sum game in which all nations can and should cooperate to develop technologies crucial to sustainable economic growth." (Yamada, 2000). In this approach, international market actors play a central role.

report that China's standardization approach shifts, often on a case-by-case basis, between the mentioned two main states. Similarly, Suttmeier and Yao (2008) report that while China's approach in setting the Audio Video Coding and IGRS standards was largely techno-globalist, its behavior was techno-nationalist in the case of WAPI.

In their attempt to better understand such variation, Lavenex et al. (2021) developed an analytical framework to better perceive the behavior of not only China but also other emergent economies in global governance. The authors draw on previous work, such as Kennedy (2018), and argue that the behavior of emergent economies largely depends on different domestic capabilities and the extent to which the countries' preferences are aligned with the global rules. Therefore, the behavior of these countries need not be consistent across issue areas, not least because such behavior is largely a function of (mostly domestic) political preferences that are expected to differ across regulatory issue areas. Depending on the strength of the domestic regulatory state and the extent of preferences divergence from the established powers, an emergent economy can be placed in five different categories: rule-taker, rule-promoter, rule-faker, rule-maker or rule-breaker.

All this implies that the behavior of China in global governance should be assessed issue area by issue area. China's ability to exert influence in a given SDO—including the goals it might pursue in exerting influence—cannot be assumed to be the same in another SDO. While such a variation in behavior limits the generalizability of previous findings to this chapters' analysis, they remain nevertheless insightful, above all in providing theoretical insights and expectations.

2.3. The Implications of China's Rise for SDOs

Some scholars who analyzed China's rise in GGOs, including SDOs, also sought to predict the outcome of its rise for the relevant organizations. These scholars fall into two camps: one emphasizes China's assumed intention to transform global governance to serve its own interests (i.e., techno-nationalist) and accordingly predicts disruption. The second expects China's rise to be more peaceful or even beneficial for the existing global governance order (i.e., techno-globalist). I summarize both views in the following discussion and describe how the analysis of this chapter can contribute to the literature.

China's ruling party's vision of "leading the reform of the global governance system" (Jinping, 2018) is a concern shared by many (Western) scholars as well as policymakers. Some raise doubts about the resilience of existing GGOs (Weiss & Wallace, 2021) and expect China to grow and eventually contest the organizations from within (Schweller & Pu, 2011); others show that China has already transformed into a rule-maker in several GGOs, such as the World Bank (Frick, 2021) and the International Monetary Fund (Hopewell, 2021; Prasad, 2016). Consequently, many of these organizations are expected to undergo organizational restructuring in order to reflect the (recent) global redistribution of economic power (Shelton, 2021). The major crises happening at the time of writing this, namely the global Coronavirus (COVID-19) pandemic and Russia's invasion of Ukraine, are expected to intensify the impact of China's rise, ushering in a more pluralistic global governance architecture, wherein China plays a central role (Aziz, 2021; Lewis, 2022).[18] All of this might provide China with opportunities to shape crucial technologies as well as increase its market shares, ultimately triggering a hegemonic transition power that could even lead to war (for a discussion, see Mearsheimer, 2014).

In the realm of international standard-setting, scholars are using different analytical approaches to analyze China's behavior in developing a certain standard/technology and are reporting evidence in line with the above while labeling it as (neo-)techno-nationalist. Many of these analyses are being conducted on Information and Communications Technology (ICT) standards such as the Wideband Code Division Multiple Access, TD-SCDMA and Long-Term

[18] For instance, the suspension of trade agreements in Asia and the EU could lead to disruptions in the global governance system.

Evolution using patent-related data (for example, see Kang et al., 2014; Kim et al., 2020). Other studies focus on the role of the government (Gao et al., 2021; Zhan & Tan, 2010) or domestic institutions (Kshetri et al., 2011) in supporting China in promoting indigenous innovation internationally. Using the actor-network theory, Shim and Shin (2019) studied China's standardization approach in the Smart Television technology and found that China has protected as well as supported its domestic industry through technological standardization.

Contreras (2014) and Gamito (2021) are among the few scholars who analyzed China's participation in international SDOs using empirical participation data. Contreras (2014) conducts the analysis in the Internet Engineering Task Force (IETF) based on four quantitative metrics: (1) attending standard-setting meetings; (2) disclosing patents; (3) authoring standards; and (4) holding leadership positions. The analysis shows a dramatic increase in China's participation, providing it with a leadership seat among the organization's most active members. The author describes China's rise at the IETF as "on its own terms," suggesting that it is holding an influential—or probably an imperative—position. In socio-legal research, Gamito (2021) focuses on the internal structure and composition of working groups—whereby standard-setting is done—at the ITU and examines China's behavior through process tracing and data collected from interviews. The author reports a significant increase in China's efforts in the ITU to drive AI standardization "toward specific directions."

In contrast to those who view China's standardization approach as (largely) techno-nationalist, some scholars call for a reappraisal of such perception (Ding, 2021; He & Feng, 2019; Jakobs, 2014). Among others, Drezner (2014) and Friedman (2010) view China's rise as an opportunity that will enhance global economic cooperation, ultimately strengthening existing GGOs. Pointing to China's marginal role in global nuclear nonproliferation or the WTO negotiations, Brown (2015) and Hopewell (2016) show that China's rise does not significantly change the global governance order. Ikenberry (2011) argues that GGOs are designed to allow for the integration of rising powers, including China.

In the realm of international standard-setting, these rather optimistic scholars draw, in part, on evidence showing that China's standardization is shifting from a techno-nationalist to a techno-globalist. They provide evidence suggesting that China is increasingly adopting WTO principles, which are implemented in developed countries' standardization regimes (Breznitz & Murphree, 2013; Foot & Walter, 2010; Lee et al., 2009). Kim et al. (2014), Han (2009) and Kwak et al. (2012) report evidence of techno-globalism in China's behavior in developing Information Security standards, TD-SCDMA and Long Term Evolution. Relatedly, scholars report much evidence suggesting that China remains a rule-taker in numerous regulatory issue areas with no significant changes due to its rise, such as the Competition Policy (Wang, 2021), International Intellectual Property Regulation (Cheng, 2018), and global financial regulatory politics (Knaack & Gruin, 2020). In public procurement regulations and Preferential Trade Agreements, China appears to be even a rule-promoter actor (Eckhardt & Wang, 2019; Križić, 2021).

Additional evidence supporting the latter stream of findings has been reported in studies on SDOs. Bruer and Brake (2021) examine China's participation in the ITU and 3rd Generation Partnership Project (3GPP) based on empirical data for three participation mechanisms: (1) contributing to standards; (2) holding leadership positions; and (3) declaring patents. The analysis shows that China has significantly increased its participation, sometimes through "unfair tactics." However, the authors do not view China's performance as alarming. Baron and Kanevskaia (2021) empirically analyze meeting attendance and leadership appointments in the working groups of four SDOs from the ICT sector.[19] The authors find an increase in China's participation in both metrics; however, the leadership positions remain dominated by

[19] The Third Generation Partnership Project (3GPP), OneM2M global partnership project, IETF and the Institute of Electrical and Electronics Engineers' working group for Wireless Local Area Network Standards (IEEE 802.11)

Western countries. In a published report, Neaher et al. (2021) analyzes the number of voting members and national representation in thirty-nine SDOs and show that Western countries, above all the United States and the EU, are/remain dominating most of the organizations; meanwhile, China is relatively not over-represented.

Most of the work on China's behavior in international standard-setting sidelines its participation in the SDOs themselves and remains narrowly focused on a small number of technologies/standards—mostly in the ICT sector. Note that findings from the ICT may not apply to other sectors, not least because the ICT standard-setting remains dominated by standard-setting forums other than the committee-based, such as the Industry Consortia (Blind & Gauch, 2008). At the same time, the bulk of the analyses is based on different domestic variables and/or patents-related data. Accordingly, the literature tells us very little about how China actually behaves in SDOs and provides very little empirical participation evidence. Moreover, the few analyses of SDOs mostly cover short periods of time while making little predictions of how China could act in these organizations. Deciding between the two competing images in the literature requires an empirical examination of the mechanisms supporting either view. The analysis of this chapter contributes to filling the gaps in the literature. Above all, it offers an empirical look at China's standardization policy and documents its ability to supply core components of the global electrotechnology.

3. DATA AND METHODS

In this analysis, I conducted an in-depth investigation of a contemporary phenomenon while asking the "Why" question (Yin, 2014). For that, I employed qualitative as well as quantitative research methods with an aim to both describe and explain such a phenomenon (Brewer & Hunter, 2006; King et al., 1994, p. 132). I traced China's behavior at the IEC according to a number of participation mechanisms over a period of two decades. For that, I utilized an original internal IEC dataset and retrieved additional data required for the analysis from other sources. The internal IEC dataset contains votes submitted by all member countries between January 1995 – August 2019. According to the IEC, the dataset includes all decision-making occasions registered electronically in their internal records. I retrieved additional data from the IEC website showing numerous information about China's status in the organization at the time of writing this. As the IEC website publishes current data only, I retrieved data for different points in time in the past from other sources. I employed longitudinal designs with multiple timeframes in certain parts of the analysis according to data availability.

I supplemented the findings of the quantitative analysis with evidence from six semi-structured interviews with IEC decision-makers, practitioners and scholars who have extensive experience in the work of the IEC and/or have been closely following China's growing activities in SDOs—Appendix D provides more details about the interviewees. Semi-structured interviews are helpful when researchers gather both opinions and data with an aim to improve their insufficient knowledge in addressing a given question (Horton et al., 2004; McIntosh & Morse, 2015). My questions for the interviewees were focused on the measures taken by China in order to increase its participation in international standard-setting and the interviewees' expectations of how China could be behaving in the IEC. More specific questions were raised to the interviewees from the IEC about the behavior/participation of Chinese delegates at the IEC. Such arrangement of questions allowed me to obtain the interviewees' insights on China's activities both within the IEC and outside of it.

4. CHINA'S STATUS AND PARTICIPATION IN THE IEC

In this section, I present my empirical analysis of China's status and participation in the IEC. The analysis covers two main aspects: (1) China's utilization of different IEC participation mechanisms; and (2) the likelihood of disruptive behavior by China through each of the mechanisms. For the first aspect, I draw on studies showing that the procedural and organizational architecture of SDOs can shape resultant standards (among others, see Gamito, 2021; Hart, 2020; Werle, 2001) and consider the following participation mechanisms as the most appropriate for this analysis: (1) Taking part in committees as a participating-member; (2) Voting in technical and strategic decision-making; (3) Voting in opposition in technical and strategic decision-making; (4) Holding decision-making positions; (5) Providing voluntary funds. Recall that these mechanisms are ascendingly ordered according to the respective potential influence gained by effective utilization of a given mechanism.

I distinguish between two notions: participation and opportunities for participation. I view the latter as largely a function of institutional and resource constraints—such as China's level of economic and technical development—and thus mostly not controlled by China, whereas the former is conditioned upon opportunities and a function of (political) choices by the Chinese government and private/state-owned firms. Influencing the IEC (standards) is viewed as a possible outcome of participation. Member countries can influence the IEC work—strategically and technically—in case they effectively utilize (opportunities for participation offered by the organization through) different mechanisms. In addition, the IEC is viewed as being led by relevant, powerful industries represented by national standardization bodies from the developed world. I also view the IEC member countries largely as self-interest-seeking. This is based on realists' views of countries—especially those equipped with relatively greater economic power—being generally self-interested and utility-maximizing actors in global governance (for example, see Mearsheimer, 1994).

For the second aspect of the analysis, I assess the likelihood of disruptive behavior by China through a given participation mechanism based on: (1) China's participation through the mechanism; and (2) the opportunities for participation that China can access through utilizing the mechanism, taking into account the internal governance rules of the IEC. Acting in a disruptive manner in a given participation mechanism is viewed as a situation whereby China is able to introduce strategic/technical preferences to the IEC's status quo in a way that cannot be blocked by other powerful member countries even if they want to. Accordingly, China can act in a disruptive manner in a given participation mechanism when two conditions are met: (1) the participation of China is significantly larger than the participation of the other powerful member countries; and (2) the opportunities for participation that China can access are larger than the opportunities that the other powerful member countries can access.

Before presenting my analysis, I briefly introduce part of the IEC governance rules and structure and the National Standardization Body of China. For each of the subsections of the analysis, I provide further details on relevant IEC rules (for extended discussions on the internal governance system of the IEC, see Büthe, 2010a, 2010b).

Participation in IEC standard-setting is, in principle, country-based and requires established national electrotechnical standardization bodies. These bodies are required to apply for membership, which is conditioned on the payment of annual dues.[20] The IEC offers two types of memberships, namely Full and Associate, each of which has certain participation privileges and amounts of annual dues. Paying Full Membership dues—which are larger in value compared to those of the Associate—provides the right to influence the IEC technically as well as strategically. The votes and comments of the Full Members are essential components for progressing the IEC (technical) work. Meanwhile, Associate Members pay much lower dues and are, in turn, not provided with many of the Full Members' participation privileges. Full Members can, and in fact are obliged to, actively participate and vote on all technical and managerial activities at every decision-making occasion/organ at the IEC. Associate Members, in contrast, can participate only on certain occasions, have no voting rights at any level at the

[20] For the calculation of dues, the IEC measures national economic activity according to the Gross National Product and annual electricity consumption per capita to calculate the required dues. At the time of writing this, the IEC has a total of 88 members, of which 62 are Full Members, and 26 are Associate Members.

IEC, and cannot hold decision-making positions. Member countries have three voting options in IEC committees: in-favor, abstain or against.

After gaining an IEC membership, member countries interested in participating in a given standard-setting area need to delegate individuals—called National Committees (NCs)—who represent all national interest(s) in that standard-setting area.[21] National Committees and experts delegated for a given standard-setting area by the different member countries are grouped in what the IEC calls Technical Committees (TCs). For special projects requiring smaller teams to focus on topics with narrow scopes, the TCs can establish subcommittees. At the TC level, an NC can participate either as a Participating member (P-member) or as an Observing-member (O-member).[22] While P-members can actively participate by submitting votes and comments in a given TC, the participation privileges of O-members are restricted. P-members are, in fact, obliged to participate. For instance, P-members that do not vote for multiple decision-making occasions risk getting their memberships downgraded to O-members (ISO/IEC, 2021, p. 14). Such participation requires significant technical and financial resources, such as the cost of hiring experts and funding them to attend relevant meetings and contribute to the technical work. Experts suggest that the participation costs of one engineer in standard-setting can reach an amount of $300,000 a year (Hart & Link, 2020).

The technical work in the IEC can also be conducted at another level called Working Groups (WGs). In WGs, independent experts are invited by TC members to provide technical inputs as needed. These experts act in personal capacities with no restrictions on their affiliation or the interest they represent. The core of the technical work is typically constructed in WGs.

[21] As a recap, member countries are represented at the IEC by delegates from respective national electrotechnology standardization bodies. The delegates/experts are often engineers who come from various—often private/commercial—sectors. Other national stakeholders such as those from the government, environmental agencies, academics and user groups can also be appointed to be part of NCs.

[22] An NC may choose to be neither a P-member nor an O-member of a given TC and, in that case, will have no participation responsibilities/rights (ISO/IEC, 2021, p. 13).

Unfortunately, public data on this participation mechanism are scarce and not available in the dataset analyzed for this chapter.[23]

The IEC also offers member countries the opportunity to voluntarily pay larger amounts of dues—on top of the membership dues—which in turn provides the donating member country with extra participation privileges beyond those offered by Full Membership. Among many others, member countries providing such funds have permanent seats at each of the IEC decision-making organs and have exceptional access to all IEC activities and data. Other member countries, meanwhile, need to invest numerous resources and win an election in order to temporarily secure an IEC decision-making position—as in the case of regular Full Members—or do not even have the right at all, as in the case of Associate Members. The IEC distinguishes six member countries providing such funding by calling them the Financial Group A (FGA). Member countries interested in joining the FGA need to apply to the IEC and must satisfy its list of 12 demanding criteria. At the time of writing this, the IEC FGA has six member countries: Germany, France, Japan, the United Kingdom, the United States and China. According to my preliminary analysis, the FGA member countries are substantially more active in utilizing every participation mechanism offered by the IEC.

IEC standards go through a number of development stages, starting with a brief technical proposal and ending with a stage whereby the standard takes its final shape. Throughout these stages, drafts of the standards get reviewed, discussed and voted upon by member countries. The IEC adopts a "one country, one vote" approach for voting on strategic and technical decision-making. Moving from one stage to the next requires, in principle, two-thirds of in-favor votes by the involved P-member and not more than 25% of against-votes. The technical work is largely led by two individuals: the secretariat and the chair.

[23] At the time of writing this, the IEC has 727 WGs, in addition to 194 of another type of smaller-sized committees called Project Teams.

The national standardization body representing China in the IEC is the Standardization Administration of China (SAC), which is part of the ministerial-level agency called the State Administration for Market Regulation (SAMR).[24] Similar to other IEC member countries, the SAC is headed by a president and a secretary. At the time of writing this, both leaders of the SAC are long-serving governmental officials from SAMR. The SAC has been a Full Member in the IEC since 1957.

4.1. Taking Part in Committees as a Participating-Member

Voting is one of the main participation mechanisms through which member countries can express their positions from different decisions being discussed in GGOs. Indeed, a number of studies on SDOs examined members' voting from different theoretical perspectives and repeatedly provided evidence suggesting that voting shapes the output of the decision-making process. Importantly, how members vote as well as who is voting, does matter for resultant standards (Baron et al., 2019; Bonatti & Rantakari, 2016; Farrell & Saloner, 1988; Goerke & Holler, 1995; Spulber, 2016). Similarly, other scholars have also argued that the composition of TCs in SDOs can have a similar impact (Gamito, 2021; Simcoe, 2012; Werle, 2001). For instance, the presence of major market players in a given committee increases the chances of maintaining the status quo. These actors can slow down the process, making it more difficult for other stakeholders to introduce major changes to the status quo of the standard/technology (Lehr, 1996; Simcoe, 2012).

In order to gain influence in the IEC work, a member country must first hold the right membership(s). Recall that the votes of P-members are considered essential components by the IEC to progress with the work. Conversely, the participation privileges provided to O-members are limited. Member countries—especially those holding Full Memberships—participating in

[24] The State Administration for Market Regulation is responsible of different matters related to products regulatory, products certification, etc.

a given committee as P-members have relatively greater interests in the respective standard-setting areas. In addition, and arguably, the greater the presence of a member country in IEC committees as a P-member, the greater the potential influence this member country has in respective decision-making. For instance, Germany held P-memberships in almost all of the IEC committees that existed in the year 2010—specifically, 170 out of the 173 committees that existed at that time. With such participation, Germany has secured high potential influence in the work being carried out in these committees. Similar to other mechanisms, my preliminary analysis shows that the member countries of the FGA have been the most active among all IEC member countries in terms of utilizing this mechanism. Accordingly, I consider joining IEC (technical) committees as an important participation mechanism that promises China—similar to other member countries—access to relevant opportunities for participation and ultimately be able to influence the IEC.

In this part of the analysis, I focus on China's participation in terms of holding P-memberships in IEC committees between the years 2010 and 2022.[25] I do not differentiate between different types of committees (i.e., TC, subcommittee, etc.). The participation of the other member countries from the FGA is also included in the analysis. For that, I identify the number of P-memberships held by each member country of the FGA in all IEC committees that existed at the beginning and end points of the mentioned period of time. Then, I present the analysis in a bar chart, as shown in Figure 1. I have also calculated the total number of IEC committees that existed in 2010 and 2022 and represented them in dashed and solid lines, respectively. This information is important to highlight the fact that as the standardization scope of the IEC expands, more committees are created for the newly created standard-setting areas.

[25] As the IEC publishes actual data only on its website, historical data are not posted there. I compiled it from the work by Büthe (2010a) for the year 2010, which is the earliest point in time I could find data for. For the year 2022, I used the data posted on the IEC website at the time of writing this research. The website shows that the IEC has 110 Technical Committees and 103 Subcommittees.

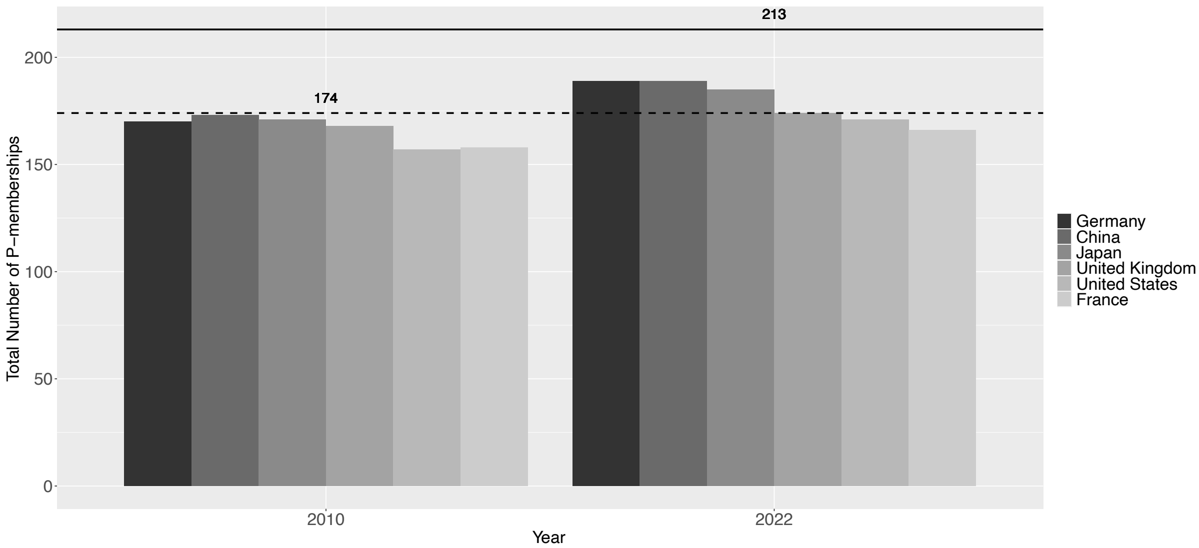

Figure 1 Number of P−memberships Held by the Financial Group A Member Countries in all IEC Committees in the Years 2010 and 2022

As shown in Figure 1, China has been one of the most active member countries in holding P-memberships in IEC committees over the entire period covered in the analysis. I assume that the likelihood of a dramatic drop in such participation level between the two points in time is very low. This is based on my preliminary analysis of not only China but also many other IEC member countries. China held the highest number of P-memberships among all IEC member countries in the year 2010, with 173 P-memberships in all of the 174 committees that existed in that year. At the time of writing this, China and Germany share the first place in terms of holding P-memberships in all IEC committees, with 189 P-memberships—for each—in all of the existing 213 committees. This analysis shows that China has been effectively utilizing the participation mechanism of holding P-memberships in IEC committees.

Evidence from interviews suggests that China has been vigorously recruiting and delegating experts to be engaged in the IEC work. Recall that holding P-memberships in a large number of committees requires, among others, substantial human capital. When I asked about the participation of Chinese nationals in the IEC, interviewee number 1 said: "*China has been sending relatively large numbers of experts to the IEC. Such a group often includes one senior expert, who has limited English language skills, and many other junior engineers who can speak better English but do not talk before coordinating with the senior. To me, the delegates* *always seem to have very clear instructions, which they strictly follow."* The same interviewee added: "*Recently, China's participation has changed. While they still send large numbers of delegates, they can generally speak better English and are more communicative with the other NCs.*" Multiple other interviewees provided a similar description of China's participation in other international SDOs.

The evidence above is in line with public reports suggesting that China has been providing massive funding to incentivize its stakeholders to increase their participation in international standard-setting (for instance, see The US-China Business Council, 2020). It is fair to expect that such funding has been utilized to recruit engineers and train them both technically and linguistically. Chinese delegates also seem to be following strict agendas aimed at certain objectives. Moreover, interviewees number 2 and 5 said that China is increasingly seeking to be engaged in new standardization areas in electrotechnology. This is in line with the above analysis, which shows that China has been very active in joining newly created IEC committees as P-member. China might have even been the proposer for establishing new TCs for some of the new standard-setting areas at the IEC.[26]

At the same time, the analysis presented in Figure 1 also shows that the other member countries of the FGA have been very active in holding P-memberships in IEC committees and are presumably interested in securing the respective potential influence. Except for a small number of committees, the other member countries from the FGA have been present as P-members in every committee whereby China has a presence.

Note that the IEC provides member countries actively participating in committees as P-members with equal opportunities for participation, ultimately preventing an individual member country from introducing significant preferences/changes without the agreement of the others. Recall that moving forward in IEC decision-making requires in-favor votes by two-

[26] Relevant data are not available in the dataset that I have access to.

thirds of the P-members involved in a given decision, and at the same time, each member country has one vote only. Accordingly, for China to be able to behave in a disruptive manner in a given committee, China will need to obtain supporting voices to its inputs from other member countries holding P-memberships. While disruptive behavior from China in IEC committees is possible, it remains unlikely, not least because of the potentially massive resources necessary to secure the required support from other member countries. For instance, convincing other P-members in a given committee to vote in support of China's inputs requires extensive lobbying to establish mutually beneficial outcomes. Gaining such support—especially from those among the FGA—becomes even more difficult in case China's inputs are not in their interests.

The analysis of this sub-section shows that China has been one of the most active member countries in terms of holding P-memberships in IEC committees throughout the past decade, providing evidence that China has been effectively utilizing this participation mechanism. Evidence from interviews complements the analysis by suggesting that China has been investing numerous resources in order to achieve such participation. Meanwhile, the other powerful member countries from the FGA have been (almost) as active as China in holding P-memberships in IEC committees. Such participation from the FGA member countries provides each of them with considerable and (almost) equal potential influence in the IEC work. Given that the IEC internal governance rules maintain equal distribution of opportunities for participation, especially for active member countries, it is unlikely that China behaves in a disruptive manner through its participation as a P-member in IEC committees.

4.2. Voting in Technical and Strategic Decision-making

As explained in the first part of this analysis, I consider IEC member countries' voting an important mechanism through which China could exert power in the organization. This is primarily based on literature suggesting that member countries' voting shapes international rule-making, including standards (Baron et al., 2019; Bonatti & Rantakari, 2016; Farrell & Saloner, 1988; Goerke & Holler, 1995; Spulber, 2016). In the last subsection of the analysis, I focused on the prerequisite for effective voting in IEC committees, namely holding P-memberships in committees. In this subsection, I focus on actual voting as another important influence promising participation mechanism. Particularly, I analyze the number of votes submitted by China and the other FGA member countries in all IEC committees between the years 1995 and 2018. My preliminary analysis shows that the member countries of the FGA were the most active among all IEC member countries in terms of utilizing this participation mechanism.

It should be noted that the voting dataset utilized for this research does not show non-voters (i.e., member countries attending a given decision-making occasion without submitting a vote). I assume that these are rare cases and, therefore, will not have a significant effect on the analysis. This assumption is based on my understanding of the IEC voting policy, through which member countries are generally obliged to vote (clause 1.7.4 of ISO/IEC Directive Part 1). Also, I include all votes in committees irrespective of the votes types as the IEC voting dataset utilized for this analysis does not differentiate the votes according to types between the years 1995 to 1999.[27]

To construct the analysis of this subsection, I first count the number of votes submitted by each member country of the FGA on a yearly basis. Then, and for each of the six member countries, I calculate respective annual shares of all votes submitted by IEC member countries in a given year. For instance, Germany's share of all votes submitted in 2018 was 0.034. This value is calculated by dividing the number votes submitted by Germany in 2018, namely 1044 votes, by the total number of votes submitted in that year in all IEC committees, namely 30843

[27] Recall that voting in IEC committees can take one of three forms: in-favor, abstain or against.

votes. Note that a member country with a votes share of 0.034 is relatively a very active voter. I present the analysis in a line chart as shown in Figure 2 below.

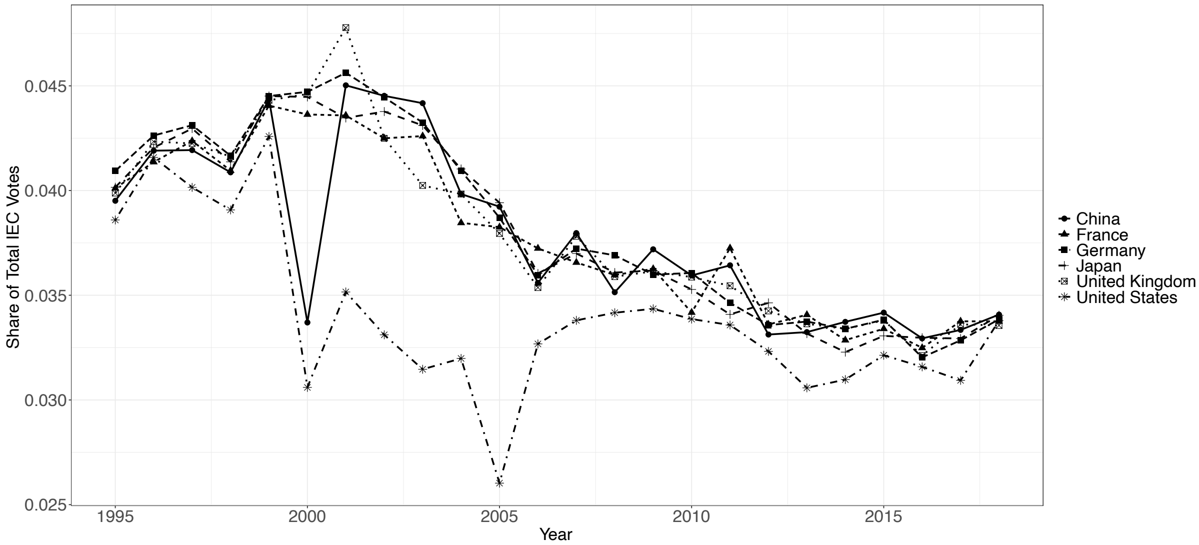

Figure 2 Change in Annual Votes Shares of the Financial Group A Member Countries between 1995 – 2018

As shown in Figure 2, China has been among the most active member countries in terms of submitting votes in IEC committees since 1995 and until the year 2018. Except for the year 2000, China maintained relatively very high annual votes shares among all of the IEC member countries. Note that because China is present in the majority of IEC committees as a P-member—and hence obliged to vote—such participation does not come as a surprise. At the same time, this very active participation is an indicator of China's unwillingness to risk losing its voice/status in the IEC. This evidence shows that China has been effectively utilizing the participation mechanism of voting in IEC committees.

The analysis also shows that the other powerful member countries of the FGA have been, similar to China, very active in terms of voting in the IEC. The observed general downward trend in annual shares of votes is—according to my preliminary analysis—due to a general increase in both the total number of annual votes and the total number of IEC member countries over the years. The observed similarity in member countries' participation—to a lesser extent in the case of the United States—indicates their interest in presenting their preferences/inputs in IEC decision-making. According to my analysis, the differences between the votes shares among the group are insignificant. With such high participation, member countries of the FGA—to a less extent in the case of the United States—have secured equal levels of potential influence through voting in IEC committees.

As explained in the last subsection of the analysis, the IEC internal governance rules are designed to maintain equal distribution of opportunities for participation among the member countries, especially those participating actively. Above all, the “one country, one vote” principle and the requirement of in-favor votes by two-thirds of P-members to move forward in a given decision disallow an individual member country to behave in a disruptive manner in IEC decision-making.

The evidence presented in this sub-section shows that China has been effectively utilizing the participation mechanism of voting in IEC committees between the years 1995 and 2018. Meanwhile, the other powerful member countries have been similarly active in the mentioned participation mechanism. Consequently, all member countries of the FGA have secured more or less equal potential influence in IEC decision-making—to a lesser extent in the case of the United States. Given the IEC internal governance rules, it is unlikely that China will behave in a disruptive manner through voting in IEC committees.

4.3. Voting in Opposition in Technical and Strategic Decision-making

In this subsection, I focus on one important type of member countries’ voting, namely submitting against-votes in opposition to the content of standards drafts and/or preferences of other member countries. Against-voting by member countries in IEC decision-making is both critical and influence-promising participation mechanism.

First, the IEC adopts the distinctive approach for reaching consensus described in the ISO/IEC Guide 2:2004, which defines consensus as: “General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments." Reaching such consensus in case of "sustained opposition" proved to be a challenge that requires considerable negotiations among the P-members and the leadership of a given committee. For instance, in case two or more P-members disagree with the content of a given standard, the circulated draft needs to be revised and recirculated until consensus among the P-members is reached. As a result, voting in opposition in IEC standard-setting could further slow-down an already bureaucratic and time-demanding process (Cargill, 2002).

Second, member countries that are able to make their against-votes be actually considered by the committee have relatively greater technical and probably financial capabilities. For instance, in order for the committee leadership to consider an against-vote, the voting member country should accompany its vote with a technical justification; otherwise, the vote will be dismissed by a decision from the TC leadership (article 2.6.2 of the ISO/IEC Directives Part 1 + IEC Supplement). Studies have shown that submitting such technical justification requires above-average technical capabilities and engagement in the standard-setting work (Büthe, 2010a, p.28; Forsberg, 2012).

Third, to be considered by the leadership of a given committee, the opposition needs to be underpinned by sufficient support from other member countries. Gaining such support requires, among others, considerable lobbying by the opposing member country; at the same time, in case the opposition is not in the interest of the other P-members, gaining their support becomes more difficult, if possible at all.

To construct the analysis of this sub-section, I identify the annual number of against-votes submitted by the FGA member countries between the years 2000 – 2018.[28] Then, for each of these six member countries, I calculate the respective share of the total number of annual votes submitted by all IEC member countries. I present the analysis in a line chart, as

[28] Recall that the IEC voting dataset that I have access to does not differentiate between the types of votes—in-favor, abstain, or against—before the year 2000.

shown in Figure 3. Note that my preliminary analysis shows that member countries rarely submit against-votes, and the majority of those votes were submitted by the FGA member countries and some other Western, industrialized countries.

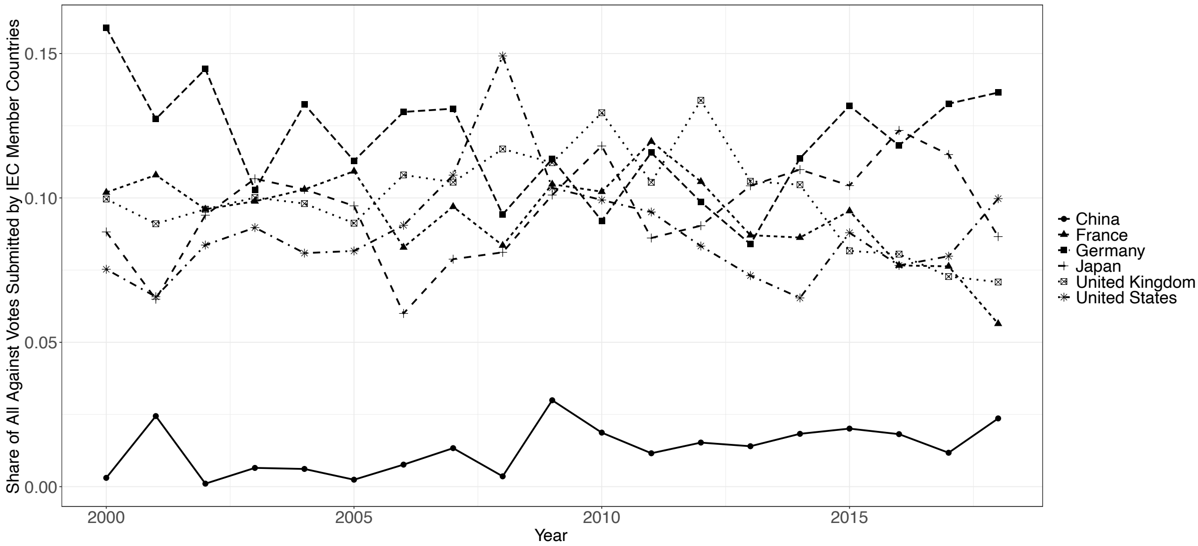

Figure 3 Change in Annual Against Votes Shares of The Financial Group A Memeber Countries between 2000 – 2018

The analysis shows that China's annual share of against-votes between the years 2000 and 2018 has been substantially smaller than its counterparts of the other member countries from the FGA. At the same time, a significant increasing trend in China's participation through this mechanism can be observed. China's participation suggests that while its utilization of this participation mechanism has been relatively less effective, it has been gradually growing over the past two decades.

Evidence from interviews supplements the above analysis with regard to China's growing technical capabilities. When I asked about the willingness/ability of China's delegates to oppose international standard-setting technically, interviewee number 6 said: "*China is still learning how to influence international standard-setting. Many of its proposals are, meanwhile, rejected for being technically insufficient.*" This suggests that China's delegates might have been hesitant/unable to submit against-votes in IEC standard-setting due to insufficient technical capabilities for underpinning their oppositions. Relatedly, China's struggle to enhance its relevant technical capabilities has been reported in the literature.

Fägersten and Rühlig (2019) show that many of China's inputs to the IEC and its sister international SDO, namely the International Standardization Organization (ISO), have been rejected for being of very low technical quality. Chinese delegates might have been motivated to submit a large number of inputs to international standards because of the financial incentives provided by the government (see report by The US-China Business Council, 2020).

Moreover, interviewee number 3 said that the IEC maintains data about the national affiliations of the delegates of its member countries. The same interviewee, who has access to this data, said that the IEC has observed an improvement in the diversity of the national affiliation of China's delegates over the past decade—as opposed to being dominated by the Chinese government. Importantly, an increase in the number of industry stakeholders among the Chinese delegates to the IEC has been observed. Relatedly, interviewee number 6 said that China has been increasingly including non-governmental national stakeholders in its delegates to international SDOs. Drawing on studies on SDOs suggesting that industry experts and commercial stakeholders are generally better equipped with technical expertise than governmental actors (Shen & Faure, 2021), I interpret the evidence provided by the interviewees as follows: the slight increase in the number of against-votes submitted by China is partly a reflection of the growing technical capabilities gained by the involvement of industry and/or commercial stakeholders in Chinese delegates to the IEC.

China's relatively low participation in submitting against-votes suggests that it has gained substantially less potential influence in IEC decision-making through this participation mechanism than the other five member countries of the FGA.

As the against-votes are governed by the same IEC rules and procedures for other types of voting, the opportunities for participation provided by the organization to member countries effectively utilizing this participation mechanism of submitting against-votes are generally equal. Moreover, in case we consider the submission of against-votes as sort of disruptive behavior—given the criticality of this participation mechanism—the analysis shows that China's participation has been so far non-disruptive. Accordingly, the likelihood of disruptive behavior from China through voting in opposition in IEC decision-making is low.

The evidence presented in this sub-section shows that China has been utilizing the participation mechanism of voting in opposition in IEC committees relatively less effectively between 2000 and 2018. Meanwhile, China's participation has been gradually increasing, providing it with growing potential influence in the IEC work. The analysis also shows that the other member countries of the FGA have been participating through the mentioned mechanism substantially more, securing relatively greater levels of potential influence. Finally, given the IEC internal governance rules and procedures for voting, it is unlikely that China behaves in a disruptive manner through submitting against-votes in IEC committees.

4.4. Holding Decision-making Positions

In this part of the analysis, I consider holding decision-making positions in the IEC as another important participation mechanism through which China could exert power in the organization. Studies repeatedly suggested that different SDOs' leadership positions provide the hosting member countries with considerable potential influence both at the strategic and technical levels of the organizations (Baron & Kanevskaia, 2021; Büthe, 2010a; Dijkstra, 2017; Dokko & Rosenkopf, 2010; Novosad & Werker, 2019).

For a clearer picture of China's participation, I differentiate between two types of decision-making positions that can be held in the IEC: technical and strategic. For the former, I analyze China's participation through holding the TC secretariats, who are responsible for leading most of the technical work in the IEC.[29] These secretariat positions are typically held by member countries that have both relatively greater interests in the respective standard-

[29] The chairs are also important actors in IEC TCs; however, their role is largely administrative. In addition, chairs are individuals nominated by the secretariats.

setting area and sufficient technical as well as financial capabilities necessary to supervise the technical work (ISO/IEC, 2022, p. 16). The secretariats carry out key activities in IEC TCs; among other, they appoint other individuals to assist in managing the work, provide (technical) advice and manage important discussions and technical documentation.

For the latter type of positions, I analyze China's participation in the IEC through appointing individuals to take decisions that are largely beyond technical in the organization (i.e., strategic). Member countries holding IEC memberships with relatively greater opportunities for participation can be elected to hold numerous decision-making positions in the organization, including the president. It is fair to argue that member countries holding such positions access extra opportunities for participation in the IEC, such as influencing the overall direction of the organization.

To analyze China's participation in holding secretariat positions in IEC committees, I identify the number of secretariats held by the member countries of the FGA at the start and end points of the period 1999 and 2022.[30] I assume that the likelihood of a dramatic change in the participation of a given member country between the two points in time is very low; my preliminary analysis shows that IEC member countries generally maintain a certain participation level for a number of years without dramatic change. I present the analysis in a bar chart as shown in Figure 4 below.[31] Note that according to my preliminary analysis, the majority of the secretariat positions in the IEC are held by the six member countries included in the analysis.

[30] Relevant data were retrieved from the IEC website.

[31] The IEC publishes actual data only on its website, and hence the data for the year 1999 was not available there. Therefore, I compiled the historical data from the work by DeVaux (2000). For the year 2022, I use the data posted on the IEC website at the time of writing this chapter.

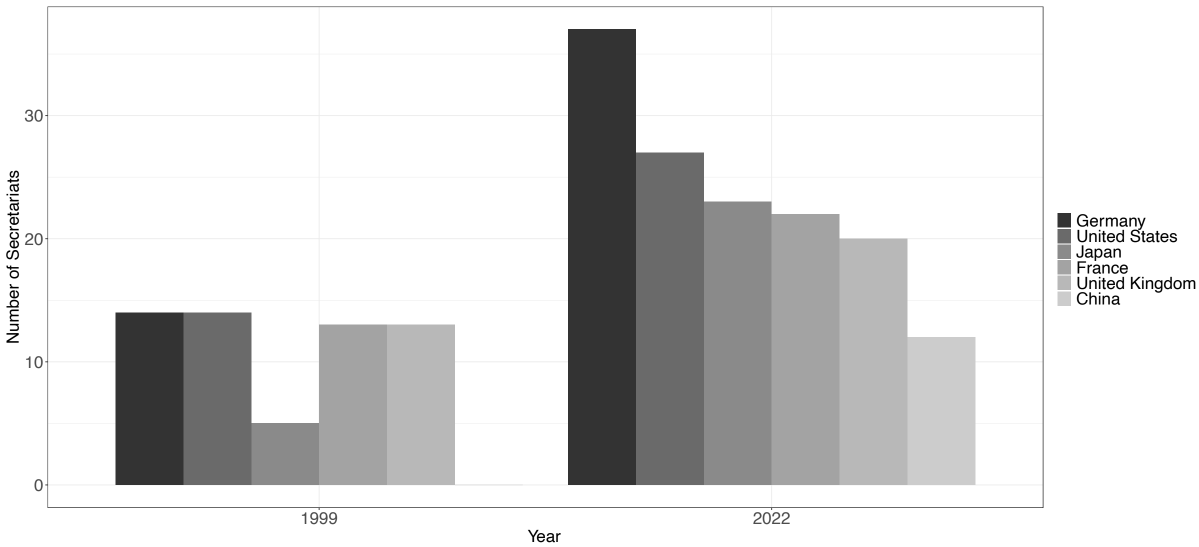

Figure 4 Number of Secretariat Positions Held by Member Countries of the Fincnial Group A in all IEC Committees in 1999 and 2022

As illustrated in the Figure above, China has significantly increased the number of secretariat positions held by its delegates over the past two decades. China went from being without any secretariat positions in 1999 to being a holder of 12 of them in 2022; such an increase in participation is relatively substantial. Note that most of the IEC non-FGA member countries remained without any secretariat positions in the organization over the entire mentioned period. Meanwhile, the six member countries included in this analysis have increased their shares of these positions as follows: Germany 23, Japan 18, United States 13, China 12, France 9, and the United Kingdom 7. With an increase of 12 positions, China ranks fourth among the very few member countries with the highest participation through this mechanism. All this provides evidence showing that China has been effectively utilizing the participation mechanism of holding secretariat positions in IEC committees since the year 1999.

At the strategic level, China has also increased its involvement in the IEC by taking over numerous (high-ranking) positions. First, being among the FGA member countries, China is automatically provided with permanent seats in every decision-making organ at the IEC such as the Council, the three main IEC boards—which govern activities related to Standardization Management, Conformity Assessment and Market Strategy—and other advisory committees and task forces. Second, the 36th IEC president is since the year 2019, a Chinese national who also serves as a chairman of one of the five largest state-owned electricity generation enterprises in China. Note that while the IEC president generally does not vote in decision-making, he/she has the right to cast a deciding vote in case member countries' votes are equally divided from a given decision. Third, several Chinese nationals have been appointed as ambassadors for representing the IEC interests in the areas of Internet of Things, Smart Manufacturing and Cyber Security.[32] Finally, an expert from China has been elected as an IEC young professional leader. China's taking over of all these positions suggests that it has been effectively utilizing the participation mechanism of holding strategic positions at the IEC.

Evidence from interviews suggests that China viewed holding positions in the IEC as key for increasing its influence in the organization. When I asked the interviewees about China's willingness to hold decision-making positions in SDOs, interviewee number 3 said: "*These positions provided China with the knowledge it needs to understand the rules of the game*." Interviewee number 1 said: "*By taking over all these positions, China has gained credibility that it missed for many years. They had to take over as many positions as possible.*" The same interviewee talked about incidents whereby Chinese delegates asked IEC high-ranking decision-makers to support proposals that serve China's interests: "*Chinese delegates felt that they have unlimited power to influence IEC standards and that they can simply push their standards to the world. This created concerns within the IEC; such behavior might trigger clashes with other member countries, above all, the United States. The IEC had to reorient some of the Chinese delegates with internal procedures and practices and explain to them that without the acceptance of the other member countries, China's proposals will not be successful. With time, Chinese delegates learn how to become experts in lobbying*."

[32] IEC Ambassadors promote IEC standards to stakeholders such as the industry, government, and academia.

China seems to be vigorously pursuing its objective of influencing the IEC strategically (as explicitly declared by the Standardisation Administration of China, 2020, p. 11). For instance, interviewees number 2 and 5 said that China is increasingly promoting publishing international standards in the Chinese language. Recently, and in an unprecedented manner, a key IEC publication that is relevant to renewable energy has been recently made available officially by the IEC in the Chinese language.[33] This guideline evaluates the renewable energy of off-grid solar lights, which are products for which China is considered an export hub (Galan, 2021, p. 93). The IEC leadership, in turn, seems to be generally supportive of China's growing role in the organization despite the unusual practices by the Chinese delegates. Interview number one said: "*Chinese committee members have been uncompromising in terms of pushing their preferences and did little coordination and collaboration with other committees. The IEC was, nevertheless, supportive in getting China involved in the work. Powerful IEC member countries have also contributed to bringing China's standardization behavior closer to existing practices.*"

Meanwhile, and as illustrated in Figure 4, other member countries from the FGA have also increased their shares of IEC secretariat positions over the mentioned period of time. The analysis shows that in spite of the recent significant increase in China's share of IEC secretariats, the majority of these positions remain held by the other member countries of the FGA. In addition, information posted on the IEC website shows that the mentioned five member countries are, similar to China, well presented in every decision-making organ in the IEC.[34] For instance, while it is the first time for China to hold it, the IEC president position has been mostly held by the other (powerful) member countries and since the organization has been

[33] Referenced as IEC Technical Specification 62257-9-5 and titled "Recommendations for renewable energy and hybrid systems for rural electrification - Part 9-5: Integrated systems - Laboratory evaluation of stand-alone renewable energy products for rural electrification."

[34] Data related to the nationalities of the people holding many decision-making positions in the IEC is unavailable or incomplete.

founded—the numbers of times each of these member countries held the president position are as follows: The United States 7; the United Kingdom 4; Germany 3; Japan 3; and France 3.[35] It is, indeed, fair to argue that most of the IEC governance system was designed by this small group of countries (for a historical review, see Yates & Murphy, 2019, chapter 2). All this shows that the other five member countries from the FGA—similar to China—have been effectively utilizing the mentioned participation mechanism, securing—or probably further increasing—their high potential influence in the organization. Such equally distributed and high potential influence prevents any of them from introducing technical and/or strategic changes that are not approved/accepted by the other member countries.

Regarding the relevant opportunities for participation, the IEC established and implements numerous rules and measures geared towards preventing dominance by an individual member country (IEC, 2021). The ultimate aim is to maintain an equal distribution of opportunities for participation offered for member countries interested in accessing them. First, the IEC maintains a certain geographical distribution of positions in its decision-making organs among the member countries. For instance, the Standardization Management Board (SMB) is comprised of a few IEC internal officers and elected individuals representing fifteen different member countries, seven of which need to be from the FGA.[36] Data posted on the IEC website shows that the positions at several main boards, including the SMB, are accordingly distributed. Second, most of the high-ranking positions can be held for a short and fixed period of time only—such as three years—and a maximum of two terms of office by a single member country. Third, the IEC "strongly recommends" that the secretariat and chair of a given TC to come from different member countries as a countermeasure against potential conflict of

[35] Non-FGA member countries took over the IEC president position some times and as follows: Italy 4; Sweden 2; Switzerland 2; The Netherlands 2; Belgium 1; Romania 1; Russia 1; Australia 1; and finally Canada 1.

[36] The individuals are elected by the IEC General Assembly, which is essentially an assembly of all IEC member countries holding Full Memberships. Member countries nominating these individuals should fulfill a demanding participation criteria set by the IEC. The seventh member country currently holding a position in the Standardization Management Board as one of the "automatically appointed members" is Italy—as it is paying high dues to the IEC.

interests or dominance. Finally, TC secretariats are required by the IEC not to behave in the interest of their national affiliations and maintain an unbiased position from different decisions and issues in the work.[37] It is fair to expect such governance rules and structure to be effective in reducing the chances of disruptive behavior by an individual member country in the IEC.

In sum, the evidence presented in this subsection shows that China has been increasingly and effectively utilizing the participation mechanism of holding decision-making positions in the IEC, providing it with a growing potential influence in the organization. Meanwhile, the other five member countries of the FGA have also been very active in participating through the mentioned mechanism. In so doing, they maintained—or probably increased—the high potential influence they already had as far back as the time the IEC was founded, allowing them to be able to block China's inputs in almost any decision-making occasion. Finally, related IEC rules are designed to maintain an equal distribution of relevant opportunities for participation, further reducing the chances for disruptive behavior by China.

4.5. Providing Voluntary Funds

Literature on GGOs has repeatedly suggested a positive correlation between funding and achieving greater potential influence for the donor (Graham & Serdaru, 2020; Reinsberg, 2017). Graham (2015) differentiates between two types of funding schemes offered by GGOs, namely mandatory and voluntary,[38] and argues that especially the latter empowers donors to translate financial support into considerable influence in GGOs.

Similar to some other GGOs/SDOs, the IEC offers both types of funding schemes for its member countries interested in participating in its work. First, the membership dues that member countries are obliged to pay in order to access certain opportunities for participation—

[37] Scholars suggested that biased behavior by secretariats—in the interest of their own national affiliations—can negatively affect their reputation, decreasing the chances of holding a similar role again (Baron & Kanevskaia, 2021).

[38] Mandatory funding schemes require states to make financial contributions to a GGO as an obligation of membership.

such as those gained by holding a Full Membership—are considered the IEC mandatory funding scheme. Second, the voluntary dues and financial support provided by member countries to the IEC in order to access extra opportunities for participation are considered the voluntary funding scheme. While both schemes provide a given member country with opportunities for participation to shape the technical aspect of the IEC work, the latter offers opportunities to influence the organization even strategically. For instance, although Full Members' delegates have the right to hold positions in different IEC decision-making organs, their chances of being successfully elected to hold such positions remain generally lower—if at all possible—than the chances of the FGA member countries' delegates, who get "automatically appointed" (IEC, 2021, appendix 5).

Obtaining a seat among the FGA member countries requires the interested member country to invest considerable resources as well as have very high participation in the IEC. A successful applicant is required to pay a share of dues that is larger than 3% of the total dues calculated at the time of application. According to a discussion with interviewee number 2, an individual member country from the FGA could pay up to 1,000,000 CHF in annual dues. The applicant should also be very active as a P-member in at least 60% of all IEC committees and employs a minimum of 200 experts engaged in the IEC work (IEC, 2021, appendix 5). At the time of writing this, the IEC Statutes and Rules of Procedure states that the FGA member countries are collectively required to pay a share of dues that could reach 50% of total dues calculated in a given year (IEC, 2021, appendix 5). According to the IEC annual report for the year 2007, the then-five FGA member countries jointly paid a total of 4,765,000 CHF in dues. Meanwhile, all the other sixty-three member countries paid 11,650,000 CHF (IEC, 2007).[39]

[39] Data related to the share of dues paid by the FGA are available only in a few IEC annual reports.

Moreover, the candidate member country should have hosted a number of IEC meetings over the few years preceding its application—further details below.[40]

While the act of providing funds by a given member country to the IEC is, strictly speaking, not participation, it remains a prerequisite for accessing very high—or probably the maximum—opportunities for participation in the organization. The demanding requirements above indicate both the high value that the IEC places on joining the FGA and the existence of (high) demand among the member countries for such membership. Accordingly, I consider the mentioned participation mechanism as the one promising the greatest opportunities for participation, which if effectively utilized can offer the highest potential influence in the IEC. Note that membership dues serve as a—or probably the—main source of income for the IEC. For instance, in the year 2007, the total amount of dues paid by all member countries was equivalent to 50% of the IEC's total income for that year (IEC, 2007). In what follows, I analyze China's participation in the IEC through providing different kinds of voluntary funds.

First, after acting as a passive participant for many years since its admission to the IEC in 1957, China voluntarily joined the FGA in 2011, securing a leadership seat among France, Germany, Japan, the United Kingdom and the United States. In so doing, China accepted to pay the high voluntary dues described above.

Second, member countries with a relatively greater interest in influencing a given IEC standard-setting area can offer to host relevant standard-setting meetings, which are often attended by hundreds of experts and stakeholders from all over the world. Hosting such (large) events requires the hosting member country to shoulder relevant financial expenses as well as other resources needed for the organization of these meetings (for the IEC Guide about this, see IEC, 2012). I consider such efforts as another form of voluntary funding that member countries can be provided to the IEC in an indirect fashion. China has been increasingly

[40] At least 20 IEC committee meetings in five years, as well as at least one IEC General Meeting in the 15 years prior to applying to the membership.

offering the IEC to host not only standard-setting meetings but also other major assemblies, such as the 83rd IEC General Meeting in 2019 and the 2017 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres (IECEx System) conference. Several recent reports show that China has been vigorously offering such support to the IEC (for example, see Webster et al., 2022). Interviewee number 3 commented on this topic by saying: "*China has been increasingly offering the IEC to host large standard-setting meetings and events*."

Third, China has been providing massive (financial) incentives for its delegates/stakeholders to increase their participation in the IEC. Three of the interviewees said that China offered financial incentives for its delegates to increase their standardization proposals and hold additional decision-making positions in the IEC (interviewees number 2, 3 and 5). Interviewee number 2 said that the Chinese government even offers support and explicit promotions for national delegates/organizations actively participating in the IEC. While such efforts are not provided directly to the IEC, they still serve as indirect support for the IEC to achieve its ultimate goals. For instance, increasing the participation of stakeholders in the IEC strengthens the organization and helps diffuse its standards.

All this shows that China has been increasingly providing different forms of voluntary funds to the IEC, and therefore, it has been effectively utilizing this participation mechanism. In so doing, China has gained very high potential influence in the IEC.

Meanwhile, the other FGA member countries have also been generous to the IEC by providing numerous forms of voluntary funding. Indeed, there is no shortage of data or literature suggesting that France, Germany, the United Kingdom, the United States and to a lesser extent Japan have been extremely supportive to the IEC as far back as it was established (Yates & Murphy, 2019, chapter 2). The Five member countries have maintained their memberships in the FGA for decades while hosting countless IEC meetings and events. While

China's efforts above have definitely provided it with significant and growing potential influence, it remains significantly lower than what the other five member countries have gained over the past century.

As described above, with its governance rules, the IEC offers equal opportunities for participation for member countries willing to provide voluntary funds. For instance, the IEC ensures that each of the FGA member countries is presented in all decision-making organs. It is fair to argue that the IEC rules prevent an individual member country from the FGA from behaving in a disruptive manner. Relatedly, interviewee number 1 said: "*While significant power has already shifted from Europe and the United States to Asia, the IEC remains what all members make it.*"

The analysis of this sub-section shows that China has invested considerable financial resources to access the highest opportunities for participation offered by the IEC. In so doing, China has been effectively utilizing the mechanism of providing voluntary funds, securing high as well as growing potential influence in the organization. However, such investment by China so far remains moderate as opposed to the century-long support by the other FGA member countries—to a lesser extent in the case of Japan. Arguably, while China's potential influence is rapidly growing, it remains lower than the potential influence of the other powerful member countries. With such a distribution of potential influence and in combination with the equal distribution of opportunities for participation maintained by the IEC rules, China's chances of acting in a disruptive manner are generally low.

5. DISCUSSION

The analysis of this chapter provided evidence showing that China has been exerting power in the IEC through effective utilization of all of the analyzed participation mechanisms. First, among all IEC member countries, China held the highest number of P-memberships in all committees over the course of the past decade.[41] Second, since the year 1995, China has been among the few member countries with the highest shares of votes submitted in all IEC committees. Third, China's annual share of against-votes submitted in all IEC committees has been gradually growing between 2000 and 2018. Fourth, China's delegates have been increasingly holding more positions in numerous IEC decision-making organs. Finally, China has substantially increased its voluntary funds to the IEC. By doing all this, China has secured high potential influence in the IEC both at the technical and strategic levels.

Meanwhile, China's participation in the IEC remains largely as high as, and sometimes below, the participation of the other five powerful member countries. First, the number of P-memberships held by China in IEC committees has been and remains—arguably—insignificantly higher than those held by the other powerful member countries. Second, the other FGA member countries have been, similar to China, very active in terms of submitting votes in IEC committees over the course of the entire period analyzed. Third, the majority of against-votes submitted between 2000 and 2018 in all IEC committees were submitted by the other five powerful member countries. Fourth, most of the IEC decision-making positions have been, and remain, held by these powerful member countries. Fifth, China's growing voluntary funds to the IEC are so far relatively moderate compared to the century-long investments made by the other powerful member countries, which can be considered as the IEC established powers—probably to a lesser extent in the case of Japan.

Evidence from interviews complemented the (quantitative) evidence above. Most of the interviewees said China has been increasingly investing numerous resources to enhance its participation in international SDOs, including the IEC. In addition, several interviewees noted China's rapidly growing capabilities necessary for achieving considerable potential influence in the IEC; such evidence is consistent with what the analysis showed about China's growing

[41] At the time of writing this, Germany and China share first place in terms of holding P-memberships.

participation in IEC mechanisms that requires relatively greater technical/financial capabilities, such as voting in opposition in decision-making. The interviews also suggests that China's delegates have been pushing certain agendas in the IEC, sometimes in a forceful fashion. With the help of the IEC leadership, such behavior seems to be slowly transforming into commonly agreed practices for international standard-setting.

In sum, the evidence of this analysis suggests that China's role is rapidly growing in the IEC both technically and strategically; meanwhile, the organization remains largely dominated by the established powers (this is consistent with previous analyses' findings, such as Baron & Kanevskaia, 2021; Bruer & Brake, 2021; Neaher et al., 2021).

A review of IEC's internal governance rules and structure suggests that member countries are generally provided with a level playing field for participation. Member countries that are able and willing to participate in the IEC can access opportunities for participation designed to maintain an equal distribution of power structure among the participants. For instance, an individual member country cannot introduce a given preference/change into the IEC standards/system without gaining the acceptance of the other member countries, especially from those member countries with relatively greater participation in the organization. In case China would insist on pushing self-interest agendas, it might breach IEC rules and ultimately risk losing its status in the organization. With that in mind, and in combination with the above participation of the powerful member countries, I argue that a disruptive behavior by China in the IEC is, albeit possible, unlikely.

The findings of this chapter can be interpreted as providing support to previous arguments about GGOs being designed to "accommodate" rising powers (for example, see Ikenberry, 2011). China's joining GGOs might ultimately strengthen the existing order of global governance (as predicted by Drezner, 2014), including the international standard-setting system. For instance, China's low opposition to other member countries' preferences might be a sign of low divergence from the preferences of the powerful member countries in the IEC. By applying the framework developed by Lavenex et al. (2021), it is fair to assume that China has so far been acting as a rule-promoter in the IEC.

That said, and given China's growing economic power and role in the IEC, a disruptive behavior by China remains certainly possible. Member countries equipped with sufficient technical/financial power are probably able to push certain agendas in the organization. This can be done, among other ways, through effective lobbying with other member countries. For instance, in contrast to the above optimistic interpretation of China's participation in submitting against-votes, its relatively low participation can be viewed as a sign of effective lobbying made by Chinese delegates before the voting stage. Moreover, China's chances of disruptive behavior substantially increase in case its efforts—aimed at strengthening its role in international standard-setting—outside international SDOs were effective. China's BRI can definitely serve as an additional mechanism to gain more support from other member countries—especially the BRI signatories adopting Chinese standards—inside the IEC (as suggested by, Rühlig & ten Brink, 2021). China's chances to transform GGOs from within (as warned by Schweller & Pu, 2011) have been so far low, but they are certainly growing (as noted by other scholars, such as Malkin, 2022).

This research has two noteworthy limitations, one of which stems from the narrow scope of the analysis (i.e., an individual member country within an individual SDO), causing the generalizability of the findings to suffer. First, China's ability to exert influence in the IEC provides modest insights to predict how China behaves in another SDO/GGO, not least because the literature suggests that China's behavior is inconsistent among organizations. The findings, nevertheless, can still provide preliminary insights for analyses in other similar SDOs. This is because these organizations share many internal governance policies and have similar internal power structures among their members. Second, the literature lacks some definitions and benchmarks necessary for the analysis, such as a definition for disruptive behavior in GGOs/SDOs. As a consequence, I had to make the critical assumptions mentioned in the introduction section above.

6. CONCLUSION

This chapter has sought to depict a more nuanced picture of China's behavior in international standard-setting by analyzing it in the case of the IEC. The chapter aimed at two main objectives: first, to achieve a better understanding of how China exerts power, if at all, in the IEC; and second, to assess the likelihood of China acting in a disruptive manner in the organization. For that, I have analyzed China's status and participation in the IEC through a number of participation mechanisms and assessed the likelihood of disruptive behavior by China in each of the mechanisms taking into account the IEC internal governance rules and structure. The analysis was based on a two-decade internal IEC dataset that includes numerous participation records for IEC member countries, qualitative evidence from six interviews and data retrieved from other public sources.

The analysis of this chapter provides evidence showing that China has been increasingly exerting power in the IEC through effective utilization of all of the participation mechanisms analyzed, securing high potential influence in the organization. Such utilization, meanwhile, was less in mechanisms requiring relatively greater technical capabilities. Despite the substantial increase in China's participation in the IEC, the organization remains largely dominated by powerful Western member countries and Japan. Such participation, combined with the level playing field maintained by the IEC rules, reduce China's chances of behaving in a disruptive manner in the short-term. That said, China can still act disruptively in the IEC, especially if its voice gains sufficient support from other (powerful) member countries. Finally, and on a general note, China's growing role inside the IEC shows that it considers electrotechnology as an important standard-setting issue area. We, therefore, should expect relevant future technologies and products to be increasingly shaped by China's (technical) preferences.

Looking forward, additional similar empirical analyses should be conducted on other international SDOs in order to achieve a greater understanding of China's behavior in other global governance issue areas. Second, scholars should examine the role of the BRI project in helping China gain the support of other member countries within SDOs. Finally, scholars should seek to access and analyze data that show China's actual influence in SDOs—for instance, how much of Chinese domestic innovation gets integrated into international standard-setting.

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Chapter 5 – The International Electrotechnical Commission A 115-Year Journey of Challenges, Change, and Resilience[1]

Tim Büthe and Abdel fattah Alshadafan*

1. INTRODUCTION

Within a few years after it was established in 1906, the International Electrotechnical Commission (IEC) became the institutional focal point for the governance of electro-technologies and has for 115 years retained this preeminence – exhibiting striking resilience. As of the end of 2021, the IEC had developed 11,200 international technical standards and standard-like documents,[2] specifying design, performance, labeling, and other aspects of millions of electrical and electronic components and products. These standards are widely used across the globe for consumer products (with implications for consumer safety, consumer choice, and market share)[3] and – even more so – in business-to-business transactions.[4] In a wide range of industries, they affect the functioning of markets, including market access and

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[2] IEC, Understanding Standards: IEC Publications at a Glance, www.iec.ch/understanding- standards#publications.

[3] See, e.g., A. F. Alshadafan, Energy Efficiency Standards: The Struggle for Legitimacy (January–June 2020) 18:1 *International Journal of Standardization Research* 1–23; T. Büthe, The Power of Norms; the Norms of Power: Who Governs International Electrical and Electronic Technology?, in *Who Governs the Globe?* (D. Avant, M. Finnemore, and S. K. Sell eds., 2010), 292–332, esp. 292–294; K. Imagawa, Y. Mizukami, and S. Miyazaki, Regulatory Convergence of Medical Devices: A Case Study Using ISO and IEC Standards (2018) 15:7 *Expert Review of Medical Devices* 497; K. Kazlovich et al., Open Ventilator Evaluation Framework: A Synthesized Database of Regulatory Requirements and Technical Standards for Emergency Use Ventilators from Australia, Canada, UK, and US (2022) 11 *HardwareX* 2–13; S. Moon and H. Lee, Exploring Standard Dynamics in Electronics Industry: Focusing on Influencing Factors and Revision of IEC Standards (August 2022) 69:4 *IEEE Transactions on Engineering Management* 1365–1377; T. S. Ustun and S. M. S. Hussain, IEC 61850 Modeling of UPFC and XMPP Communication for Power Management in Microgrids (2020) 8 *IEEE Access* 141696–141704.

[4] See, e.g., S. Moon, K. Chin, and H. Lee, IEC Standard Revision Dynamics: Symbiosis between Standard and Technology (2018) *Portland International Conference on Management of Engineering and Technology (PICMET) 848–1751; J. C. Webb, T. Neighbours, and H. Karandikar, IEC versus IEEE/ANSI MV Switchgear: Matching the Standard to the Application, 2020 IEEE/IAS 56th Industrial and Commercial Power Systems Technical Conference (I&CPS, 2020), at 1–9; M. Voytchev, R. Behrens, R. Radev, Latest Updates for the IEC Standards for Active and Passive Dosemeters (2020) 166 Radiation Physics and Chemistry 108–509.*

the distribution of costs and benefits, through interoperability, substitutability, etc. IEC standards thus ultimately govern technologies ranging from magnetics; electro-acoustics; batteries, and energy production, storage, and distribution; to information and communication technologies and various aspects of the digital economy, including artificial intelligence–supported applications and virtual/extended reality.

IEC technology governance thus is an example of private authority. The IEC exercises this authority as a nongovernmental transnational organization, along with its national member bodies (of which the most prominent ones are also mostly nongovernmental) and the overwhelmingly private-sector experts who populate its technical committees and carry out most of the technology governance functions in practice. This chapter examines the resilience of IEC private ordering.[5]

Notwithstanding the often high commercial stakes and the substantive societal importance of its standards, the IEC has attracted much less attention than its companion international standard-setting body, the International Organization for Standardization (ISO), examined in this volume in the chapter by Stephanie Biljmakers.[6] One reason why the IEC has received less public and scholarly attention is that it has deliberately steered clear of getting involved in efforts to govern broad issues such as general quality management, environmental impact assessment and management, and corporate social responsibility, which the ISO addresses through its 9000-, 14000- and 26000-series of standards, respectively. These issues are of great economic and societal importance and have created much, sometimes controversial, visibility for the ISO. The public interest in these issues has prompted ISO to set

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[5] On the notion of transnational orders, see B. D. Richman, Firms, Courts, and Reputation Mechanisms: Towards a Positive Theory of Private Ordering (2004) 104:8 *Columbia Law Review* 2328–2367; T. Halliday and G. Shaffer (eds.), *Transnational Legal Orders* (2015).

[6] See S. Bijlmakers, "The International Organization for Standardization: A Seventy-Five-Year Journey Toward Organizational Resilience" in this volume (Chapter 13). [Bijlmakers, Stephanie (2023). The International Organization for Standardization: A Seventy-Five-Year Journey toward Organizational Resilience. In Panagiotis Delimatsis, Stephanie Bijlmakers, & Konrad Borowicz (Eds.), *The Evolution of Transnational Rule-Makers through Crisis* (pp. 261–286). Cambridge University Press.]

up multi-stakeholder processes that have been extensively scrutinized by scholars and practitioners alike[7] but remain atypical of the technical standard-setting processes in ISO and IEC (as well as the many organizations that mimic the ISO-IEC blueprint).[8]

IEC standards tend to be more strictly technical and relatively narrowly focused on issues specific to electro-technologies. Most scholarship about the IEC has accordingly been standard-specific.[9] And with very few exceptions,[10] previous work has paid little attention to the IEC's institutional resilience.

This dearth of analytical attention is unfortunate since the IEC has, over the course of its 115-year history, experienced a series of challenges to its centrality as the preeminent international body for the governance of electro-technology and a key node in the increasingly global network of electrical and electronics engineering, which make studying the IEC insightful for understanding institutional resilience. The IEC has adapted to technological

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[7] See, in particular, J. Clapp, The Privatization of Global Environmental Governance: ISO 14000 and the Developing World (1998) 4:3 *Global Governance* 295–316; K. T. Hallström, Organizing the Process of Standardization, in *A World of Standards* (N. Brunsson and B. Jacobsson eds., 2000), 85–99; K. T. Hallström and M. Boström, *Transnational Multi- Stakeholder Standardization* (2010); P. Gibbon and L. F. Henriksen, On the Pre-history of ISO 9000: The Making of a Neo-liberal Standard and C. N. Murphy and J. A. Yates, ISO 26000, Alternative Standards, and the 'Social Movement of Engineers' Involved with Standard Setting, both in *Governing Through Standards* (S. Ponte, P. Gibbon, and J. Vestergaard eds., 2011), 130–158, 159–183; P. Catska and Ch. J. Corbett, Diffusion, Impact and Governance of ISO 9000, ISO 14000, and Other Management Standards (2015) 7:3–4 *Foundations and Trends in Technology, Information and Operations Management* 161–379; R. Hahn and C. Weidtmann, Transnational Governance, Deliberate Democracy, and the Legitimacy of ISO 26000: Analyzing the Case of a Global Multistakeholder Process (2016) 55:1 *Business and Society* 90–129.

[8] See T. Büthe and W. Mattli, Private Regulators in Global Product Markets, in *The New Global Rulers: The Privatization of Regulation in the World Economy* (2011), 126–161. The deliberate- ness of the IEC decision to steer clear of contentious issues of broad public significance was conveyed to the authors in not-for-attribution interviews with current and former members of the IEC Standardization Management Board; it may be considered part of its resilience strategy (avoiding risks to the IEC's legitimacy by getting directly involved in public controversies).

[9] In addition to the work noted above (*supra* notes 2 and 3), see, e.g., M. Ianoz, H. Kunz, and D. Moehr, Standardization Activities in the Field of EMC, in *Proceedings from the 3rd International Symposium on Electromagnetic Compatibility, 21–24 May 2002* (L. Zhang and Y. Wen eds., 2002), 23–26; M. Felser and T. Sauter, Standardization of Industrial Ethernet: The Next Battlefield?, in *International Workshop on Factory Communication Systems: Proceedings* (2004), 413–420; A. Schreiner-Karoussou, Review of Image Quality Standards to Control Digital X-Ray Systems (2005) 117:3 *Radiation Protection Dosimetry* 23–25. Note, however, that electro-technology has long been understood to include electronics and hence in principle any and all issues related to gathering, storing, processing/analyzing, and otherwise using data. In the digital age of industry 4.0, it is therefore ever less obvious what issues are outside the purview of IEC standard-setting. General (brief) overviews of the IEC and its role in global technology governance are provided by J. Buck, International Electrotechnical Commission, in *Handbook of Transnational Economic Governance Regimes* (C. Tietje and A. Brouder eds., 2010), 573–584; O. Kanevskaia, International Electrotechnical Commission (IEC), in *Elgar Encyclopedia of International Economic Law* (T. Cottier and K. Nadakavukaren Schefer , 2017), 149–150.

[10] T. Büthe, Engineering Uncontestedness? The Origins and Institutional Development of the International Electrotechnical Commission (IEC) (2010) 12:3 *Business and Politics*; H.-W. Liu, International Standards in Flux: A Balkanized ICT Standard-Setting Paradigm and Its Implications for the WTO (2014) 17:3 *Journal of International Economic Law* 551–600; Alshadafan, *supra* note 2.

changes, the rise of the consumer movement, power shifts in the world economy, and other challenges with remarkable agility, building and exhibiting resilience, often by heading off challenges before they became existential crises. Examining the pursuit of resilience in the specific case of the IEC is valuable not just because it is even more purely representative of institutionalized technical standard-setting than the ISO, but also because it offers some distinctive insights, in part due to its longer history. We therefore provide this analysis of IEC resilience as a complement to the analysis of ISO resilience by Stephanie Bijlmakers.[11]

Our analysis of IEC resilience builds on Panagiotis Delimatsis' notion of resilience as the ability to "absorb stress and reorganize after the occurrence of a disturbance that upsets" the status quo equilibrium.[12] A private regulatory body – or more generally an inter- or transnational organization – is resilient to the extent that it does not just nominally survive an exogenous (or possibly endogenous) sudden shock or gradual yet serious challenging internal or environmental changes but "absorb[s] stress," adapts, reorganizes, or in other ways responds to the "stress" on the system so as to "emerge" from the episode "resembling its former state and functionality."[13]

A conceptualization of resilience as persistence through adaptability, however, raises the – theoretically and empirically challenging – question of at what point adaptability entails so much change that it is no longer a means of resilience but rather an indication of the lack thereof, as illustrated by the long-standing conceptual and empirical debate over escape clauses

[11] See S. Bijlmakers, "The International Organization for Standardization: A Seventy-Five-Year Journey Toward Organizational Resilience" in this volume (Chapter 13). [Bijlmakers, Stephanie (2023). The International Organization for Standardization: A Seventy-Five-Year Journey toward Organizational Resilience. In Panagiotis Delimatsis, Stephanie Bijlmakers, & Konrad Borowicz (Eds.), *The Evolution of Transnational Rule-Makers through Crisis* (pp. 261–286). Cambridge University Press.]

[12] See P. Delimatsis, "The Resilience of Private Authority in Times of Crisis" in this volume (Chapter 1). [Delimatsis, Panagiotis (2023). The Resilience of Private Authority in Times of Crisis. In Panagiotis Delimatsis, Stephanie Bijlmakers, & Konrad Borowicz (Eds.), *The Evolution of Transnational Rule-Makers through Crisis* (pp. 21–46). Cambridge University Press.]

[13] Ibid.

in trade agreements.[14] Similarly, when EU political leaders temporarily set aside state aid rules to allow member states to subsidize their domestic firms to help businesses stay afloat and prevent mass unemployment in light of, first, the COVID-19 pandemic and subsequently the Russian invasion of Ukraine, is this indicative of the resilience of the state aid rules or indicative of how brittle European political leaders' commitment to the ordo- liberal regime of controlling economic nationalist subsidies really is?[15] In Section 15.1, we therefore briefly introduce the IEC as a private regulatory body, focusing on four fundamental, defining characteristics or "attributes" of IEC-based technology governance, which would have to remain largely intact for any adaptation of this private regulatory body under changing circumstances to be considered indicative of resilience.

In Section 15.3, we then sketch the theoretical framework guiding our empirical analyses, before we identify and discuss four key challenges to the IEC's preeminence and legitimacy over the course of its 115-year history in Sections 15.4–15.7, where we examine how the IEC has responded to those challenges. In Section 15.8, we discuss whether the experience of previous challenges has increased the private rule-making body's resilience over time.

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[14] A. O. Sykes, Protectionism as a "Safeguard": A Positive Analysis of the GATT "Escape Clause" with Normative Speculations (Winter 1991) 58:1 *University of Chicago Law Review* 255–305; B. P. Rosendorff and H. V. Milner, The Optimal Design of International Trade Institutions: Uncertainty and Escape (Autumn 2001) 55:4 *International Organization* 829–857; K. Bagwell, K. and R. W. Staiger, Enforcement, Private Political Pressure, and the General Agreement on Tariffs and Trade/World Trade Organization Escape Clause (June 2005) 34:2 *Journal of Legal Studies* 471–513; K. J. Pelc, Seeking Escape: The Use of Escape Clauses in International Trade Agreements (June 2009) 53(2) *International Studies Quarterly* 349; W. Phelan, *In Place of Inter- State Relations: The European Union's Rejection of WTO-Style Trade Sanctions and Trade Remedies* (2014).

[15] See, e.g., S. Meunier and J. Mickus, Sizing up the Competition: Explaining Reform of European Union Competition Policy in the Covid-19 Era (2020) 42:8 *Journal of European Integration* 1077; I. Agnolucci, Will COVID-19 Make or Break EU State Aid Control? An Analysis of Commission Decisions Authorising Pandemic State Aid Measures (January 2022) 13:1 *Journal of European Competition Law & Practice* 3–16. For a pre-crisis account of the evolution of the regime, see T. Büthe, Historical Institutionalism and Institutional Development in the EU: The Development of Supranational Authority over Government Subsidies (State Aid), in *Historical Institutionalism and International Relations: Explaining Institutional Development in World Politics* (T. Rixen, L. A. Viola,and M. Zürn eds., 2015), 37–67.

2. THE INTERNATIONAL ELECTROTECHNICAL COMMISSION: ESSENTIAL ATTRIBUTES

Advances in electrical engineering in the late nineteenth century motivated prominent electrical engineers from across the then-developed world to seek common terms and measurements. In creating common metrics and nomenclatures, they sought to facilitate scientific and commercial exchange, reduce safety risks in the development and operation of electrical machinery, and foster the development of electrical engineering as a new field of science and engineering without borders. The developments in electro-technology and other considerations, which prompted them to institutionalize their information exchange and standardization efforts by founding the IEC in 1906, have been examined in some detail elsewhere.[16] Rather than recap the early history of the IEC, we highlight here four essential or "fundamental attributes"[17] of the IEC. These fundamental attributes would need to remain intact in the face of stress-induced adaptation for persistence to constitute "resilience" as defined above.

The first essential attribute of the IEC is being the institutional focal point for inter- or transnational electro-technology governance – or at least being able to make a defensible claim to being such a focal point and have that claim be widely believed. Being such a focal point implies, above all, providing the institutional structure and having the technical and administrative ability for developing high- quality technical standards in its area of expertise. It also implies that those standards, once they have been developed, will be widely used across the globe, not just where their implementation might be required by public laws and government regulations but also voluntarily because they are considered useful by producers

[16] Büthe, *supra* note 2, at 297–302; Büthe, *supra* note 9, esp. 16–20; J. A. Yates and C. N. Murphy, *Engineering Rules: Global Standard Setting since 1880* (2019), esp. 63–80.

[17] See P. Delimatsis, "The Resilience of Private Authority in Times of Crisis" in this volume (Chapter 1). [Delimatsis, Panagiotis (2023). The Resilience of Private Authority in Times of Crisis. In Panagiotis Delimatsis, Stephanie Bijlmakers, & Konrad Borowicz (Eds.), *The Evolution of Transnational Rule-Makers through Crisis* (pp. 21–46). Cambridge University Press.]

and users of the products and services governed by those standards.[18] If a standards-developing organization (SDO) is widely believed to have these qualities, it will lead to a widespread expectation that this SDO will (maybe even should) be the place where stakeholders will address further standard-setting needs related to the organization's area of expertise.

As highlighted by Büthe and Mattli's typology of global regulation,[19] having such a single focal institution for technical standard-setting in a given jurisdiction or market avoids the (often drawn-out and resource-intensive) process of multiple standards competing in "standards wars" for market share *after* two or more conflicting standards have been fully developed – though at the cost of shifting the underlying conflicts of interest to the standard-setting stage.[20] It creates incentives to invest in institutionalized joint standards development before a particular technical solution gets finalized and adopted as an international standard – subject to the structure, rules, and procedures of the standards-developing organization.

A second essential attribute of the IEC is maintaining internationally broad-based input legitimacy for its role as a global governor through inclusiveness toward all legitimate stakeholders based on a structure of nominally equal national representation.[21] The creation of the International Electrotechnical Commission was pre- ceded in the late nineteenth century by the establishment of domestic electro- technical "societies" – professional associations of

[18] For a discussion of the many economic, socio-political and legal incentives to implement such "voluntary" technical standards (or at least claim compliance) even when it is not required, see T. Büthe, Private Regulation in the Global Economy: A (P)Review (October 2010) 12:3 *Business and Politics* 1, esp. 15–20; T. Büthe, Global Private Politics: A Research Agenda (October 2010) 12:3 *Business and Politics* 1, esp. 8–11; and H. Schepel, *The Constitution of Private Governance: Product Standards in the Regulation of Integrating Markets* (2005).

[19] Büthe and Mattli, *supra* note 7, at 18–41.

[20] On standards wars, see, e.g., C. Shapiro and H. R. Varian, The Art of Standards Wars (Winter 1999) 41:2 *California Management Review* 8–32; A. Augereau, S. Greenstein, and M. Rysman, Coordination versus Differentiation in a Standards War: 56k Modems (Winter 2006) 37:4 *Rand Journal of Economics* 887–909; A. A. Quark, *Global Rivalries: Standards Wars and the Transnational Cotton Trade* (2013); G. Llanes and J. Poblete, Technology Choice and Coalition Formation in Standards Wars (June 2020) 68:2 *Journal of Industrial Economics* 270–297. The classic analysis of the efficiency of cooperative development of technical standards vs. standards wars remains J. Farrell and G. Saloner, Coordination through Committees and Markets (Summer 1988) 19:2 *Rand Journal of Economics* 235–252.

[21] On legitimacy and participation in global governance institutions, see J. Pauwelyn et al., eds. *Rethinking Participation in Global Governance: Challenges and Reforms in Financial and Health Institutions* (2022); esp. M. DeMenno and T. Büthe, Voice and Influence in Global Governance: An Analytical Framework, in Pauwelyn et al. (eds.), 31–70; regarding the notion of global governors and their various possible sources of authority, see D. D. Avant, M. Finnemore, and S. K. Sell, Who Governs the Globe?, in *Who Governs the Globe?* (D. Avant, M. Finnemore, and S. K. Sell eds., 2010), at 9–14.

physicists and early electrical engineers – within virtually all the "advanced," industrializing countries at the time. The highly transnationally connected individuals who started the IEC were mostly the leading figures within those domestic bodies.[22] And while they initially largely acted on their own (and often with a personal commercial stake in the matter as commercially successful scientist-entrepreneurs), they laid a claim to acting on behalf of those national bodies. The IEC then later asserted these bodies to be representatives of all legitimate stakeholders in those countries. The IEC's structure reflects this historical legacy to this day, and it is central to its claim of legitimacy based on inclusiveness toward all legitimate stakeholders via internationally broad representation. This claim to internationally broad representation means concretely that participation in IEC governance is organized by country and requires each participating country to have a domestic Electrotechnical Committee, which, upon becoming the country's IEC member body, is recognized as the country's "National Committee" in the IEC.

A third essential attribute of the IEC is its status as a nongovernmental (and therefore transnational) organization. The electro-technical societies that were the IEC's founding member bodies were mostly nongovernmental bodies.[23] Over time, many of them have been recognized by their respective governments as private bodies with a public purpose; quite a few are also partially government-funded and/ or regulated by governments; and a number of the national committees, especially from the Global South, are even government entities. The IEC, however, considers itself a strictly nongovernmental body – a defining feature that was

[22] Büthe, *supra* note 2, at 297–301; D. Cahan, Helmholtz in Gilded-Age America: The International Electrical Congress of 1893 and the Relations of Science and Technology (2010) 67:1 *Annals of Science* 1–38; E. Warburg, Werner Siemens und die Physikalisch- Technische Reichsanstalt (1916) 4:50 *Naturwissenschaften* 793–797; Yates and Murphy, *supra* note 15, at 64–67.

[23] Even in cases such as Hungary, for which the delegate at the 1906 meeting officially represented the Ministry of Commerce, the body that became the IEC member body for Hungary was the nongovernmental Elektrotechnischer Verein.

consciously and emphatically selected already in the very beginning[24] – and governments as such have no direct role in IEC governance.[25]

The IEC's nongovernmental status has numerous important consequences. Among them is that the IEC does not have guaranteed public financial support but instead depends for its financial viability on buy-in from its – mostly commercial – stakeholders. Those stakeholders provide the IEC with expertise through their participation in standard-setting as well as financial resources, directly, by literally buying the documents that contain the technical specifications of IEC standards, as well as indirectly, via the National Electrotechnical Committees that comprise the IEC and pay membership fees. At the same time, the IEC's nongovernmental character constrains the usability of traditional power resources of states[26] but also means that the legitimacy of global technology governance may be much more easily challenged than the legitimacy of a traditional (inter-state) international organization.

The fourth "fundamental attribute" of IEC governance is maintaining a balance between decentralized, bottom-up agenda-setting and decision-making, on the one hand, and centralized coordination and oversight, on the other, to ensure coherence and consistency as well as maintain the IEC's ability to act in pursuit of its organizational self-interest. As discussed below (Section 15.3.2), the pursuit of this balance has been a key driver of the IEC's structure and procedures and an essential source of both its technical authority (enabling it to become the focal institution for international electro-technical standard-setting) and its legitimacy.

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[24] Report of Preliminary Meeting, London: International Electrotechnical Commission, 1906, at 10.

[25] Büthe, *supra* note 2, at 312–314.

[26] W. Mattli and T. Büthe, Setting International Standards: Technological Rationality or Primacy of Power? (October 2003) 56:1 *World Politics* 1–42.

3. EXPLAINING RESILIENCE

3.1. Theoretical Sketch

A fully developed theory of organizational resilience is beyond the scope of this chapter. Yet an explicit sketch of the theoretical ideas underpinning our empirical analysis is warranted before we turn to examining specific challenges faced by the IEC over the course of its 115-year history. Building on Büthe's proto-theory of preeminence in global private governance,[27] we posit that, for a substantively important international organization or transnational governance body, resilience – in the sense of its ability to survive shocks and environmental changes, such that it still resembles its former state and functionality as defined by its essential attributes – requires such a body to have three characteristics:

(1) Capacity and Capability for Autonomous Agency. To be resilient, a global governance body needs to be set up in such a way that it is able to pursue its organizational self-interest even in cases when the body's interests are distinctive from the interests of the national-level or sub- national units that comprise the inter- or transnational body. Such capacity for agency implies a structure where the leadership and staff support does not just rotate among these "members" but has some permanence and genuinely identifies with, or has allegiance toward, the global governance body. It also requires the leadership to be authorized and incentivized to speak and act on behalf of the organization with some degree of autonomy.

Following Cafaggi and Pistor's work on regulatory regimes, Lavenex, Serrano and Büthe have recently introduced into the analysis of global governance bodies Nussbaum and Sen's distinction between capacity and capability. The latter is defined as "the ability to recognize and articulate" the organization's self-interest, even when it is not just the lowest common denominator (or some other function) of the constitutive units' self-interest but might

[27] Büthe, *supra* note 9, at 9ff., esp. 10–12.

even diverge from them. Capability thus also implies an ability to develop original, alternative proposals for how best to pursue the organization's own interests.[28] Having capability implies that the transnational body must have some permanent staff with the requisite analytical skill set, as well as financial resources that are at least in part independent of its members.

(2) Embeddedness among Stakeholders. There is no global governance in a Hobbesian state of nature. Governance authority at the inter- or trans- national level must be built and actively maintained since such authority is usually and traditionally situated at the local or national level – or at most at the level of regional common markets.[29] To be resilient, retain authority, and remain a focal point for developing standards or to govern other aspects of technology in the face of challenges, a global governance body needs to be at least sufficiently embedded among its members (and possibly other stakeholders) to ensure the continued relevance of the organization's work to those stakeholders. Particularly important in this respect is the ability to recognize and meet the needs of stakeholders who might be in a position to participate in, or even set up, alternative inter- or transnational governance arrangements – sufficiently so that it reduces the incentive of those stake- holders to explore alternatives. At the same time, meeting the particular needs of those stakeholders must not to so far that the global governance body loses the required autonomy or legitimacy in the eyes of the organization's other stakeholders.[30]

(3) Ambition. The combination of capacity and capability should in principle assure the active and strategic pursuit of the organization's survival with its essential attributes intact

[28] S. Lavenex, O. Serrano, and T. Büthe, Power Transitions and the Rise of the Regulatory State: Global Market Governance in Flux." Introduction to a Special Issue (July 2021) 15:3 *Regulation and Governance* 445–471, at 450. See also F. Cafaggi and K. Pistor, Regulatory Capabilities: A Normative Framework for Assessing the Distributional Effects of Regulation (June 2015) 9:2 *Regulation and Governance* 95–107.

[29] P. Genschel and R. Werle, From National Hierarchies to International Standardization: Modal Change in the Governance of Telecommunications (July–September 1993) 13:3 *Journal of Public Policy* 203–225; S. Schmidt, and R. Werle, *Coordinating Technology: Studies in the International Standardization of Telecommunications* (1998); M. Egan, *Constructing a European Market: Standards, Regulation, and Governance* (2001).

[30] On the notion of embeddedness, which informs this discussion, see J. Ruggie, International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order (Spring 1982) 36:2 *International Organization* 379–415; and P. B. Evans, *Embedded Autonomy: States and Industrial Transformation* (1995).

– that is, its resilience – because the continued existence and substantive relevance can be assumed to be an essential first-order preference of any organization.[31] In practice, however, the actual active and strategic pursuit of the organization's self-interest is also a function of the skill of the organization's leadership and its ambition to ensure the organization's continued existence and importance. Institutional factors, such as career incentives and rewards for senior leaders' skillful pursuit of resilience, can increase the likelihood that the global body will exhibit such ambition and develop the skills to pursue resilience, but the idiosyncratic qualities of the individuals who fill those leaderships conditions also matter.[32]

3.2. Does the IEC Meet the Requirements for the Pursuit of Resilience? Applying the Analytical Framework to the Specific Case.

Operationalizing the required characteristics for the specific case of the IEC suggests that the IEC meets (and for a long time has met) the criteria set up abstractly above, which should empower it to pursue resilience. We first discuss how the IEC assures embeddedness, which is critical to the IEC's technical expertise and authority, as well as key to the commercial usefulness of its standards. Given that electro-technology has changed tremendously over the course of the IEC's existence (and it continues to evolve over time), with innovations resulting in "new" areas of electro-technology not yet covered by the IEC's structure, maintaining (the ambition for) such preeminence also implies the ability to pursue organizational interests actively and strategically. It also implies a responsiveness to – and maintaining a reasonable balance between – major stakeholders who might other- wise have the credible option to try to

[31] T. Büthe, Historical Institutionalism and Institutional Development in the EU: The Development of Supranational Authority over Government Subsidies (State Aid), in *Historical Institutionalism and International Relations: Explaining Institutional Development in World Politics* (T. Rixen, L. Viola, and M. Zürn, 2016), 37–67.

[32] See J. A. Yates and C. N. Murphy, Charles Le Maistre: Entrepreneur in International Standardization (2008) 51 *Entreprises et Histoire* 10; and *supra* note 15.

"go it alone"[33] by developing competing standards outside of the IEC.[34] So does the IEC exhibit capacity and capability, as well as embeddedness?[35]

The IEC's structure and procedures ensure its embeddedness. As of the end of 2021, the IEC has 110 Technical Committees (TCs); some of them also have numerous subcommittees (SCs), for a total of 212 TCs and SCs.[36] Much of the technical work in those TCs and SCs is actually done in distinct working groups (of which there were 725), project teams (200), and maintenance teams (669 as of the end of 2021). This structure and the procedural norms and rules of the IEC allow for bottom-up agenda-setting, making it very easy for a small number of national member bodies to launch the development of a new standard for a product or electro-technical phenomenon.[37] Consensus norms then give a right to be heard to all member bodies that have elected to be "participating members" (P-members) of the TC where a given standard is developed, reviewed, or revised. These norms – at least in theory – provide all stakeholders with opportunities to make alternative or compromise proposals for all aspects of the technical work. They are reinforced by procedural rules governing the IEC standards development process, which require large super-majorities in formal votes on the penultimate "Committee Draft for Voting" (CDV)[38] and for the adoption of the resulting "Final Draft" as an official IEC standard.

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[33] L. Gruber, *Ruling the World: Power Politics and the Rise of Supranational Institutions* (2000); J. Odell, *Negotiating the World Economy* (2000), esp. 47ff.

[34] A focus on practically "useful" IEC standards has been a characteristic of the IEC from the beginning, since many of the scientist-engineers that played a central role in founding the IEC were also highly commercially successful entrepreneurs. They therefore sought to bridge emphatically valued basic research and the creation of entrepreneurial opportunities for commercial applications.

[35] The ambition and skills of IEC leaders are harder to operationalize at the level of generality required for this preliminary discussion; they will be discussed as part of the empirical analyses in subsequent sections.

[36] For instance, TC23, devoted to "electrical accessories and related systems" for household, industrial, and other commercial uses (www.iec.ch/dyn/www/f?p=103:7:::::FSP_ORG_ ID:1299) and has separate SC's inter alia for circuit breakers; plugs and socket-outlets; couplers for electric vehicles; switches for appliances; and devices for monitoring, measuring, controlling, managing, and optimizing the efficient use of AC and DC electrical energy (www.iec.ch/ dyn/www/f?p=103:7:::::FSP_ORG_ID:10046).

[37] Büthe, *supra* note 9, esp. 32–34.

[38] Positive votes on a CDV committee draft can and negative votes must be accompanied by comments. This gives P-members a formal opportunity to object to any aspect of the proposed standard and to request changes as a condition for supporting the adoption of a revised version as an IEC standard. The TC in charge of the standard then has an opportunity to revise the standard one last time before submitting the resulting Final Draft International Standard (FDIS) to a vote of the full IEC

Balancing these decentralized elements of the IEC's institutional structure, the IEC has for a long time reserved a crucial (if mostly light-touch) centralized role for the IEC leadership, especially its Standardization Management Board (SMB) and the IEC Central Secretariat. Jointly, they provide coordination and oversight to ensure coherence and consistency as well as maintain the IEC's ability to act in pursuit of its organizational self-interest.

The IEC leadership consists of a president, three vice presidents (one each for standardization management, market strategy, and conformity assessment), a treasurer, and the IEC Secretary General.[39] Candidates for the part-time positions of president or vice president(s) tend to come from the private sector and customarily have previously held prominent leadership positions in one of the largest IEC's national member bodies. They are elected for (once-renewable) three-year terms, and during this time, (vice)presidents are supposed to pursue the interest of the IEC, only, though they usually retain their private sector full-time (and income- providing) position.

Not as visible but at least as important for the IEC's capability and its capacity for autonomous agency are the Secretary General and the senior staff of the central secretariat of the IEC. They are longer-term, full-time employees of the IEC, which gives them a strong incentive to think and act in the institutional self-interest of the organization. The staff, which supports the work of the IEC leadership and administratively and technically handles most of the coordination between the IEC's many committees, is lean (much smaller than the ISO's) but readily provides the support to enable capacity and capability.

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membership. At the CDV stage, National Committees also have the option to provide comments while voting to "abstain," thus allowing the committee to proceed while reserving judgment on the resulting FDIS.

[39] The three vice presidents lead, respectively, the IEC Standardization Management Board (discussed separately below), the Market Strategy Board (tasked with early identification of important technological changes and market trends that might warrant an IEC response), and the Conformity Assessment Board (tasked with overseeing the IEC's four, commercially very important conformity assessment programs). These three fifteen-member boards are the primary management bodies of the organization, their tasks officially delegated to them from the overall IEC Board, the core executive body of the organization; see IEC, Management Structure, www.iec.ch/management-structure.

The SMB is critical to the IEC's agency, as it coordinates and oversees the work of the many technical committees, subcommittees, and working groups of the IEC. It ensures that these various groups do not work at cross-purposes, for example, by developing competing IEC standards for the same purpose where the purview of two or more committees might overlap. The SMB (similar to the other boards) comprises "automatically appointed members" (representatives of the largest member bodies in terms of their contributions to the IEC annual budget and staff support for technical committees), elected representatives of the remaining member bodies, and IEC senior staff ex officio. The elected members of the SMB are elected for three-year terms, renewable once, by the IEC General Assembly, usually in the annual meeting of the member body presidents and senior officers.

SMB oversight is supposed to ensure timeliness and high quality of the technical output – and that all IEC work follows the procedural rules and norms for IEC standard-setting and no one company or country might highjack any TC or larger parts of the organization. The SMB also may reorganize the technical work by merging TCs; it appoints TC secretariats and chairmanships; it adjudicates jurisdictional conflicts between the TCs; and it is responsible for relations with other organizations.[40] In doing so, the SMB ensures the ability of the IEC to act in the self-interest of the organization while keeping the IEC leadership grounded in the organization's member bodies – which we would expect to play an important role in the IEC's ability to exhibit organizational resilience.

4. IEC RESILIENCE IN THE FACE OF TECHNOLOGICAL CHANGE

One of the remarkable features of the early history of the IEC is how few committed individuals it took to launch a transnational private body that has – for 115 years and counting – played a major, increasingly global role in the development and governance of an enormous range of

[40] For details, see IEC, Management Structure: SMB, www.iec.ch/dyn/www/f?p=103:48:0::::FSP_ORG_ID,FSP_LANG_ID:3228,25; Büthe, *supra* note 2, at 318–320; and *supra* note 9, at 24.

electro-technologies. The entrepreneurial approach and skill of key figures – above all Charles Le Maistre, the IEC's first and long-term secretary general – surely was important for bringing the IEC into existence as an organization with its consensus-oriented structure and procedures for developing "voluntary" technical standards.[41] The relative ease of its creation may also have been a function of fortuitous temporal sequence: the IEC was the first body of its kind, set up to address functional needs and serve the (largely common) interests of key political-economic stakeholders in the early years of a new field (electrotechnology).[42] Rapid technological development in this field meant that standardization tended to open up a wealth of new, profitable opportunities while foreclosing few. Standardization at that time thus resembled a coordination game with large gains from coordination and relatively small distributional effects, making distributional conflicts a second-order concern.[43]

Yet, the conditions that facilitated the establishment of the IEC in 1906 also applied to a greater or lesser extent in later cases of "new" technologies. Indeed, over the decades, the development of new areas of electro-technology – such as batteries for mobile electrical devices, digital audio and video formats, electronics, and more recently artificial intelligence – have time and again created challenges to IEC preeminence. The IEC has proven remarkably resilient in the face of these technological changes.

The IEC was initially set up to agree upon a common set of terms and measurements that would be foundational for the development of electro-technologies and electrical products

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[41] Yates and Murphy, *supra* note 31. Regarding the role of entrepreneurial actors in global governance more generally, see also J. F. Green, *Rethinking Private Authority: Agents and Entrepreneurs in Global Environmental Governance* (2014).

[42] On the issue of temporality and sequence for institutional development in general, see T. Büthe, Taking Temporality Seriously: Modeling History and the Use of Narratives as Evidence (2002) 96:3 *American Political Science Review* 481–494. See also P. Pierson, Not Just What, but When: Timing and Sequence in Political Processes (2000) 14:1 *Studies in American Political Development* 72–92; W. Streeck and K. Thelen (eds.), *Beyond Continuity: Institutional Change in Advanced Political Economies* (2005); C. Trampusch, Sequence-Oriented Policy Analysis (2006) 16:1 *Berliner Journal für Soziologie* 55; D. Bach and A. L. Newman, Governing Lipitor and Lipstick: Capacity, Sequencing, and Power in International Pharmaceutical and Cosmetics Regulation (2010) 17:1 *Review of International Political Economy* 665–695; E. Posner, Sequence as Explanation (2010) 17:4 *Review of International Political Economy* 639–664; O. Fioretos, T. G. Falleti, and A. Sheingate (eds.), *Oxford Handbook of Historical Institutionalism* (2015); T. Rixen, L. Viola, and M. Zürn (eds.), *Historical Institutionalism and International Relations: Explaining Institutional Development in World Politics* (2016).

[43] See Büthe, *supra* note 9, at 35.

– anything from light bulbs to electricity-powered heavy machinery.[44] Its agenda soon broadened to include the development of standards for the design and performance of actual electrical devices. Initially, the focus was on power-generating equipment, industrial machinery, and standards for use (in scientific research and) within and between private enterprises.[45] Already by 1911, the agenda had become so broad that discussing all current projects in a single (multi- day) plenary meeting was deemed impractical, prompting the IEC to delegate the technical work to more specialized committees, known today as the IEC Technical Committees.[46] Setting standards for consumer goods was added to the IEC agenda starting in the 1920s and became an important focus of multiple TCs after World War II thanks to the widespread electrification of households throughout advanced industrialized countries and the mass-market production of electrical devices for household use.[47] And as new electro-technologies were developed, the scope of IEC rule-making broadened further.

IEC standards have remained essential to the development of a wide range of electrical (and in more recent decades electronic) technologies in part because IEC standards define elements and components used as the foundation or building blocks for innovations and technological change. The units and methods for the measurement of voltage and frequency of electrical currents, established by the IEC early on, remain a good example: using other units or methods has become literally unthinkable. Another, more recent example are sensors, which have long had various industrial and household uses, and continue to become ever more important as key parts of complex smart manufacturing and a wide variety of artificial intelligence–driven or –supported systems.[48] A variety of sensors have, for instance, been

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[44] See 1904 Declaration for the establishment of the IEC; E. B. Paxton, AIEE: A Leader in Electrical Standards (1954) 25:8 *Magazine of Standards* 242–245, at 244ff.

[45] W. H. Onken Jr., Work of the International Electrotechnical Commission (April 17–26, 1919) 73 *Electrical World* 856–857.

[46] Yates and Murphy, *supra* note 31), at 17 note 53.

[47] L. Ruppert, *Brief History of the International Electrotechnical Commission* (1956), at 6ff.; A. Raeburn, IEC Technical Committee Creation: The First Half-Century, 1906–1949 (on file with the authors).

[48] Sensors can interpret analog or electrical stimuli, including temperature, sound, motion, smell, and pressure.

integrated into smart "wearable technologies"[49] used, inter alia, in the health- care sector. Such devices promise great improvement in patient care by tracking, recording, and (remotely) monitoring physiological processes and biomedical signals.[50] The COVID-19 pandemic brought this into focus: sensors installed in a wearable device can alert the user when changes in their metrics match those associated with COVID-19 or even track the stability and recovery of those infected.[51] The IEC plays a role in the development of all these new technologies because the sensors used are designed and manufactured according to the IEC 60747-14 "family" of standards, developed by IEC Technical Committee 47, such as the IEC 60747-14-10 for glucose sensors.[52]

Even more important is that the IEC has proven adept at adding new issues to its agenda to keep abreast of technological changes. This is partly a function of the relative ease with which a "new work item" can be added to any Technical Committee's standards development agenda. Such a proposal to develop a new standard can be put forward by any National Committee, any Technical Committee (for topics fitting its expertise), the secretary of that TC, the SMB, or the IEC leadership. The proposal is then put to a vote only among the P-members of the TC or SC specified in the proposal as the one to develop the standard. Among them, a simple majority and a commitment of at least four of them (five for larger committees) is all that is required to launch the new standards project. These procedural rules make it very easy to extend the scope of the IEC's technical authority while making it very difficult for those who do not want to see an IEC standard developed to prevent the launch of such an effort, as long as at least a small number of members share the desire to develop it.[53]

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[49] Wearables are a class of Internet of Things devices that act as a portable computer system attached to the user's body such as smart-watches, patches, and t-shirts.

[50] S. Patel, H. Park, P. Bonato, L. Chan, and M. Rodgers, A Review of Wearable Sensors and Systems with Application in Rehabilitation (2012) 9:1 *Journal of NeuroEngineering and Rehabilitation* 21, doi: 10.1186/1743-0003-9-21.

[51] A. Ravizza, C. De Maria, L. Di Pietro, et al., Comprehensive Review on Current and Future Regulatory Requirements on Wearable Sensors in Preclinical and Clinical Testing (2019) 7 *Frontiers in Bioengineering and Biotechnology* 313.

[52] Sensors inserted under the skin can monitor diabetes and transmit the information to a device.

[53] For details, see Büthe, *supra* note 9, at 31–34.

There are limits, however, to such incremental additions to existing technical committees' agenda as a response to the need for standards development, especially if this work requires distinctive expertise or involves a distinct set of stakeholders. Accordingly, the SMB added entirely new TCs to the IEC portfolio (and occasion- ally restructured existing TCs), including for computing and information-processing standards in the 1960s; for laser equipment in 1970s; for fiber optics (TC86), superconductivity (TC90), and wind turbines (now "wind energy generation systems", TC88) in the 1980s; for fuel cells (TC105) in the 1990; and for flat- screen panels (TC110), for nanotechnology in electrical and electronic products (TC113), and for marine energy (i.e., the conversion of tidal and other water currents into electric energy, TC114) in the 2000s. Recently established TCs include committees focused on smart grid user interfaces (TC118), wearable electronic devices and technologies (TC124), and "robotics for electricity generation, transmission and distribution systems" (TC129). Even the development of futuristic-sounding flying cars will involve IEC standardization: such urban air mobility devices will likely rely upon existing standards and standards newly developed by IEC TC100 for surround- view monitoring of the car, by ISO/IEC JTC1 for biometric interchange formats, and IEC 62668 to ensure that the electronic parts safely work together.[54]

In sum, the IEC has, time and again, responded to technological change directly by extending the range of electro-technologies (by now long including in principle all kind of electronics, too) for which it claims standard-setting expertise and authority. While this has not completely prevented the creation of new, more specialized bodies for developing technical standards (see below), it has allowed the IEC to remain the preeminent forum for such activities, especially where cooperation, coordination, and interoperability with related

[54] IEC, Auto Manufacturer Says Flying Cars Will Arrive in Cities by 2030, www.iec.ch/blog/auto- manufacturer-says-flying-cars-will-arrive-cities-2030; Z. Kleinman, Flying Car Completes Test Flight between Airports, BBC News June 30, 2021, www.bbc.com/news/technology-57651843; I. Bogost, When Cars Fly, *The Atlantic*, May 2016, www.theatlantic.com/magazine/archive/2016/ 05/when-cars-fly/476382.

technologies is import- ant, as the standards for them are often already being developed or maintained at the IEC. Importantly, IEC resilience in the face of technological change was by no means coincidental but part of a conscious strategy, as occasionally documented, such as when TC111 was set up in 2004 and assigned the task to "monitor closely the corresponding regional standardization activities worldwide to become a *focal point* for discussions concerning standardization."[55]

5. IEC RESILIENCE VIS-À-VIS POSSIBLE COMPETITOR SDOS

Having been the first transnational body for setting electro-technology standards gave the IEC something of an incumbency advantage, making it the default focal point for subsequent initiatives to achieve coordination or even harmonization of technical standards related to any area of electro-technology.[56] From early on, however, other standards-developing organizations arose at various times, and it appears that IEC leaders quite consciously sought to head off possible challenges from potential competitor organizations by establishing more or less formal relation- ships with them, turning them into collaborators instead. The International Conference on Large Electric Systems and the World Power Conference, for instance, were initially set up as fora for electro-technical standard-setting in 1921 and 1926, respectively, thus effectively threatening the IEC's preeminence for commercially very important segments of electro-technology.[57] Over time, however, their standards-developing activities were either absorbed by the IEC, or they yielded them to the IEC. Other potential competitors established a symbiotic, complementary relationship vis-à-vis the IEC, as in the case of the International Federation of National Standardizing Associations (ISA), founded in

[55] Original official scope of the work of TC111 in 2004, today online at TC 111 Scope, www.iec.ch/dyn/www/f?p=103:7:110017303512038::::FSP_ORG_ID,FSP_LANG_ID:1314,25 (emphasis added).

[56] Büthe, *supra*, note 9.

[57] The empirical record of the individual motivations of the key actors and the internal deliber- ations within these bodies is slim (for the most comprehensive treatment, see Yates and Murphy, *supra* note 15) but appears that the pursuit of the IEC's organizational self-interest by Le Maistre and other early IEC leaders was quite conscious.

1926 and also headed by Le Maistre, who ensured that its portfolio was defined as standardization outside of the field of electro-technology.

IEC resilience was also helped by fortuitous elements of its institutional design, which allowed it to survive the hiatus of World War II largely unscathed – in contrast to many other inter- and transnational organizations. The statutes of the ISA, for instance, required the organization to hold a general meeting at the latest every three years and tied the terms of office of anyone who could claim to act on behalf of the organization to that meeting schedule. Having held a meeting in 1939 just prior to the beginning of the war, the ISA could go until 1942, but then the ISA arguably ceased to exist; it thus became a collateral organizational casualty of the war. The IEC's more minimalist rules, by contrast, allowed its secretary general to continue to serve in that role until the next meeting after the war (at which Le Maistre was confirmed once more).[58]

After World War II, the establishment of the ISO as a standards-developing organization for all industries put the IEC's preeminence or independence at risk. Yet, here again the IEC, led by Le Maistre (who continued as IEC secretary general until 1952), intervened to make certain that the ISO agenda would not clash with the IEC's. The IEC then proceeded to establish quite quickly institutional mechanisms for a division of labor between IEC and its "sister organization" and to ensure that, for any issue at the intersection of the IEC's and ISO's respective areas of specialization, they would not develop competing standards but coordinate. This cooperation has been maintained for more than seven decades – albeit with a growing set of work items assigned to various subcommittees of the rather unwieldy "Joint Technical Committee 1," which the two standards bodies manage and staff jointly.

The most serious challenge to the IEC's institutional preeminence in recent decades arose from a group of IEC "insiders" in the process of the EU Common Market initiative in the

[58] J. A. Yates and C. N. Murphy, Coordinating International Standards: The Formation of the ISO, Unpublished manuscript (on file with the authors), MIT 2006; Yates and Murphy, *supra*, note 15.

1980s. After the failure of its attempts to achieve regulatory harmonization through inter- or trans-governmental negotiations,[59] the EU sought to overcome divergent, markets-fragmenting regulatory requirements, standards, and norms by delegating the development of technical standards to transnational, non- governmental standard-setting bodies.[60] Seeking to balance the attainment of common technical standards with the achievement of legitimate public policy objectives as defined by Europe's political (governmental) authorities through democratic processes, they set up a system where European policymakers specify the overarching objectives through legislative processes, then delegate finding a "consensus" technical solution for achieving those objectives (subject to international trade law and EU stipulations against discrimination, anti-competitive conduct, etc.) to the then-nascent European-level standard-setting bodies, CEN and CENELEC (corresponding to ISO and IEC, respectively). This arrangement constituted a dangerous challenge to the IEC's preeminence, given the prominent role of numerous EU countries' IEC member bodies in IEC-based electro- technology governance.

The IEC responded to this challenge (heading it off for the most part, though not without compromising some of its autonomy) by striking the 1991 Lugano Agreement and then the 1996 Dresden Agreement with CENELEC, which sets out detailed procedures for cooperation between the two transnational SDOs.[61] For new standards, for instance, it specifies joint decisions by the pertinent TCs of both organization about whether IEC or CENELEC shall take the lead in developing the standard. If IEC takes the lead, it commits to writing a standard that allows for achieving the EU objectives, as well as completing the work on the

[59] A. Dashwood, Hastening Slowly: The Community's Path Toward Harmonization, in *Policy- Making in the European Community* (H. Wallace, W. Wallace, and C. Webb eds., 1983), 177–208.

[60] J. Pelkmans, The New Approach to Technical Harmonization and Standards (1987) 25:3 *Journal of Common Market Studies* 249–269; K. Schreiber, The New Approach to Technical Harmonization and Standards, in *The State of the European Community* (L. Hurwitz and C. Lequesne eds., 1991), 97–112; Egan, *supra*, note 28.

[61] See Egan, *supra* note 28; G. Eickhoff and B. Hartlieb, Einfluss auf Normen-Inhalte: Europäischer und internationaler Fokus, in *Normen und Wettbewerb* (T. Bahke, U. Blum, and G. Eickhoff, 2002), 172–188.

time line necessary to meet the EU legislative mandate. IF CENELEC takes the lead, it keeps the corresponding IEC committee informed, but the technical work then takes place in CENELEC, where non-European IEC member bodies do not have any automatic status. Either way, voting on the final draft standard takes place in parallel in both organizations. If adopted by both, then the often-European-made standard becomes an international standard without further technical discussion at the IEC.[62]

Notwithstanding the IEC's propensity to swiftly pick up on (market demand for transnational private governance of) new technological developments, some firms have sidestepped the IEC to develop standards for new technologies in so-called standards consortia – ad hoc groups of firms set up (sometime formally as joint ventures) to develop a technical standard for a particular use and usually with exclusive intellectual property rights claims regarding the standard and the technical expertise contained therein.[63] There are precedents for developing standards collaboratively in small, exclusive groups of firms,[64] but standards consortia became a distinct method of standard-setting only in the late 1980s and early 1990s, especially in the fast-changing information and telecommunications sector, where the long time required for IEC standards development (five to eight years in the 1980s) was considered particularly problematic.[65] The IEC responded to this challenge by taking various measures to accelerate the technical work in the TCs, SCs, and working groups, shortening the average time required, from the launch of a proposal for a new standard to the vote on the final draft, to less than three years by the early 2000s.

[62] See Mattli and Büthe, *supra* note 25, at 28.

[63] See T. Büthe and J.-M. Witte, Product Standards in Transatlantic Trade and Investment: Domestic and International Practices and Institutions, AICGS Policy Report no. 13, Washington, DC, American Institute for Contemporary German Studies (2004), at 32ff.; R. Werle, Institutional Aspects of Standardization: Jurisdictional Conflicts and the Choice of Standardization Organizations 8:3 (2001) *Journal of European Public Policy* 392–410.

[64] See, e.g., C. F. Cargill, *Information Technology Standardization: Theory, Process, and Organization* (1989).

[65] R. Hawkins, The Rise of Consortia in the Information and Communication Technology Industries: Emerging Implications for Policy (1999) 23 *Telecommunications Policy* 159–173; S. Bolin (ed.), *The Standards Edge* (2002); J. Baron, Y. Ménière, and T. Pohlmann, Standards, Consortia, and Innovation (September 2014) 36 *International Journal of Industrial Organization* 22–35.

The IEC also has incorporated into its portfolio numerous standards initially developed by standards consortia (thus committing the holders of standards-essential patents to license those patents to any user on "fair, reasonable, and nondiscriminatory" [FRAND] terms while usually also greatly enhancing the value of those patents). To give just two examples with particular importance to the entertainment industry: the audio CD standard, maintained since 1987 as IEC standard 60908, was originally developed by a Sony-Philips consortium in 1979/80.[66] And the Blu-ray optical disc standard, maintained since 2011 by ISO/IEC JTC1/SC23 as ISO/IEC 30193, was originally developed in 2000 by the Sony-Philips-Panasonic-led consortium in a fierce race with the Toshiba-led consortium, which had developed the competing High Definition DVD standard.[67] In all three cases (and many more like it), the IEC succeeded in gaining authority and in some sense restoring its pre- eminence, though at the cost of recognizing and arguably sanctifying standards developed without IEC input and without regard to the procedures and norms of IEC standardization.

Another challenge to the IEC's authority arose from governments in the context of the multilateral international trade regime of GATT and WTO. In the 1960s and 1970s, cross-national differences in technical standards (as such or when subsequently used as a basis for government regulations) were increasingly recognized as important non-tariff barriers to trade.[68] By the 1990s, their trade-inhibiting effect for manufactured goods was estimated to far exceed the effect of the remaining tariffs for such goods between advanced industrialized countries, resulting in a strong push to incorporate the previously optional GATT Agreement on Technical Barriers to Trade into the WTO Treaty, of which it became an integral part, binding on all WTO member states. The resulting international trade law obligation to use

[66] See Büthe and Mattli, *supra* note 7, at 46ff.

[67] See S. Greenstein, Format Wars All Over Again (2006) 26:1 *IEEE Micro* 7, 140; Ibid., at 27ff., 34ff.

[68] R. E. Baldwin, *Nontariff Distortions of International Trade* (1971); M. Emerson (ed.), *The Economics of 1992: The E.C. Commission's Assessment of the Economic Effects of Completing the Internal Market* (1988); J. Grieco, *Cooperation among Nations: Europe, America, and Non- Tariff Barriers to Trade* (1990).

"inter- national standards" as the "technical basis" for regulatory measures (whenever international standards exist that can achieve the stated regulatory purposes, such as consumer health and safety) promised to be very profitable for competitive producers and to yield substantial macroeconomic gains.[69]

For the IEC, the new prominence of international standards in international trade law created unprecedented visibility (beyond the niche world of standards experts), but it also created two risks: first, it created the risk that the IEC's preeminence might be diluted through provisions in the inter-governmental agreement for the recognition of alternative transnational bodies for electro-technical standard-setting. Second, it created the risk of overt politicization and government attempts to interfere in the work of the IEC. Working jointly with ISO, the IEC addressed these risks, first, by actively lobbying (successfully) for the incorporation of the ISO-IEC joint Code of Good Practices for the Preparation, Adoption and Application of Standards, which was written into the TBT-Agreement as Annex 3, which also gave ISO and IEC, via their joint "Information Center," an official role in the implementation of the agreement. They also successfully lobbied against any mention of other "international standards" bodies (except for the more specialized, inter-governmental ITU) in the Agreement. The exclusive recognition of IEC, ISO, and ITU does not, strictly speaking, give these organization exclusive rights, but it raised their status and made it clear that they met the requirement for WTO recognition as an international standard-setter.[70] IEC responded to the second risk by being even more protective of its nongovernmental status. In the end, the entry into force of the WTO Treaty with its TBT provisions thus confirmed and may have even strengthened the resilient IEC and its preeminence.

[69] K. Blind et al., Volkswirtschaftlicher Nutzen and A. Töpfer et al., Unternehmerischer Nutzen, in *Gesamtwirtschaftlicher Nutzen der Normung* (B. Hartlieb ed., 2000), 23–34; 9–22; WTO, World Trade Report 2005: Exploring the Links Between Trade, Standards, and the WTO (2005), esp. 57ff.; H. de Vries, Standards for Business: How Companies Benefit from Participation in International Standards Setting, in *International Standardization as a Strategic Tool* (2006), 131-141.

[70] T. Büthe, Agent Selection in the International Delegation of Regulatory Authority: Food Safety, Health Regulations, and Free Trade under the WTO, unpublished manuscript (on file with the authors), Duke University and University of California, Berkeley, February 2009.

The most recent risk to the IEC from an SDO competitor arises from China's efforts to enhance its role in global technology governance, especially technical standardization through its Regional Comprehensive Economic Partnership and, more generally, through its Belt and Road Initiative (BRI). The BRI is an extremely broad – comprehensive, though not necessarily cohesively planned, and in parts still rather vague – initiative, sparked by Chinese President Xi Jinping in 2013, to connect China-centered continental East Asia more closely with East and South Asia, Oceania, Central Asia, Europe, the Middle East, and Africa via land and maritime networks.[71] These networks go by now far beyond the trade and transport networks of the Han Dynasty's "silk road," which is said to have inspired the BRI. It includes foreign direct investments, all kinds of development cooperation, and various forms of international, trans-governmental, and transnational exchanges (though the latter appear often high centrally directed from the Chinese side).

Most of the BRI is not about technical standards at all, but many observers have reported that China has been using BRI-created or -intensified interdependence as leverage to get other countries to accept Chinese national technical standards as de facto international standards – facilitated by the hub-and-spokes bilateral rather than multilateral structure of BRI governance, which guarantees China a dominant position vis-à-vis each of its BRI partners.[72] A recent example has been the pandemic-induced demand for digital tools to fight COVID-19 to get BRI partners to adopt technologies based on Chinese standards that diverge from international ones.[73] Chinese officials have attributed such efforts (as well as occasional talk of

[71] See, e.g., Y. Huang, Understanding China's Belt & Road Initiative: Motivation, Framework and Assessment (September 2016) 40 *China Economic Review* 314; European Bank for Reconstruction and Development, China's Belt and Road Initiative, www.ebrd.com/what-we- do/belt-and-road/overview.html.

[72] See, e.g., T. N. Rühlig, *Technical Standardisation, China and the Future International Order: A European Perspective* (2020); R. Arcesati, Chinese Tech Standards Put the Screws on European Companies, Mercator Institute for China Studies *Kurzanalyse*, January 29, 2019, www.merics.org/de/blog/chinese-tech-standards-put-screws-european-companies; M. Ziegelmeir, The Politics of High-Speed Rail: Understanding the Role of Intellectual Property Rights and Technology Standards for China's Overseas Rail Investments (2020); J. C. Byrnes, Is This Belt One Size Fits All? China's Belt and Road Initiative (2020) 8 *Penn State Journal of Law & International Affairs* 723.

[73] K. Iwasaki, Covid-19 Brings New Developments in China's Digital Silk Road (October 2020) 3:9 *Japan Research Institute Research Journal* 1–12.

possibly setting up BRI-based institutions for international joint development of technical standards) to the inability of Chinese – or, generally, developing and transition economy countries' – technical experts to get a fair hearing with the IEC. We therefore postpone discussion of this issue to Section 15.6.3.

6. IEC RESILIENCE AND THE GLOBAL SOUTH: ECONOMIC GLOBALIZATION, INTERNATIONAL POLITICS, AND TRANSNATIONAL REGULATION

6.1. A Growing Yet Still Marginal Role for Most Stakeholders from the Global South

From the beginning, participants in IEC standard-setting have paid their own way, which created a bias in favor of commercially successful stakeholders from rich countries. By the time World War I put the IEC on hold (eight years after it had been founded in 1906), the IEC had member bodies from only seventeen countries. Most of them were European: Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Russia, Spain, Sweden, Switzerland, and the United Kingdom. Canada and United States also were among the founding members. Argentina (at the time one of the richest, most technologically advanced countries) and the quickly rising Japan were the only countries beyond the Northern transatlantic area to have national electrotechnical societies that joined the IEC before World War I.

In the beginning, this exclusionary focus was generally overtly considered desirable – as it was expected to facilitate agreement through similarities in engineering expertise, professional norms, and general needs and interests in international standards.[74] And the IEC became only marginally more diverse during the interwar years, adding mostly further European members and only five member bodies from countries beyond Europe: Australia

[74] Assessment based on the founding documents and exchanges between IEC participants of the early meetings; see also C. Ainsworth, Standardization Abroad 35:12 (December 1964) *Magazine of Standards* 364–367; Büthe, *supra* note 2, at 301ff.; Yates and Murphy *supra* note 15, at 67–71.

(1927), India (1929), Egypt (1930), China (1936), and South Africa (1938). After the end of World War II, IEC membership continued to grow further but only at a very modest pace throughout the decades of the Cold War compared to other international and transnational organizations with a similarly universalist claim to global governance.[75] By the end of the Cold War in 1990, the IEC had grown to have member bodies from forty-four countries, including twenty non-OECD countries (eleven of them from the Global South).

The de facto role of stakeholders from non-OECD countries and especially the Global South in IEC-based global governance, however, remained more marginal as the membership roster might suggest: IEC National Committees from the non- OECD countries generally held participating membership in only a few IEC Technical Committees and Subcommittees; their actual participation in the process of developing new IEC standards was even rarer; and secretariats and chair positions were virtually all held by the technologically most advanced countries with the largest domestic markets (Sweden, Switzerland, and the Netherland were outliers as "small" countries regularly holding more than one of those positions).

The limited membership roster and the even more limited actual participation in standards development became a problem for the IEC in the post–Cold War period. It threatened the IEC's persistence as the focal institution for the global governance of electro-technology in the post–Cold War years for four reasons. (1) Intensified economic globalization in the 1990s integrated ever more countries of the Global South into truly global markets and value chains, from which they often ended up excluded or unable to reap the full benefits without adopting international standards (including IEC standards) domestically.[76] The WTO-

[75] It is noteworthy, not least in light of the reaction to Russia's invasion of Ukraine in 2022, that the fluctuating tensions of the Cold War appear to have had relatively little effect on the IEC. Russia itself, as well as Romania, Serbia, and Hungary, which had become members in 1911, 1927, 1936, and 1949, respectively, all retained their full membership throughout the Cold War (and Bulgaria even joined anew in 1958), although a review of the minutes of technical committee meetings shows that the active participation of non-USSR Eastern European technical experts notably declined when the USSR tightened its control over Eastern bloc countries in the 1950s.

[76] S. M. Stephenson, Standards, Conformity Assessment and Developing Countries, World Bank Policy Research Working Paper no. 1826 (May 1997); K. Maskus, O. Tsunehiro, and J. S. Wilson, The Cost of Compliance with Product Standards for Firms in Developing Countries, World Bank Policy Research Paper no. 3590 (May 2005); J. P. Singh, The Evolution of

enhanced role of IEC standards in governing market access gave many countries quite suddenly a much greater stake in IEC standards, leading them (and some observers) to make their marginalization in IEC governance an issue. (2) The explosive growth in preferential trade agreements (PTAs) in the 1990s, covering a growing range of issues, including regulatory issues and technical non-tariff barriers to trade,[77] created a risk for the IEC that standards other than IEC standards might get written into PTAs as the technical basis for trade integration – especially in the growing number of South- South PTAs – unless at least one and ideally both countries had a stake in ensuring the continued centrality of IEC standards.[78] (3) The shift from the bipolar to a multipolar international system reduced the willingness of many countries, especially in the Global South, to be deferential to a small group of Northern countries on issues such as market governance, all the more so in light of simultaneous widespread demands for more democratic participation, both domestically within many countries and in global governance.[79] This resulted in rising expectations that global governance bodies provide at least for "voice opportunities" for the Global South and arguably also influence over outcomes.[80] Global governance institutions that failed to live up to these expectations were increasingly subjected to legitimacy challenges.[81] (4) The economic and political transition

National Interest: New Issues and North-South Negotiations During the Uruguay Round, in *Negotiating Trade: Developing Countries in the WTO and NAFTA* (J. S. Odell ed., 2006), 41–84; J. Lee, G. Gereffi, and J. Beauvais, Global Value Chains and Agrifood Standards: Challenges and Possibilities for Smallholders in Developing Countries (December 13, 2010) *Proceedings of the US National Academcy of Sciences*, doi.org/10.1073/pnas.0913714108; T. Dietz et al., The Voluntary Coffee Standard Index (VOCSI) (August 2018) 150 *Ecological Economics* 72.

[77] A. Estevadeordal, K. Suominen, and R. Teh (eds.), *Regional Rules in the Global Trading System*. (2009); A. Dür and M. Elsig (eds.), *Trade Cooperation: The Purpose, Design and Effects of Preferential Trade Agreements* (2015).

[78] See R. Hartlem et al., Internationalization of Cable Standards: An Overview of the Variety of Methods and Motivations of Standards Developing Organizations around the World (1997) 17:11 *IEEE Power Engineering Review* 19–20; Büthe, *supra* note 9, 38ff.

[79] See, e.g., J. Steffek, C. Kissling, and P. Nanz (eds.), *Civil Society Participation in European and Global Governance: A Cure for the Democratic Deficit?* (2008); J. Tallberg, et al., *The Opening up of International Organization: Transnational Access in Global Governance* (2013); R. B. Stewart, Accountability, Participation, and the Problem of Disregard in Global Regulatory Governance (April 2014) 108:2 *American Journal of International Law* 211–270; A. Grigorescu, *Democratic International Organizations? Normative Pressures and Decision-Making Rules* (2015). See also R. W. Grant and R. O. Keohane, Accountability and Abuses of Power in World Politics (February 2005) 99:1 *American Political Science Review* 29–43.

[80] For a discussion of the difference, see Pauwelyn et al. and esp. DeMenno and Büthe, *supra* note 20.

[81] For a recent review of the literature, see A. Berman et al., Introduction: Rethinking Stakeholder Participation in Global Governance, in Pauwelyn et al., *supra* note 20, at 3–30.

after the end of the Cold War resulted in several countries becoming new major powers, especially China, India, and Brazil. Until the 1980s and in some areas even the 1990s, they had been "rule-takers" in global economic affairs; but from the 1990s or 2000s onward, they have increasingly demanded greater voice and real influence in the governance of the world economy.[82]

The IEC responded to these challenges with several initiatives to grow and diversify its membership, as well as some efforts to increase opportunities for substantively meaningful participation by countries from the Global South. IEC leaders worked with several Global South countries' electro-technical organizations to transform their informal relationships with the IEC into official associate (or even full) memberships. These efforts were complemented by the introduction of the Affiliate Country Program in 2001, through which developing countries can (to a limited but substantively meaningful extent) participate in IEC standard-setting without the financial burden of membership. In addition to gaining access to up to 200 standards documents free of charge (which they can then sell to interested users in their respective countries, providing them with resources they can use to strengthen domestic electro-technical standards bodies), the program gives participants access to IEC meetings and IEC trainings.

In some sense, these efforts have been tremendously successful. The IEC today has sixty-two full members plus twenty-six associate members (which pay lower fees in exchange for more limited participation rights) and eighty-six affiliate countries (which have certain voice opportunities but no voting rights).[83] The IEC member- ship has thus become much more global and diverse, enhancing its input legitimacy, at least formally. P-membership in the IEC Technical Committees and Subcommittees, too, has increased for many non-OECD countries, including countries from the Global South (see Figure 1).

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[82] For a review, see the introduction to the recent special issue of *Regulation & Governance* by Lavenex et al.,*supra* note 27.
[83] See IEC, National Committees, www.iec.ch/national-committees; and Affiliate Country Program, www.iec.ch/acp.

As Figure 1 shows, however, for most developing countries, the increase is very small, and most of the long-dominant larger OECD countries have actually increased their P-memberships to the same extent or even to a proportionally larger extent. A similar pattern emerges with regard to committee chairs and secretariats, as depicted in Figure 2 for the (more powerful) committee secretariats: Only four non-OECD countries hold any committee secretariats today. Russia, which used to hold one such secretariat in 2000, holds none anymore; the number of South Africa's secretariats has shrunk from two to one; and EU members Croatia and Poland each hold one (unchanged even when considering the longer twenty-year time span for which this data is available). The striking exception to this overall pattern is China, which has significantly increased both its P-memberships and the number of secretariats held (from five to twelve).

Complementary qualitative evidence supports this interpretation of the quantitative evidence summarized in the figures: with the exception of Chinese participants, experts from the Global South report in interviews that they are still facing challenges in participating in IEC standard-setting. Participants from affiliate countries, in particular, report insufficient advance awareness of IEC work to be able to make substantive contributions to the development or revision of standards, and several of them indicated that much more training and advance preparation would be needed for them to be able to understand how the IEC works as an SDO (despite the IEC offering some training opportunities on just these issues already).[84] Our evidence aligns with a recent internal survey conducted by the IEC.[85] Additionally, our data show that, since the introduction of the affiliate program, only 59 comments on standards proposals have been submitted by more than one hundred affiliate- participants over the period 2004–2020, during which thousands of IEC standards were developed or revised.

[84] Not-for-attribution telephone and online interviews, mostly conducted by Abdel Alshadafan, July 2020–January 2022.

[85] www.iec.ch/blog/affiliate-country-programme-survey-results. What we observe, moreover, matches the experience of developing countries in international standardization more generally, see P. C. Mavroidis and R. Wolfe, Private Standards and the WTO: Reclusive No More (January 2017) 16:1 *World Trade Review* 1.

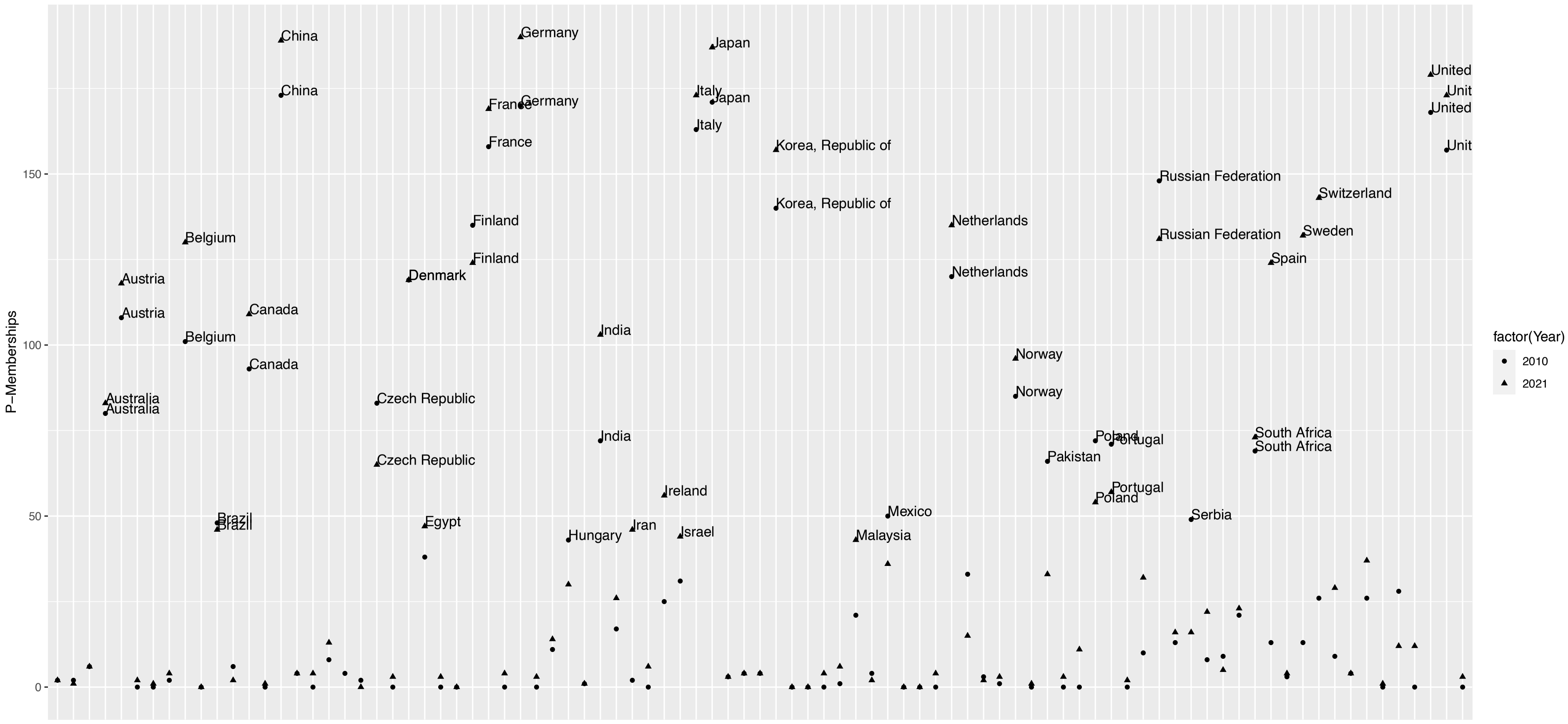

Figure 1. IEC P-Memberships 2021 vs. 2010.
Source: Authors' original work based on publicly available data from the IEC website October 2010 and January 2022

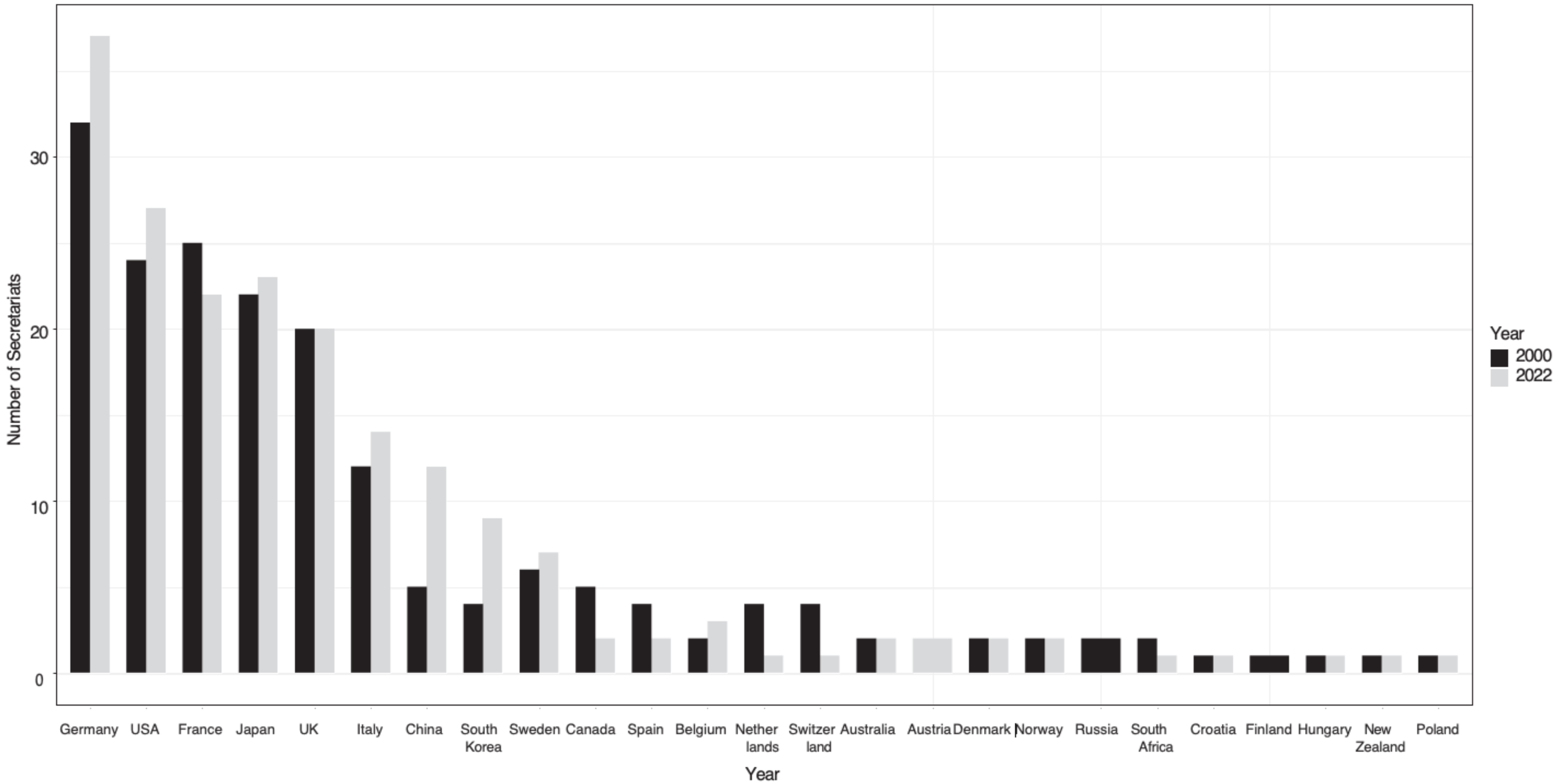

Figure 2. IEC TC Secretariats 2021 vs. 2000.
Source: Authors' original work based on publicly available data from the IEC for January 1, 2000 and January 1, 2022

6.2. The Rise of China as a Special Challenge for the IEC

Recent decades have not only seen a greater role of the Global South in the world economy. Distinctly – even when compared to the other "rising" BRICS powers – China has risen to the status of an economic superpower, demanding a greater voice and real influence in global economic governance, including in the governance of technology.

Communist/mainland China's standardization regime emerged in the early 1950s. Under strong influence from the Soviet Union, it was characterized by top- down state control and widely considered ineffective in supporting Chinese industrial and technological development.[86] Beginning in the 1980s and accelerating in the 1990s, China introduced a series of reforms, which made technical standards, including international standard-setting, a central element of China's national development policies, initially with the primary aim of reducing dependence on foreign technologies and the respective intellectual property rights.[87] These reforms included massive state funding to boost engineering education, structural changes in the Chinese domestic standards developing institutions, specialized training courses for technical standards development, as well as numerous incentives to encourage Chinese stakeholders to increase their participation at the international level, resulting in increased Chinese presence across a broad range of inter- and transnational SDOs.[88]

Having superseded the United States as the largest patent applicant in the world, China is now capable of developing domestically sophisticated alternative technical standards to

[86] W. Ping, W. Yiyi, and J. Hill, Standardization Strategy of China, Achievements and Challenges, 2010, EAST-WEST Center Working Paper no. 107 (January 2010); R. Suttmeier and C. A. O. Cong, China's Technical Community: Market Reforms and the Changing Policy Cultures of Science, in *Chinese Intellectuals Between State and Market* (M. Goldman and E. Gu eds., 2004), 138–157; Y. Zhou, and X. Liu, Evolution of Chinese State Policies on Innovation, in *China as an Innovation Nation* (Y. Zhou et al. eds., 2016), 33–67.

[87] M. Murphree and D. Breznitz, Innovation in China: Fragmentation, Structured Uncertainty and Technology Standards (2013) *Cardozo Law Review De Novo* 196.

[88] D. Breznitz and M. Murphree, The Rise of China in Technology Standards: New Norms in Old Institutions. Research Report Prepared on Behalf of the U.S.-China Economic and Security Review Commission (2013); M. C. Gamito, From Private Regulation to Power Politics: The Rise of China in AI Private Governance Through Standardisation (2021), https://ssrn.com/abstract=3794761; S. Hoffmann, D. Lazanski, and E. Taylor, Standardising the Splinternet: How China's Technical Standards Could Fragment the Internet (2020) 5(2) *Journal of Cyber Policy* 239.

many international ones. This can already be observed in its pursuit to establish, among other others, a homemade satellite navigation system (as an alternative to GPS) and a Cross-Border Interbank Payment System (as an alternative to SWIFT).[89] These developments have posed a major challenge to the IEC as the focal institution for electro-technical standard-setting, for at least three reasons. First, China internationalizing its technical standards outside the IEC's institutional framework directly undermines the IEC preeminence and status as the focal institution for electro-technical standard-setting. Second, China has occasionally hinted at establishing competing international bodies to allow stakeholders that are traditionally marginalized at the IEC to have better representation. This might prompt such stakeholders to leave the IEC to join the China-led institutions. Finally, China- centered competing institutions threaten established powers' ability to keep tabs on newly developed standards and technologies. This is important, not least because they are particularly skeptical of Chinese activity in the area of digitalization and data protection.[90]

6.3. IEC Responses to the Rise of China

China has repeatedly emphasized that it has no desire to overthrow the current standardization regime and that it only seeks to ensure that its interests are taken into account similarly to those of the other major, technologically most advanced countries.[91] The IEC's response has taken these Chinese assurances seriously and has attempted to accommodate China to a greater extent, so as to give it a greater stake in the continued functioning and preeminence of the IEC – in sense of what we have defined as resilience in the introduction.

Concretely, the IEC has facilitated China becoming one of the most active and prominent member countries. Since 2011, China has been recognized as one of the leading

[89] N. Godehardt, *Wie China Weltpolitik Formt: Die Logik von Pekings Außenpolitik unter Xi Jinping* (2020).

[90] B. Bartsch and A. Laudien, *Survey: Europe's View of China and the US-Chinese Conflict* (2020).

[91] Y. Kuang, China in Global Technology Governance: Experimentation, Achievements, and Uncertainties, in *China: Champion of (Which) Globalisation?* (2018), 81–100.

members, entitled to an automatically appointed seat on the SMB and the other IEC decision-making bodies. China also holds two IEC “ambassador” positions (responsible for representing the IEC interest in IoT and cyber security). And in 2019, the IEC elected Yinbiao Shu, chairman of one of China’s five largest state-owned electricity generation enterprises, as its next president; his three-year term started on January 1, 2020.

Already a P-Member of most TCs, China has increased its formal participation even further with P-memberships in now 90 percent of the IEC TCs. At least as importantly, the volume and quality of Chinese delegates’ contributions to the technical discussions at the committee and working group level has notably increased. China has also substantially increased the number of TC secretariats held by its delegates. Working with some of the traditionally leading member bodies (especially Germany’s DIN/DKE), IEC has also attempted to address what are widely seen as key reasons for Chinese experts’ arguably often limited success in IEC committees, including language skills and lack of understanding the norms and procedures of IEC committee work.[92] Interviews with a former secretary general (CEO) of the IEC confirmed that these changes were a conscious response to the rise of China, seeking to elevate its status in the IEC in accordance with its increased status in the world economy.

[92] An interviewee highlighted, for instance, incidents whereby Chinese delegates attempted to push their position by asking high level IEC decision-makers to intervene. This created concerns within the IEC, that such behavior might trigger clashes with other member countries. The IEC offered special training sessions to familiarize some Chinese nationals with the relevant internal procedures and practices and explain that without the approval of the other member countries (achieved via negotiating, compromising, lobbying), China’s proposals would not be successful. Regarding the China-Germany link, see D. Fuchs and S. Eaton, Diffusion of Practice: The Curious Case of the Sino-German Technical Standardization Partnership (2022) 27:6 *New Political Economy* 958-971.

7. UNRESOLVED CHALLENGES

7.1. Democratic versus Expertise-Based Legitimacy: The Rise and Resurgence of the Consumer Movement

The IEC has always maintained that it welcomes the input and seeks balanced participation from all who have a legitimate stake in the development of electrotechnology.[93] The IEC Code of Conduct for Technical Work also requires the national member bodies to represent all interests at the national levels. In practice, however, stakeholder representation has been (with rare exceptions) limited to technical experts whose participation is funded by private sector employers with an immediate commercial stake in the issue at hand.

This predominance of private sector experts is consistent with the IEC's reliance, from the start, on the expertise-based authority of the IEC, its national member bodies, and the individual participants in its technical committees for the legitimacy of IEC governance.[94] The IEC's expertise-based authority has in recent decades been supplemented by delegated authority, especially since WTO member states designated ISO and IEC standards (in the WTO's TBT-Agreement) as a way to achieve legitimate public policy objectives without setting up unnecessary technical barriers to trade through divergent national standards.[95] The consumer movement, however, increasingly calls into question the IEC's reliance on little more than expertise-based and delegated authority.

The IEC started to develop standards specifically for consumer products – and explicitly acknowledged consumer safety and welfare as objectives of IEC regulatory governance – starting with the lamp socket standards it developed in the 1920s.[96] But the question of whether consumers needed to be incorporated into the standard- setting process to safeguard the IEC's

[93] Yates and Murphy, *supra*, note 15, at 73.
[94] Avant et al., *supra* note 20, esp. 12ff.; Büthe, *supra* note 2, at 296, 302ff., 305.
[95] Büthe, *supra* note 2, at 304ff.
[96] A. Raeburn, IEC Technical Committee Creation: The First Half-Century (1906–1949), www.iec.ch/history/first-50-years.

centrality and legitimacy was only brought to the fore by the rise of the consumer movement in the late 1960s and the 1970s,[97] as well as the broader shift toward post-materialist values across most advanced capitalist democracies.[98] To be sure, consumer interests are far from assured voice or influence over policy – even in democratic political systems,[99] which might be due to organized opposition from producer interests[100] or difficulties in discerning consumer preferences.[101] Research on the political consequences of post-materialism also yields mixed findings regarding the relationship between post-materialism and political consumerism or, more generally, willingness and forms of political participation. Yet the dearth of consumer representation (and more generally the representation of noncommercial interests) in IEC technology governance[102] has consequences for the contents of IEC standards and increasingly has come to be seen as a threat to the IEC's legitimacy.[103]

In response, IEC (and ISO) in 2019 created the ISO/IEC Guide 59, which mirrored the "Six Principles for the Development of International Standards, Guides and Recommendations," articulated in 2000 by the WTO TBT Committee as part of its Code of Good Practice: transparency, openness, impartiality and consensus, relevance and effectiveness, coherence, and ensuring de facto opportunities for participation by stakeholders

[97] L. Cohen, *A Consumers' Republic: The Politics of Mass Consumption in Postwar America* (2003); M. Hilton, Social Activism in an Age of Consumption: The Organized Consumer Movement (May 2007) 32:2 *Social History* 121.

[98] See, e.g., R. Inglehart, *The Silent Revolution: Changing Values and Political Styles among Western Publics* (1977); and *Culture Shift in Advanced Industrialized Society* (1990); R. Inglehart and C. Welzel, *Modernization, Cultural Change and Democracy* (2005).

[99] T. Betz and A. Pond. The Absence of Consumer Interests in Trade Policy (April 2019): 81:2*Journal of Politics* 585. Regarding voice and influence in global governance more generally, see M. DeMenno and T. Büthe, Voice and Influence in Global Governance: An Analytical Framework in *Rethinking Participation* (J. Pauwelyn et al. eds., 2022).

[100] See, e.g., S. Eckert, *Corporate Power and Regulation: Consumers and the Environment in the European Union* (2019).

[101] D. Vogel, When Consumers Oppose Consumer Protection: The Politics of Regulatory Backlash (October–December 1990) 10:4 *Journal of Public Policy* 449.

[102] B. Farquhar, Consumer Representation in International Standards (January/February 2006) 16:1 *Consumer Policy Review* 26; C. Hauert, Where Are You? Consumers' Associations in Standardization (2010) 8:1 *International Journal of IT Standards and Standardization Research* 11.

[103] Alshadafan, *supra* note 2.

from developing countries.[104] ISO/ IEC Guide 76:2020 also calls for taking consumers' inputs in consideration in developing service standards.[105]

To implement the Guides, the IEC sought to facilitate noncommercial stake- holders' participation in standard-setting, for instance, by allowing "liaison organizations" participation (differentiating between three types with different participation rights).[106] Moreover, the IEC has increased its use of digital tools to boost participation. Beginning in 2001 already, it required all comments to be submitted online and started to introduce electronic voting on technical work. More recently, the IEC introduced to its website a tool to allow the public to submit comments online, and it has continued to increase opportunities for remote access to documents and standard-setting activities – including through the "online authoring tool," introduced to enable participants to work on a given document simultaneously. All of these steps aim to lower the costs of participation (which had been frequently noted as an important impediment for noncommercial stakeholders).

Regrettably, however, the limited publicly available information – as well as interviews with IEC insiders with access to performance data for the IEC-internal systems – suggest that all of these efforts have yielded little actual participation by consumers so far. The public commenting tool, for instance, has registered a small number of records only.

[104] See www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm; also P. Delimatsis, Global Standard-Setting 2.0: How the WTO Spotlights ISO and Impacts the Transnational Standard- Setting Process (2018) 28 *Duke Journal of Comparative and International Law* 273, at 311.

[105] www.iso.org/obp/ui/#iso:std:iso-iec:guide:76:ed-2:v1:en

[106] www.iec.ch/global-partnerships

7.2. Gender Equality in IEC Standard-Setting

The IEC has also been repeatedly criticized for the lack of women participants in its work.[107] Recently, the IEC admitted the existence of the problem, having examined it through an internal survey.[108]

The IEC has, so far, responded to this, above all, by promising to take corrective action. It also joined the United Nations Economic Commission for Europe, supposedly to ensure representation of women in TCs. Additionally, the IEC has partnered with the ISO under the stewardship of the Joint Strategic Advisory Group to develop guidance to help TCs ensure they are developing gender-responsive standards. These efforts, however, have only recently begun, and it remains to be seen whether they are effective, given the continued strong gender imbalance in most engineering fields.

8. CONCLUSION: LEARNING RESILIENCE?

Over the course of its 115-year history, the IEC has exhibited remarkable resilience in the face of numerous and diverse challenges to its preeminence – challenges that have arisen from technological change, the emergence of alternative institutions for developing electrical and electronics standards, and geopolitical upheavals and related power shifts in the world economy, including two world wars, decolonization, the end of the Cold War and the arrival of new, rising powers in the world economy. In this chapter, we have provided a sketch of this resilience and examined its drivers (as well as its limitations).

We started by identifying (in Section 15.2) four essential attributes of the IEC, which, we suggested, would have to remain intact in the face of otherwise extraordinary adaptability

[107] See, e.g., M. Parkouda, *When One Size Does Not Protect All: Understanding Why Gender Matters for Standardization* (2020); P. Heß, SDG 5 and the Gender Gap in Standardization: Empirical Evidence from Germany (2020) 12:20 *Sustainability* art.8699. For compelling examples of the – likely unconscious yet consequential – biases that result from such under-representation, see T. Betz, D. Fortunato, D. Z. O'Brien, Women's Descriptive Representation and Gendered Import Tax Discrimination (2021) 115:1 *American Political Science Review* 307–315.

[108] www.iec.ch/blog/disappointing-results-gender-survey-technical-committees.

to head off challenges to its predominance and legitimacy, if we are to consider the IEC's continued existence indicative of genuine resilience. We then sketched a theory of resilience, extending Büthe's proto-theory of organizational preeminence in light of Delimatsis' analytical framework for this book. The empirical account of IEC resilience in light of a variety of challenges that it has encountered over the course of more than a century show time and again the central importance of the IEC's autonomous agency in pursuit of its organizational self-interest – while largely maintaining the inclusive, participatory governance structures and procedures on which its legitimacy is in large part based.

At the same time, the IEC cannot be said to have (yet) successfully addressed all challenges to its preeminence, raising questions about the extent to which resilience can be "learned." To be sure, some changes made by the IEC in response to earlier challenges, such as its creation of the Standards Management Board (originally set up in the 1920s as the Committee on Action to coordinate the work of its then-fifteen Technical Committees), have lastingly enhanced its ability to combine autonomous agency with legitimacy-enhancing embeddedness of the IEC leadership in the community of member bodies. Yet the ultimate test of resilience arises from having to respond to shocks that are different from prior ones, necessarily limiting the extent to which past resilience might predict future resilience.

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Chapter 6 – Dissertation Conclusion

As I discuss the findings and conclusions of the three individual studies in the respective chapters, the purpose of this chapter is to present a holistic discussion of findings and themes in light of the overarching research question. In addition, I highlight some limitations, practical recommendations and avenues for future research.

1. SUMMARY AND MAIN FINDINGS

In line with other scholars, this dissertation set out with the premise that we are confronted with a challenge in our global governance system. Specifically, the global economy depends time and again on rules that are largely orchestrated by a group of western/industrial-dominated Global Governance Organizations (GGOs) characterized by democracy and legitimacy deficiencies. While this challenge continues to be an unresolved issue, I posit that two recent developments might bring change to, among others, the power structure of the global governance system, introducing vagueness in our understanding of the already persistent challenge.

First, as an attempt to tackle deficiencies associated with their rule-making processes, some GGOs, including those developing technical standards, have carried out various opening up measures to improve, among others, their inclusiveness (Jönsson & Sommerer, 2013; Pauwelyn et al., 2022; Tallberg et al., 2014). Second, we are witnessing shifts in the global economic power toward the developing world, as well as a rise of China as a global power (Higgins & Richards, 2019; Horner et al., 2018; Langford, 2019). It is fair to expect these two episodes to ultimately impact the power structure of GGOs, and challenge the resilience of these organizations.

A review of the literature showed that we have little (empirical) knowledge about which and how countries/stakeholders participate in global governance, especially in the wake of the above two developments. I aimed to contribute to filling this gap by scrutinizing participation in an area that has to date, received limited attention, namely international technical standard-setting. Particularly, this dissertation leveraged the case of the International Electrotechnical Commission (IEC) as a means to study the broader phenomenon of participation in global governance.

By and large, this dissertation shows that the participation of countries/stakeholders in international technical standard-setting continues to involve traditional power-bargaining dynamics. In line with recent studies suggesting that participation in global governance is primarily a country-level decision (for example, see Lavenex et al., 2021), the findings show that participation in international technical SDOs is largely driven by country-level economic and relevant industrial capabilities. This might also suggest that SDOs bear only part of the responsibility for the participation imbalance among their member countries.

In addition, the opening up of SDOs did not benefit presumably originally targeted countries and stakeholders. There is scant evidence to suggest that the opening up measures increased the (qualitative) participation of stakeholders with relatively less economic and industrial capabilities. That is not to say that the opening up movement was not fruitful at all, but that its positive effect should not be overestimated, especially for stakeholders from the developing world.

Meanwhile, the recent shifts in global economic power have been largely reflected in the internal power structures of technical SDOs. In other words, the growth in economic and industrial capabilities of some countries led to pressures to render SDOs' decision-making more representative, albeit mostly of perspectives from those recognized by the literature as emerging economies. This has been most prominent in the case of China. As emerging economies gain more power in SDOs, we should expect to witness an emergence of new actors in shaping future technology markets as well as products.

In combination with the SDOs' pursuit of their organizational self-interest—including their powerful countries/stakeholders—the above developments might ultimately lead to strengthening or at least maintaining SDOs' influential role in the global governance system. The findings of this research suggest that—at least major—international SDOs are exhibiting resilience in the face of a variety of challenges. Consequently, we should expect a growing role of various GGOs not only at the international but also—ultimately—at the national levels.

Chapter 2 highlighted several deficiencies with respect to the application of the Good Standardization frameworks by the participating stakeholders in the process of setting an international standard for measuring the energy efficiency of the Television. Importantly, evidence collected from the interviews with the participating actors and analysis of relevant documents and records shows an underrepresentation of the non-commercial interests and low transparency about the basis for the technical assumptions made in the international standard. In addition to these deficiencies in the input legitimacy of the standard-setting process, the resultant standard was inadequate in achieving its intended objective (i.e., reducing the energy consumption of TVs), hindering the output legitimacy of the process. In sum, the IEC's overarching technocratic framework is shaping its internal politics and participation rules, leading to challenges to the SDO's legitimacy as a democratic and representative GGO.

Chapter 3 sought to achieve two main objectives: the first is to assess the effect of the opening up measures taken by the IEC to improve the participation of developing countries in its work, and the second is to achieve a better understanding of what could explain the variation in member countries' participation in the IEC. For that, a large amount of (IEC-internal) cross-national participation data were empirically analyzed. For the first objective of the chapter, the participation of IEC member countries was analyzed through almost all of the participation mechanisms offered by the SDO with an aim to examine a potential increase in participation, as suggested by theory. For the second objective, a regression analysis was carried out to examine the theoretical expectations of positive correlations between two country-level variables, namely economic power and the relevant industrial capability, and the likelihood of participation in SDOs. The findings of this chapter suggest that the IEC opening up measures have been, at best, only slightly effective in achieving their objectives. If these measures had any effect, they benefited member countries experiencing growing economic and industrial capabilities and contributed to strengthening the IEC by increasing the number of its member countries and the diffusion of its standards globally.

Chapter 4 sought to examine whether and how China exerts power in the IEC and then assess the likelihood of it acting in a disruptive manner in the organization. For that, I analyzed China's status and participation in the IEC through a number of participation mechanisms and assessed the likelihood of disruptive behavior by China in each of the mechanisms taking into account the IEC's internal governance rules and structure. The analysis was based on two decades of (internal) IEC data that include numerous participation records for IEC member countries, qualitative evidence from six interviews and data retrieved from other public sources. The analysis shows that China has been increasingly exerting power in the IEC through effective utilization of all of the participation mechanisms analyzed, securing high potential influence in the organization. Such utilization, meanwhile, was less in mechanisms requiring relatively greater technical capabilities. Despite the substantial increase in China's participation in the IEC, the organization remains largely dominated by powerful Western member countries and Japan. Such participation, combined with the level playing field maintained by the IEC rules, reduces China's chances of behaving in a disruptive manner in the short run. That said, China can still act disruptively in the IEC, especially if its voice gains sufficient support from other (powerful) member countries. Finally, we should expect future electro-technologies to be increasingly shaped by China's (technical) preferences.

In Chapter 5, the lead author of it and I analyzed the IEC's resilience against a variety of challenges and identified four essential IEC attributes that arguably would have to remain intact in the face of otherwise extraordinary adaptability to head off challenges to the SDO's preeminence and legitimacy.[1] For that, we employed an original theoretical framework that emphasizes the IEC's capacity and capability for autonomous pursuit of the organization's institutional self-interest, its embeddedness among stakeholders and the skill and ambition of the organization's leadership. The empirical account of the IEC's resilience shows the central importance of the IEC's autonomous agency in pursuit of its organizational self-interest—while largely maintaining the inclusive, participatory governance structures and procedures on which its legitimacy is in large part based. Through the challenges, the IEC exhibited adaptability while keeping its essential, defining attributes intact. Finally, we highlighted several unresolved challenges, such as gender inequality in IEC standard-setting. Therefore, the IEC cannot be said to have (yet) successfully addressed all challenges to its preeminence.

2. CONTRIBUTIONS

Beyond the above findings, this dissertation pushes the global governance literature forward in several ways. Taken together, the four studies in this dissertation brought novel empirical evidence on participation in international technical SDOs and GGOs more broadly. Based on the following insights, the dissertation engages in theory-building.

By providing empirical evidence on the implementation of the noble principles of Good Standardization in a prominent international SDO, Chapter 2 takes an important step toward bringing theories about international standard-setting practices closer to reality (in line with

[1] First, the IEC is an institutional focal point for global electrotechnology governance. Second, the IEC's maintenance of internationally broad-based input legitimacy for its role as a global governor through inclusiveness toward all legitimate stakeholders based on a structure of nominally equal national representation. Third, the IEC's status as a nongovernmental (and therefore transnational) organization. Such status has numerous important consequences. Fourth, the IEC's ability to balance between decentralized, bottom-up agenda-setting and decision-making, on the one hand, and centralized coordination and oversight, on the other, to ensure coherence and consistency as well as maintain the IEC's ability to act in pursuit of its organizational self-interest.

what has been previously done, for example, see Delimatsis, 2018; Forsberg, 2012; Kanevskaia, 2020). The empirical evidence collected is considered both scarce and important knowledge in the literature, not least because it helps us better understand the complexity behind the committees' work. In so doing, the dissertation contributes to the limited body of research seeking to address the problem of experts' authority in SDOs. Specifically, SDOs and National Committees should be more critical of the inputs submitted by the external experts at the Working Group level. Additionally, the findings of Chapter 2 advance our understanding of the legitimacy of the standard-setting process by highlighting that deficiencies in input legitimacy might hinder the output legitimacy.

Besides laying a cross-national participation map in a major international technical SDO over the past two decades, Chapter 3 elucidated the factors that derive this participation. Particularly, the chapter reframes the relationship between country-level power and participation in international technical standard-setting by providing a framework that fully appreciates the effect of the industrial-specific capability. For instance, by knowing more about the national origin of the participating stakeholders, we can now make better predictions about their participation in international standard-setting. This dissertation thus also contributes to the growing body of research on the opening up of GGOs by shedding light on the evolution of SDOs (Pauwelyn et al., 2022), especially in terms of how democratic and representative they have become after the claimed opening up. Relatedly, with regard to the North-South imbalance in GGOs, the findings of Chapter 3 suggest that the imbalance largely continues to exist but with the entrance of a few emerging economies.

The analysis of Chapter 4 contributes to several debates, above all, those seeking to predict the implications of the emerging economies' ascent into global governance (for example, see Frick, 2021; Hopewell, 2021; Kastner et al., 2020; Kennedy, 2018; Križić, 2021; Weiss & Wallace, 2021). In so doing, this research takes an additional step toward addressing the debate of whether the overall system is going toward convergence or fragmentation. Relatedly, the evidence suggests that a small group of traditionally passive actors is becoming rapidly more active in international standard-setting; nevertheless, their growing participation will probably not fragment the system. This dissertation provides empirical evidence on these new entrants' behavior in SDOs, focusing on the most prominent emerging economy, namely China. Among other findings, Chapter 4 shows that China should no longer be viewed as a rising power in international technical standard-setting but as one of the most active actors in this realm.

Chapter 5 advances our understanding of GGO's resilience—including its possible limits—against a variety of challenges. Specifically, conceptualizing resilience as perseverance through adaptability requires identifying ex-ante the essential attributes of the potentially resilient GGO. Otherwise, we risk mistaking for resilience what is really just nominal persistence without real continuation of the defining characteristics due to the organization's excessive willingness to adapt to changing circumstances. In addition, while GGOs generally exhibit resilience against challenges, the ultimate test of resilience arises from having to respond to future shocks that are different from prior ones. The unresolved challenges highlighted in the chapter suggest that past resilience is only partially predictive of future resilience. Finally, and by analyzing the evolving nature of participation in the IEC, this chapter provides lessons for stakeholders participating in or affected by international standard-setting. For instance, SDOs seem to be positively responsive to their actors' demands as long as these demands are in the interest of the organization and its leading stakeholders/countries.

Methodologically, the use of mixed methods and the triangulation of quantitative and qualitative evidence could offer the field new tools to be utilized as a basis for similar research in other studies and regulatory issue areas.

This dissertation also contributes to studies examining the extent to which the opening up measures are actually implemented in SDOs' internal operations (see few recent studies, Delimatsis, 2018; Forsberg, 2012; Kanevskaia, 2020; Pauwelyn et al., 2022), ultimately helping to find mechanisms to increase the diversity of the participating stakeholders. For instance, while introducing various digital tools in IEC standard-setting—aimed at boosting participation—has slightly increased members' quantitative participation, such tools cannot be considered as stimulus for participation. These findings also have implications for the debate surrounding the legitimacy of international SDOs (Bernstein & Cashore, 2007; Hahn & Weidtmann, 2016; Palazzo & Scherer, 2008; Ponte et al., 2011). The dissertation, therefore, takes an additional step toward answering the question of how SDOs can be institutionally designed to enhance the legitimacy of their decision-making processes.

Finally, this research offers an in-depth description of patterns of countries' participation in international standard-setting over a period of two decades. Note that the participation dynamics observed could also exist in other SDOs similar to the IEC, such as the International Organization for Standardization and the International Telecommunication Union.

3. LIMITATIONS AND WEAKNESSES

Several limitations and weaknesses of this dissertation are worth noting. First, this research is generally aimed at generating largely descriptive and practical insights about (the legitimacy of international standard-setting. In so doing, the dissertation does not revisit or improve the conceptual frameworks of legitimacy. This was partly due to the lack of methods for assessing the legitimacy of international standard-setting.

The second limitation of this research relates to the datasets utilized for chapters 3 and 4. While voting can be considered an important form of participation, the former does not necessarily lead to influence. Interview evidence suggests that many NCs vote just to fulfill the IEC obligation to participate. This raises doubts about the significance of voting as a meaningful form of participation.

Finally, given the narrow scope of the dissertation's empirical focus (i.e., an individual SDO), the generalizability of the findings might suffer. The findings can apply to major international SDOs similar to the IEC, such as the ISO, as these organizations share many international governance procedures and practices. At the same time, and given the differences between the IEC and other GGOs, assuming that the findings can automatically apply to other GGOs is challenging. Nevertheless, this research has contributed valuably to our understanding of contemporary GGOs.

4. AVENUES FOR FUTURE RESEARCH

The dissertation offers interesting avenues for further research. First, future research could examine stakeholders' participation in other regulatory issue areas. This would be helpful in, among others, observing whether the same dynamics found in the IEC are present in other GGOs. Second, whether an inclusive approach contributes to developing more effective international standards than one dominated by certain interests (i.e., the commercial) would be a valuable hypothesis to test. Finally, in order to depict a more nuanced picture of the participation of emerging economies in global governance, future studies could examine the participation of countries other than China, such as India.

5. PRACTICAL IMPLICATIONS

The findings of this dissertation suggest that the process of setting IEC standards can be improved to enhance compliance with the Good Standardization principles.

First, the IEC can enhance its transparency toward stakeholders by relaxing access rules to documents related to standard-setting. The IEC procedure for accessing internal records, even by the members themselves, is one sign of its strict access rules. Also, the IEC could be more transparent about the discussions and decisions made at the Working Group level.

Second, the IEC could allow stakeholders without full memberships to participate in more standard-setting activities than they currently can. This should improve the IEC's legitimacy and probably accountability, ideally without jeopardizing the economic interests and technical confidentialities. Evidence from interviews suggests that IEC members with observer status wish to patriciate in more activities than they currently could.

Third, the IEC should put in place stricter rules for how members can enhance their influence in its standard-setting using mechanisms beyond those currently offered by the IEC. Interview evidence suggests that China is aiming to increase its influence in the IEC through "unfair" tactics. Also, industry players seem to be able to secure the votes of member countries where they have a presence.

Finally, improving participation in standard-setting requires, among others, increasing the awareness of the impact of international technical standards on other stakeholders beyond the industry. More efforts by the IEC can be devoted to increasing such awareness globally. For instance, the IEC could find ways to present the content of the standards in a material that is more accessible to non-expert stakeholders.

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Appendices

APPENDIX A – FURTHER DETAILS ABOUT THE INTERVIEWS FOR CHAPTER 2

In the table below, I present brief biographical profiles of the interview subjects and further details about the interviews.

No.	Bio of Interview Subject	Date	Duration	Method
1	Widely recognized as a leader in the display community with a number of inventions and awards. He served at the IEC as the principal architect of the TV energy measuring procedure in the IEC 62087:2008.	April 17, 2019	Two hours	Phone
2	He was the head of standardization at one of the major displays manufacturers. He served as the national committee for the U.S. and as a technical area manager at the TC100. He is known for, among other things, spearheading the IEC 62087. He was awarded with eighteen patents related to multimedia.	May 21, 2019	One hour	Phone
3	A senior standardization manager at one of the major displays manufacturers. He served as a senior member of multiple technical areas in TC100 as well as acted as an NC.	April 30, 2019	Two hours	Phone
4	A senior manager at a major telecommunications equipment manufacturer based in the US. He was involved in drafting various international standards and efficiency initiatives, including the European Code of Conduct on the energy efficiency of digital TV devices and the ENERGY STAR program. He acted as an NC at TC100.	April 25, 2019	One hour	Phone
5	A former engineering vice president at one of the main Plasma TVs manufacturers and acted as an NC at TC100.	May 8, 2019	One hour and 30 min.	Phone
6	An audio product engineer who is working at one of the major displays manufacturers. He acted as a project leader for the audio part of IEC 62087.	May 15, 2019	-	Email
7	A standardization manager who is working in one of the national standardization bodies that significantly shaped the IEC 62087.	April 23, 2019	-	Email
8	A standardization consultant at the Netherlands Standards Institute/ Netherlands Electrotechnical and a secretary for the Dutch mirror committee. He was also working with the Dutch consumer association Consumentbond.	Septembe r 23, 2019	Two hours	Phone
9	Director at the Royal Netherlands Standardization Institute and a National Secretary at the IEC.	January 31, 2020	Two hours	Personal
10	Senior standardization counsel at one of the major displays manufacturers and a member of the standardization management board at the IEC.	January 30, 2020	Two hours	Personal
11	An expert in home appliances' testing. ANEC also hired him for many years.	February 07, 2020	Two hours	Phone
12	Serves for Public Affairs & Media Relations at the Portuguese consumer association.	December 20, 2019	-	Email

APPENDIX B – FURTHER DETAILS ABOUT THE VARIABLES FOR THE ANALYSIS IN CHAPTER 3

Table 4 Additional Information on Sources and Definitions of Variables

Variable	Description	Source
NUMBER OF VOTES	A total of 551,733 votes submitted by IEC member countries over the period of January 2000 – August 2019.	Internal IEC database
GDP PER CAPITA	Gross domestic product divided by mid-year population. Values are in constant U.S. dollars (base year 2010).	World Development Indicators dataset. Economy and Growth Indicators. World Bank database.
EXPORT VOLUME	Represent the value of all goods—in this work restricted to products with HS 85—that are exported to the rest of the world. Values are in current U.S. dollars.	United Nation Comtrade Database
DEMOCRACY INDEX	"The participatory principle of democracy emphasizes active participation by citizens in all political processes, electoral and non-electoral. It is motivated by uneasiness about a bedrock practice of electoral democracy: delegating authority to representatives. Thus, direct rule by citizens is preferred, wherever practicable. This model of democracy thus takes suffrage for granted, emphasizing engagement in civil society organizations, direct democracy, and subnational elected bodies." (International Democracy Community, 2020)	Varities of Democracy Institute (V-Dem)
POPULATION SIZE	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.	World Development Indicators dataset. Climate Change Indicators. World Bank database.
Gross National Income Level (GNI)	Values are in U.S. dollars, converted from local currency using the World Bank Atlas method. Estimates of GNI are obtained from economists in World Bank country units; and the size of the population is estimated by World Bank demographers from a variety of sources, including the UN's biennial World Population Prospects.	World Development Indicators dataset. Economy and Growth Indicators. World Bank database.
OECD MEMBERSHIP	Data was collected from the website of the Organisation for Economic Co-operation and Development. OECD members are considered developed countries; otherwise developing.	OECD Website

APPENDIX C – FIGURES C1, C2 AND TABLE 3 FOR THE ANALYSIS IN CHAPTER 3

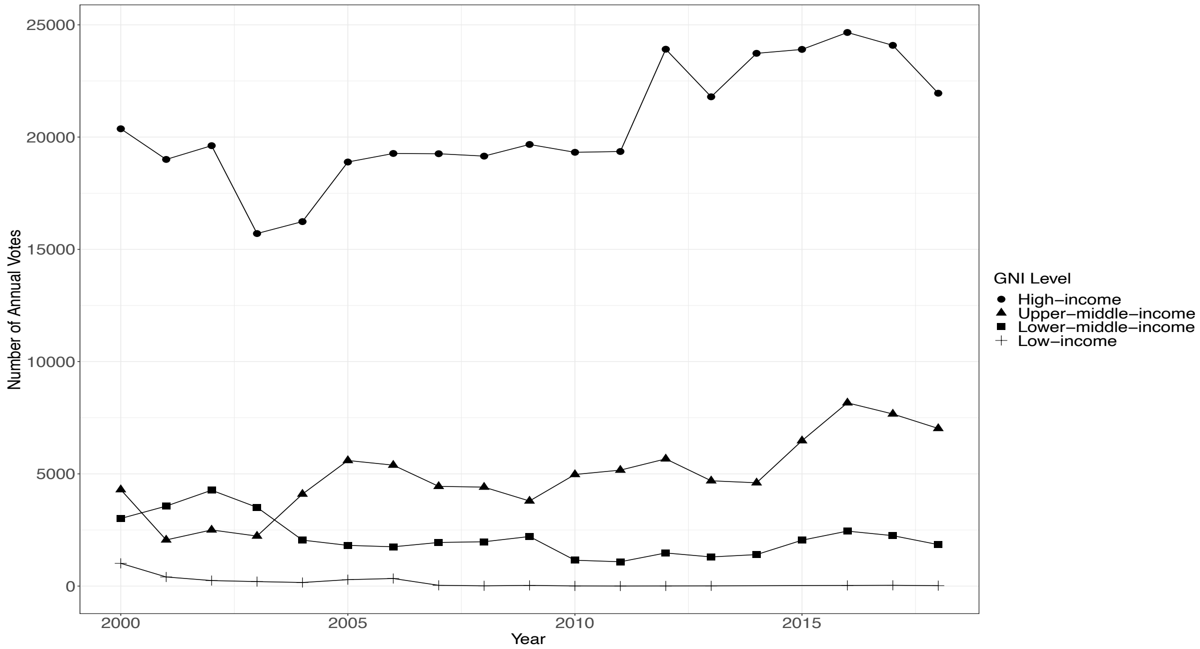

Figure C1 Change in Total Number of Annual Votes Submitted by Member Countries From Different GNI Levels Between 2000 – 2018

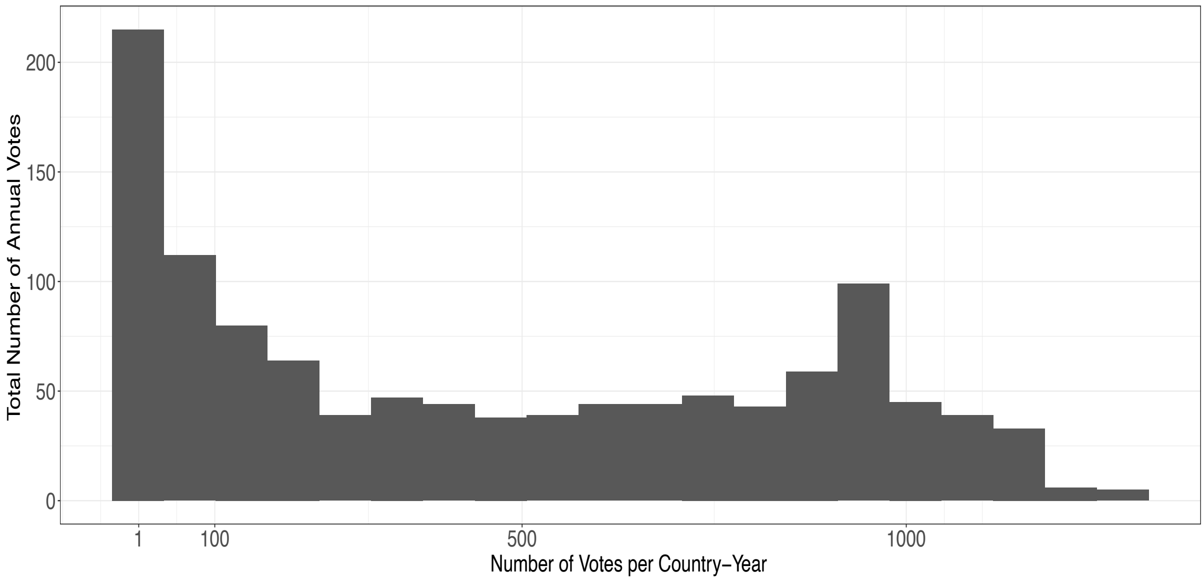

Figure C2 Histogram of Main Dependent Variable

Table 3 Variance Inflation Factor for the Variables Included in the Empirical Model

Variable	VIF Values
log GDP PER CAPITA	4.45
log EXPORT VOLUME	1.78
DEMOCRACY INDEX	1.56
log POPULATION SIZE	1.87
OECD MEMBERSHIP	3.58

APPENDIX D – FURTHER DETAILS ABOUT THE INTERVIEWS FOR THE ANALYSIS IN CHAPTER 4

In the table below, I present further Information about the interviews and the interviewees.

No.	Bio of Interviewees	Interview Method and Duration
1	Former high-ranking person in the IEC with several decades of experience in the industry and national and international standard-setting.	Virtual meeting on June, 14th 2021. One hour and thirty minutes.
2	Standard-setting expert with more than 15 years of experience in China's involvement in the ISO and IEC as well as China's cooperation with other parts of the world in standard-setting.	Virtual meeting on April, 14th 2021. One hour and thirty minutes.
3	High-ranking person in the IEC with several decades of experience in non-profit organizations.	Virtual meeting on April, 21st 2021. One hour and thirty minutes.
4	Former high-ranking person in China National Institute of Standards and Technology and an Advisory Research Fellow at a major Chinese University.	Virtual meeting on May, 12th 2021. One hour and thirty minutes.
5	Expert in China's standard-setting with several decades of experience in Conformity Assessment and Quality Management both in China and Europe.	Virtual meeting on May, 6th 2021. One hour.
6	Academic scholar with extensive experience in standard-setting in the USA and China.	Virtual meeting on April, 17th 2021. One hour.

APPENDIX E – CO-AUTHORSHIP STATEMENT FOR CHAPTER 5

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Erklärung zur Ko-Autorenschaft

für das Kapitel:
The International Electrotechnical Commission:
A 115-Year Journey of Challenges, Change, and Resilience

Das Kapitel "The International Electrotechnical Commission: A 115-Year Journey of Challenges, Change, and Resilience" ist in Ko-Autorenschaft entstanden. Es geht zurück auf eine Einladung von Prof. Dr. Panos Delimatsis an Tim Büthe, einen Aufsatz zu einem federführend von Prof. Delimatsis herausgegebenen Buch beizutragen. Aufgrund der großen Nähe zwischen dem vom Herausgeber erwünschten thematischen Fokus und dem thematischen Schwerpunkt von Abdel Alshadafans Dissertation (sowie seiner fachlichen Expertise) hat Tim Büthe vorgeschlagen, dies Kapitel gemeinsam zu verfassen. Dabei hat sich die folgende Arbeitsteilung entwickelt:

Konzeptionalisierung (conception of the work): Erstentwurf Abdel Alshadafan; Ausarbeitung/Weiterentwicklung: Tim Büthe und Abdel Alshdafan; insgesamt: 50-50

Sammlung neuer Daten (original data collection): 70% Abdel Alshadafan; 30% Tim Büthe

Datenanalyse und Interpretation (data analysis and interpretation): in gleichen Teilen; zunächst primär Abdel Alshadafan; dann primär Tim Büthe; insgesamt: 50-50

Verschriftlichung, Erstentwurf (first draft, writing): Abdel Alshadafan (federführend, ca.70%) mit erheblichem Input von Tim Büthe (ca. 30%)

Revision (Revisions): Tim Büthe (70%) mit erhelblichem Input von Abdel Alshadafan (30%)

Finaler Review und Approval der endgültigen Version (Druckfahnen): Abdel Alshadafan (70%) und Tim Büthe (30%)

München und Berlin, im März 2023,

Abdelfattah Alshadafan

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