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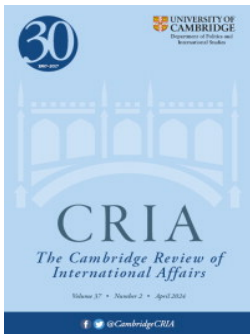
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Nuclear regime complex and state relations in nuclear ordering

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Abstract *There is a growing number of institutional structures in the nuclear field—at present, there are 35 various agreements with over 200 participants in them. This paper explores how growing regime complexity in the nuclear order links to the changing relations among states. How does the growing nuclear regime complex influence the relations? In this paper, I use a comprehensive dataset of agreements in the nuclear regime complex. By using social network analysis, I study the changing relations among states. The analysis leads to three results. Firstly, the regime has grown in terms of both participating states and agreements, and this growth is not driven by a small number of agreements with a large number of participants. Secondly, the interactions among states are becoming more common and frequent, also outside the main treaties. This has a potential to create efficiencies, but also creates opportunities for forum shopping and contestation. Thirdly, the regime complexity has led to a segmentation of both states and treaties, where some agreements and some states become more central with higher relevance for the regime as such. Such findings have consequences for debates about the vitality of the nuclear regime complex.*

Introduction

Any student of nuclear politics will sooner or later become exasperated with the sheer number of abbreviations afloat in the field. They often refer to diverse institutional structures in the field, and the proliferation of abbreviations indicates a proliferation of institutional structures. Sixty years ago, in 1962, there were three treaty regimes with 73 states participating in them. In 2022, there are 35 treaty regimes with 204 entities participating in them. These institutional structures give rise to a regime complex, ‘an array of partially overlapping and non-hierarchical institutions governing a particular issue-area’

I am thankful to the participants of the two ‘complexity in nuclear ordering’ workshops, especially Harald Müller and Tom Vaughan, as well as Nicola Leveringhaus and Wouter Spekkink for their helpful comments on the earlier versions of the paper. I am also thankful to Carmen Wunderlich and Martin Senn for including me in this project. The helpful feedback from the CRIA editors and three diligent reviewers helped me to improve the manuscript. Mary Graham and Mark Farrell proofread the text with much care. All errors remain my own. I thankfully acknowledge the support from Charles University Grant Program UNCE 24/SSH/018 (Peace Research Center Prague II).

(Raustiala and Victor 2004, 279). Increasing regime complexity is not a feature of nuclear politics alone; in fact, existing scholarship in international relations in almost any field has pointed to an increasing complexity and increasing number of institutional structures (see, for instance, Hafner-Burton (2009) on human rights; Brosig (2017) on international peacekeeping; or Quaglia and Spendzharova (2022) on financial data).

Yet, increasing complexity does not happen overnight. By contrast, it is intrinsically connected to the process of *nuclear ordering*. As the editors of this special issue mention in the introduction, drawing on Walker (2012), ordering is about a process of making interaction among actors more regular, 'regular and thus predictable' (Senn and Wunderlich forthcoming, 8). Ordering reshapes, among others, relations among actors within the order. In this paper, I look at how regime complexity shapes relations among states as the primary actors in the nuclear regime complex, for two intertwined reasons.

Although I define nuclear regime complex in the second section, it might be useful to underscore that regime complexes tend to describe governance structures which emerge in the presence of 'more actors, more rules and norms, and growing overlap between them' (Eilstrup-Sangiovanni 2023, 2094). In the nuclear field, there has been a steady increase in works which have studied regime complexity in the nuclear field (Dee 2023; Eilstrup-Sangiovanni 2023; Mallard 2014) What has been less explored in the existing study is how nuclear regime complexity is linked to transformation of relations among states. This is the gap that my paper aims to fill.

In doing so, this paper uses the transformation and increasing complexity of the nuclear regime complex to shed new light on nuclear ordering by studying the relations among actors (states), with particular attention to the increasing complexity in which the interaction among actors takes place. This paper will demonstrate that the story of the increasing complexity of the nuclear regime complex is a story of an increasing number of participants, an increasing number of institutional structures, and the increasing complexity of participants' interconnections.

Certainly, there is no shortage of papers trying to elucidate the nuclear regime complex, particularly when it comes to its rules and reasons. Some scholars attempt to be very comprehensive (Knopf 2018); others take a more evaluative approach (Fields and Enia 2009); yet others have attempted to take the historical route to explain its socio-legal origins (Mallard 2014), or even argued that an emergence of a new regime complex is taking place before our eyes (Patton, Philippe, and Mian 2019). Some measure the regularity within the regime complex by counting the number of institutions (Bandarra 2021), whereas others measure it according to state participation in it (Carcelli et al. 2014). Scholars have also linked the nuclear regime complex to broader arms control agendas, including conventional weapons (Kühn 2020).

This paper addresses a gap in existing scholarship by examining how the emergence of the nuclear regime complex transformed the relations among states, thus focusing on an understudied aspect of nuclear ordering. Hence, I go beyond counting the number of regimes or counting how many institutions states participate in Bandarra (2021) and Carcelli et al. (2014). Because participation in treaties facilitates interaction between states as parties, I measure relations between states as a connection emerging from joint membership in an

institutional agreement. Therefore, I use social network analysis to examine how the emergence of the nuclear regime complex has transformed how the states in it are connected, drawing on, and expanding, the work of Kreps (2018) on institutions in arms control regimes.

The remainder of the paper continues as follows. In the second section, I discuss the existing work on the nuclear regime complex through the lens of the existing work on regime complexity. In the third section, I outline how the nuclear regime complex has become *more* complex, through increasing the number of institutions and the state participation therein. Subsequently, I present the results of the social network analysis, demonstrating how increased regime complexity has led to increased interactions among states. In the concluding section, I discuss the link between the ordering and regime complexity.

Nuclear regime complex

As argued in the introduction, regime complexes define ‘an array of partially overlapping and non-hierarchical institutions’ (Raustiala and Victor 2004, 279). As Alter and Meunier (2009) add, it is the nature of *international* regime complexes to be particularly difficult to navigate. In their review of existing work on regime complexity, Alter and Raustiala (2018, 332ff) underline three key aspects for addressing regime complexity: ‘elemental institutions with an authority claim for a particular issue area’; absence of hierarchy; and systems effects. Increasing regime complexity can have differentiated effects on the functioning of the regimes. While the existing literature does not address this issue of regime functionality explicitly, regime complexes can work very well or terribly badly. Regime complexes tend to work well when the division of labour within the individual elements of the regime is clear, and individual institutions (elements of the regime) do not make competing authority claims. Such cooperation allows states to reap the benefits of cooperation and create efficiencies. However, cooperation can work very badly when individual institutions make competing claims, undermine one another, or try to assert authority over one another (see some discussion in Gehring and Faude 2013).

Among these ideal types, the nuclear regime is often assumed to be closer to the conflictual end, where gains from potential cooperation are not realised. This is because the new elements of the regime complex are only partially created to fill in the gaps and often because actors are unable or unwilling to cooperate through the existing institutions. This was the case with the foundation of the Nuclear Suppliers Group (NSG) (Anstey 2018; Burr 2014; Sarkar 2019); or with the foundation of the Treaty on the Prohibition of Nuclear Weapons (TPNW) (Gibbons 2018; Williams 2018). However, the nuclear regime complex also has elements, which truly aim to fill the gaps within the regime, such as nuclear-weapons-free zones or US-Soviet arms control negotiations.

Most scholars of regime complexity are very critical of its effects (see the extensive review in Alter and Raustiala 2018). Often, regime complexity is seen as a ploy by rich and powerful states to shift regimes in order to maintain their advantages. Fragmentation (and proliferation of rules) is often seen

as a negative feature because it decreases legal certainty. The record of the nuclear regime complex is again mixed. There are elements of the regime complex where the powerful try to maintain control over the regime and its elements at play. As Gheorghe (2019, 89) explains, the great powers attempt to 'thwart' proliferation by 'limiting what suppliers can sell'. But there are also elements where weaker powers use the regime complexity to protect themselves from the powerful actors. Nuclear-weapons-free zones are a very good example of this practice. Rodriguez and Mendenhall (2022) argue, for instance, that the provisions related to maritime transport in the Tlatelolco Treaty are specifically designed to keep the superpowers out of the region. Mpofo-Walsh (2020) argues that nuclear-weapon-free zones are about rebelling against the underlying norms of the nuclear order. Egel (2022) argues that the main motivation for the small and middle powers to negotiate the TPNW was to protect themselves from the powerful countries. The resulting image, therefore, is one of contested multilateralism, which includes forum shopping and regime shifting (for a discussion of contested multilateralism, see Morse and Keohane 2014).

Increasing complexity

One of the key elements of the nuclear regime complex is its increasing complexity, both in terms of agreements and participants. To analyse this increasing complexity, I have studied participation in forty different agreements making up the nuclear regime complex. As a starting point, I have used the list of agreements prepared by Kreps (2018, 132) in her work on the institutional structure of arms control. Kreps's list includes 'all nuclear arms control measures negotiated between 1945 and 2010'. As Kreps's list includes also arms control agreements, which have not materialised, I have excluded those that did not come into existence. Furthermore, I have added the TPNW to Kreps's list as a treaty concluded after the publication of Kreps's paper. The resulting list of agreements can be found in [Appendix 1](#).

In her list, Kreps includes both bilateral and multilateral agreements. Most of these agreements are treaties. Both bilateral and multilateral treaties are part of the nuclear regime complex, as they both address core issues related to nuclear weapons. Bilateral treaties are those signed between two countries, usually between the United States and Russia. Multilateral treaties are by definition open to multiple (and often all) states to join.¹ For the purposes of the analysis, I counted ratification as a sign of participation in a treaty.² However, some are formal intergovernmental organisations (the moment of ratification or formal membership was counted as participation), while yet others are informal intergovernmental organisations (Vabulas and Snidal 2013; the moment of participation or admission was counted as participation), and one of them is a UN Security Council Resolution which

¹ Regional treaties are often open to all states but primarily regional states join them. Such differentiated participation then translates into specific community detection.

² As Herzog (2021) explains, it is only ratification when the final commitment to the treaty is made.

creates specific obligations for states (submission of the report was counted as participation).

This list has advantages over existing work since it does not limit its scope solely to the governance of nuclear energy (Perkovich 2008; Scheinman 2016) nor solely to nuclear weapons (Kutchesfahani 2019).³ The agreements included in the list engage all four elements of nuclear order identified by Horsburgh (2015): deterrence, arms control, non-proliferation and disarmament.

At the same time, it is also important to recall that not all of these agreements are still in place, as some have been superseded by later agreements, or simply ended. While the data is longitudinal, I have decided to divide it into seven snapshots, one decade apart, starting from 1962, and lasting until 2022. The choice of interval allows studying the changes over time without becoming overwhelmed by the data. Looking back from the year 2022 (the time of writing), the starting point of 1962 reflects the time point when the nuclear regime complex was starting to fall into place.⁴

Overall, state participation in the nuclear regime complex is increasing. The number of countries participating increases over time. However, the embedding of countries, measured by the number of institutions a country is simultaneously a member of, increases as well. The median number of agreements a country participates in increased from one to nine between 1962 and 2022, yet this increase is unequal, and a clear segmentation among the states can be observed. For instance, the United States and Soviet Union (or later, Russia) remain the most embedded participants in the regime complex. Australia is a close third, and post-Cold War, Ukraine has been a very active participant measured by the number of agreements. By contrast, some countries scarcely participate in diverse agreements. South Sudan participates in only one treaty; countries usually considered 'serious players' when it comes to the nuclear order actually exhibit very low participation rates in the regime complex. Egypt and Iran, for instance, participate only in five agreements each, on par with Andorra, Haiti and Eritrea. Even Israel is more embedded in the regime complex, with six agreements.

At the same time, some agreements are becoming increasingly more central to the regime complex by virtue of their endorsement by states. Between 1972 and 1992, the agreements with the highest member of participants hardly changed at all. Three of them—the NPT, the International Atomic Energy Agency (IAEA) and the test ban regime—remain at present among the top five most endorsed elements. In the last twenty years, the number of agreements dealing with nuclear security, as a special instance of non-proliferation, in the regime complex increased. Nuclear security agreements include, for instance, the UNSCR 1540, which covers also nuclear terrorism and the Convention on the Physical Protection of Nuclear Material (CPPNM), which covers the physical protection of nuclear materials and facilities. Because these two elements

³ One agreement which is not included in the list is the Joint Comprehensive Plan of Action, also known as the JCPOA. The agreement was concluded in 2015. It could have been included in the 2022 snapshot. However, by 2022, the status of the agreement was uncertain, as it was an informal agreement which its two main participants (USA and Iran) did not consider to be binding. After a discussion with the journal editors and special issue editors, I have opted not to include it in this list.

⁴ A decade earlier (in 1952), only one 'nuclear' institution existed: the Coordinating Committee for Multilateral Export Controls (CoCom).

are closely linked to global institutions (UNSCR 1540) and to another ‘popular’ element of the regime complex (IAEA), it is not really a surprise that they rose very quickly to take a central role in the regime complex.

These institutional elements of the regime complex underscore its fundamental norms, such as non-proliferation, including nuclear security. In total, as of October 2022, nine institutional elements have more than one hundred participants, which underscores their centrality in the whole regime complex. In addition to the five listed above, there are the Limited Test Ban Treaty (LTBT), Nuclear Terrorism Convention, Outer Space Treaty and Proliferation Security Initiative.

This differentiated endorsement of agreements is a sign of different segmentation within the nuclear order. Certain agreements gain a more central position—their position becomes quasi-constitutional. This does not mean that other institutional elements do not matter, but it does mean that these quasi-constitutional elements acquire a position within the regime which is very difficult to challenge. Consider the NPT, which is the most widely subscribed to agreement. Even the critics of the NPT’s performance, such as the parties to the TPNW, often feel compelled to reiterate their commitment to the NPT. The criticism of the NPT’s unequal structure is relatively common, but there are very few countries openly denouncing the treaty for this reason (one such example would be India, see Smetana and Onderco 2018).

Increasing the number of institutions as well as the participation of states in them has profound consequences for the nuclear regime *order* as well as for nuclear *ordering*. If ‘orders’ are seen as a fact, or the state of affairs (Hurrell 2007), then the increasing participation in the nuclear regime complex demonstrates an increasing involvement of states in the complex, as well as a growing number of rules and institutions creating regularity in the order.⁵ Institutions, in many ways, help consolidate the order (Mpofu-Walsh 2020). As Mpofu-Walsh (2020) argues, drawing on Barkawi and Laffey (2006), this view has a somewhat progressive tint, and tends to see the opposition to order in a rather Manichean way. One can, however, use the increasing nuclear regime complexity as an indication of order consolidation, in which case the increasing nuclear regime complexity is linked closely to ordering. Ordering is a process whereby states become more embedded within the order, accepting its rules, and by extension, also its reasons. In the next section, I will discuss how the connections of states within the regime complex transform.

State relations in nuclear regime complex

In the previous section, I explained how the nuclear regime complex has become more complex over time with the increase in the number of

⁵ This observation obviously suffers from the ‘selection on observables’ bias, that is, the fact that it measures only the institutional elements that actually emerged. There is a number of examples where the activities and involvement of certain actors would not be observed because they did not immediately lead to a successful conclusion. The activities of actors from the Global South are, of course, a target for this bias (see, for instance, Abraham 2018), but not exclusively (see, for instance, Stefancic 1987).

agreements. This increase in complexity brings about a transformation in state relations.⁶ I conceptualise state relations as the connections that develop among states through their participation in the same international agreement. Joint membership in international agreements provides states with opportunities to exchange ideas and engage with one another, thereby fostering relations between them.

Similarity in state participation in various agreements can tell us a great deal about how states relate to one another in international politics in general and in nuclear politics in particular. States that tend to be members of the same agreements are more likely to share diverse traits and hence, participation in these agreements can tell us much about the similarity of the underlying preferences of such states. Using social network analysis, as a methodological tool here is helpful, as it helps with visualising this similarity. Furthermore, social network analysis allows us to identify which states are more prominently present and active in diverse agreements, and hence able to influence the overall network (Hafner-Burton, Kahler, and Montgomery 2009; Hafner-Burton and Montgomery 2006; Pauwelyn 2015). As sociologists have argued, the more prominent a role in the network an actor has, the easier it is for it to control said network (Padgett and Ansell 1993). Political economists found a similar effect—states that are more centrally located tend to be better able to influence the outcomes of policy processes (Wincoff 2015). States that are particularly well connected are also able to strengthen their positions, collaborate better, and find it generally easier to find new allies (Henke 2017).

To study the relations that states build by membership in different agreements, I conceptualise individual agreements as networks. Obviously therefore, membership in agreements (and hence in diverse networks) overlaps. Such conceptualisation is not uncommon in the study of international relations, where scholars in the past conceptualised overlapping membership in international institutions as networks (Böhmelet and Spilker 2016; Goddard 2018; Sommerer and Tallberg 2019).

Figure 1 offers a simple topology of the nuclear regime complex, using social network analysis. In these visualisations, I used a Louvain algorithm to identify communities (Blondel et al. 2008). A Louvain algorithm offers an unsupervised method, which does not require researchers' input. It is a bottom-up method, which 'starts from a local structure ... and expands to the overall network' (Souravlas et al. 2021, 74). From a social sciences perspective, a major advantage lies in the straight-forward implementation in existing software (such as Gephi, which was used for the present analysis).⁷ This algorithm essentially analyses the co-membership of different networks (agreements, in this paper), and on the basis of this data, identifies clusters of actors (states, in

⁶ In this paper, I focus on the relations among states. Despite growing participation in international organisations and non-state actors in such settings, they are (overwhelmingly) not able to ratify agreements and join international organisations; and their participation in the different institutional settings (such as participation in the NPT Review Conferences) depends on the approval of states.

⁷ It is important to recognise that, within the context of social network analysis, this network is relatively small. The computational advantages provided by alternative methods are not pertinent to such a small-scale network. As a recent review affirms, 'the Louvain scheme is still referred as one of the best solutions to the community detection problem' (Souravlas et al. 2021, 74).

our case) who tend to be members of the same networks. While the language of communities might suggest to an international relations scholar some shared norms and values (and hence, some semblance of coherence), in this case, the notion of communities refers to clusters of membership co-occurrence. In [Figure 1](#), different colours identify different communities.⁸ The size of individual nodes is relative to the number of institutional elements they are a member of, and the thickness of the line connecting any two nodes is equal to the number of shared memberships between them (and relative within the subgraph). Lastly, to improve readability, membership in institutional elements where more than 50 per cent of states are present has not been visualised (which would otherwise lead to poor readability of the figures).

A number of trends can be observed in [Figure 1](#). In 1962, the nuclear regime complex network is rather sparse, composed of a mere handful of states that are relatively weakly connected to one another. This was a period with only three agreements in place, and two communities detected. The relations between states are quite limited, and the density of connections remains rather low.⁹ This is not a particularly tight network.

In 1972, we can detect three communities, which indicate how the relations between states developed, two of which are fairly intertwined, with the third one remaining separate. The network density increases as both the number of states and the number of agreements increase. A similar pattern occurs in 1982, but there, the three communities show more interconnections. In 1982, the Western countries created their own community (and the Soviet Union was a member only due to the numerous arms control agreements with the US). Most of the Soviet satellites, but also more broadly, the countries from the Global South, created their own community (in blue); whereas the Latin American countries created yet another community (in green). This figure also shows that the relations between the states follow primarily geographical pattern and that there is a significant variation in the degree to which states are embedded in the regime.

By 1992, the integration among the three communities increases, which indicates a growing number of agreements, which bind states beyond the quasi-constitutional agreements. This also signifies a growing interconnection between states, and growing number of relations between states. Within the nuclear order, states increase the number of relations between one another. At the same time, the density of the network declines and the network breaks into four communities. This is partially driven by a growing number of treaties concluded in this period, which have only limited applicability (whether regional treaties or superpower arms control agreements). Therefore, the number of agreements and states increases, but the density of connections among them declines.

The density increases over the following ten years. In 2002, we see that states intensify relations between each other. Again, this has to do with an

⁸ Individual colours associated with a given community are not consistent across the individual sub-graphs.

⁹ Density is measured as a number of observed connections as a share of all possible connections. In this calculation, I remove the quasi-constitutional elements with over 50 per cent participation, because once these are included, all states share at least one connection.

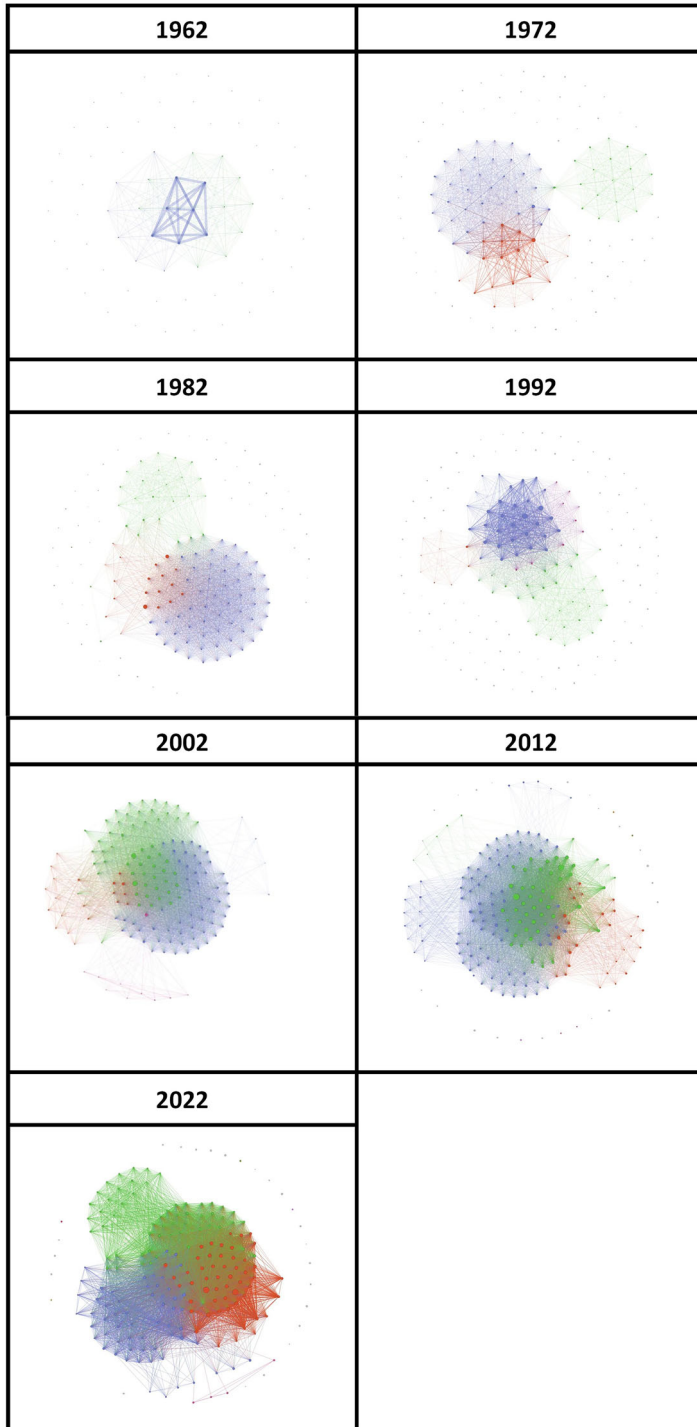


FIGURE 1. Individual colours represent communities. Colours and communities are not consistent across sub-graphs.

increasing number of agreements with large state participation, which nevertheless do not reach the level of quasi-constitutional agreements. This period sees still the formation of four communities. However, the community including the Global North countries did not include China nor Australia; the community, including the Latin American countries, had fewer states from outside the region. At that time, too, there were a significant number of countries that were only poorly connected to the remainder of the regime complex, for instance, the Pacific Islands.

Yet, the density (and hence integration) continues to increase further, which signals growing relations between states. In 2012, the network density reaches its peak, but there is also a growing pattern of smaller ‘splinter’ groups with fewer connections to the ‘core’ of the regime complex. This pattern prevails and is intensified in 2022. In 2022, the ‘red’ community is composed primarily of the countries of the Global North, but also includes Russia, China, India, Kazakhstan and South Africa. These are countries that tend to be members of numerous export control regimes and are also deeply embedded in the regime through membership in a great number of agreements. The ‘green’ community is represented primarily by African countries, as well as some smaller countries from other regions. These countries are often not members of major export control regimes and their membership in other institutional elements is also limited. The ‘blue’ community is composed of primarily Latin American countries and some countries in the Middle East and Pacific, whose membership in other treaty regimes is also restricted.

Overall, we may observe that while the intensity of relations between states increases over time. However, there remain important geographical patterns which shape the relations between states—for instance, states from the Latin America tend to cluster together, often ending up in the same community as some of the other regions. While regional patterns do not perfectly explain the shape of the communities (and thus the relations between states), the paper is further evidence that the regional element matters greatly in the nuclear regime complex and nuclear order (Rodriguez and Mendenhall 2022; Mathy [forthcoming](#)).

Since 1972, the dyad with the highest number of shared memberships has always been the USSR/Russia—United States. At its peak in 2002, Russia and the United States shared membership in twenty institutional elements; in 2022, they shared membership in 16 elements. This indicates a decline in the shared agreement membership in the nuclear regime complex by the two countries at its core, by 20 per cent in the last twenty years. This finding also underlines that this bilateral relation is at the core of the nuclear order. As much as the order increases and adds new members, the bilateral tie between these two countries is key to the regime complex. Interestingly enough, since independence, Ukraine has been the second or third most common co-member for both USA and Russia.

Overall, the pattern emerging from these figures is rather clear, and over time, three trends emerge. The first one is rather simple: a growing number of states participate in the nuclear regime complex, in an increasingly growing number of agreements. This is, in itself, not a novel finding, but this paper provides another piece of evidence to show this increase. Secondly, the results show that through differentiated participation in various agreements, states

can be divided into clearly defined communities. Thirdly, and relatedly, these communities are not isolated and in fact there is overlap among them. Over time, growing integration among the communities of states becomes observable. This growing integration emerges even when the quasi-constitutional institutions with large memberships are excluded from the analysis. In other words, the integration of the communities of states is not driven (solely) by major agreements, but also by an increase in cooperation in other, smaller agreements. Over time, the nuclear regime complex has become *more* inclusive, *more* compact, and *more* interconnected. This confirms the findings of scholars who have argued that the concern about the fragility of the nuclear regime is overstated (Horowitz 2015; Smetana and O'Mahoney 2022).

Regime complexity and nuclear ordering

Integrating regime complexity and state relations into the thinking about global nuclear order expands how scholars have in the past engaged with the idea of 'nuclear order'. It goes beyond the ordering principles advocated by William Walker as a leading scholar of the idea of 'nuclear order' (Walker 2000, 2007, 2012). They also go beyond the existing critiques of the idea of nuclear order, which unmask the underlying status quo (Egeland 2021) or study its power basis (Ritchie 2019). It also goes beyond understanding the nuclear order as purely purpose driven (Knopf 2022). Rather, the transformation of the state relations within the nuclear order over time can tell us a great deal about nuclear ordering. This perspective has thus far been missing.

Overall, three overlapping takeaway messages emerge from the empirical analysis, linking the transformations within the nuclear regime complex to nuclear ordering. Firstly, the analysis confirms what others have found before—that regime complexity has increased over time, both in terms of the number of states participating in it, as well as in the number of international agreements which make up this regime complex (see, for instance, Senn and Wunderlinch in the introduction to this special issue, or Bandarra 2021). This growing complexity leads to more rules applicable within the nuclear order, but also regularity of interactions, driven by ever-increasing number of reasons, leading to changing patterns of relations among states. However, and this is where the paper adds to the existing scholarship, this increase in complexity is not only driven by a few agreements with a large number of participating states, but also due to a growing number of agreements with a smaller number of participating states which create an increasingly dense network of connections among states.

This observation leads to the second key takeaway. The interactions among the states in the nuclear regime complex have become more frequent, and while clear communities can be identified, the whole regime complex has become 'more connected'. This also means that the order has become interconnected as the relations intensify with growing repetition. Again, this is not a factor of a small number of states or agreements, but a general trend within the regime complex. States have now more platforms than ever to address various collective action problems.

As with other instances of regime complexity, this has a potential to create efficiencies, but also exacerbate inequality and encourage forum shopping and

contestation (Alter and Meunier 2009; Drezner 2007). Future research should explore further whether and how forum shopping in the nuclear regime complex happens. For instance, the establishment of the NSG or the TPNW could be seen as forum shopping as states were unwilling or unable to work through existing agreements. However, it is not yet clear whether forum shopping in the nuclear regime complex benefits the well-connected actors (who also often benefit from other inequalities, such as more plentiful representations in multi-lateral negotiations, see Onderco 2019); or whether it benefits the less well-connected actors who use it to reframe the discussion (as was the case with the humanitarian initiative, see Gibbons 2018).

One example where forum shopping has had an impact already was the rise of the humanitarian initiative for nuclear disarmament and the associated emergence of the TPNW. These developments mean that there is now a discussion about whether treaty-based solutions for nuclear disarmament are to be debated only among the nuclear powers (a rather traditional and old-fashioned approach) or in a broader group of states including those who have denounced nuclear weapons (an approach on which the humanitarian initiative for nuclear disarmament is based; see Gibbons 2018). The emerging dispute is an indication of the perils of regime complexity.

Thirdly, the nuclear regime complex, and hence also the nuclear order, has led to a multilevel segmentation among both agreements and states. Some of the rules become more privileged because they are more broadly subscribed to; some states become much better embedded in the order and hence have in theory a higher chance to control the order. As much as not all agreements are equal in the nuclear order (and some are more fundamental than others, because they are more subscribed to than others), not all states have equal standing in the nuclear order. Scholars in the past identified structural power as a reason why some states are endowed with more power within the regime (Ritchie 2019; Ruzicka 2018), however, this paper indicates that there is more to why some states have a more prominent position. In fact, it indicates that the increased participation of some states gives them a better position within the regime. However, such control is not automatic and the ability of states to exercise it varies over time. For instance, Onderco (2022) argues that the United States was able to leverage its privileged position to push through the indefinite extension of the NPT, but as Spektor (2023) argues in his recent review of Onderco's book, such power is much weaker today (for a similar argument, see Anderson, Bell, and Tretter 2023). At the same time, this participation is, of course, not the only reason why certain states gain prominence. As mentioned above, Egypt, for instance, is rather poorly present in the nuclear regime complex but occupies an important role in the nuclear order (Fahmy 2020). As scholars start to pay more attention to the inequalities created by nuclear weapons (see, for instance, Stärk and Kühn 2022), attention to systemic inequalities created by differentiated embedding in the nuclear regime complex will surely reappear on the scholarly agenda.

The results from the research also have consequences for the broader debate about the decay in the nuclear order. This debate about the decay of the nuclear order links to the discussion of 'disordering' of the nuclear order. While it is not the central focus of this paper, the results speak to it. In short, the paper demonstrates that contrary to the narrative of decay within the

nuclear order, the order at this moment shows not only signs of resilience, but also of consolidation. The order *as such* moves towards closer cooperation and in many ways shows signs of resilience. The evidence of such cooperation and resilience can be found in practical policy. For instance, at the 2023 NPT Preparatory Committee conference in Vienna, states could find almost a consensus about the final document. The consensus was not found due to Russia's last-minute veto. This situation followed a similar pattern from 2022 NPT Review Conference (Potter 2023).

This does not mean that everything within the nuclear regime complex is going swimmingly. There are at least three reasons to see negative trends in the existing nuclear regime complex. For instance, Onderco (2020) argues that within the NPT regime, an ossification has set in and the alignment of states has almost not budged. Onderco and Portela (2022) have also found that EU states have moved towards differentiated cooperation over time, with a clearly delineated group of states differing from the rest. One can also observe that the tandem which was at the heart of the nuclear regime complex—the US and Russia—has stopped actively cooperating. Between 2002 and 2022, the number of shared memberships between Russia and the US decreased by 20 per cent, while the overall trend is rather the opposite. This not only corresponds to other observations about the crisis of arms control (cf. Krepon 2021; Wisotzki and Kühn 2021) but suggests that the cooperation within the heart of the regime complex is not smooth.

At present, the existing problems within the regime complex cannot be attributed to the growing complexity, but rather to intransigence of particular members (here particularly Russia and to a certain degree Iran). Growing regime complexity has, thus far, not been as deleterious in the nuclear field as one could expect, based on what the scholarly work on regime complexity warns (Alter and Raustiala 2018). The parties to the TPNW, for instance, still strongly underscore their link to other elements of the regime (such as the NPT; see United Nations 2023, para. 23).

Through their membership in different agreements, states indicate that their preferences and views in the nuclear order are growing more alike, not more apart. This is particularly clear when one thinks about nuclear non-proliferation and peaceful uses of nuclear energy; although (as stated above), the situation is more challenging when it comes to arms control and disarmament (and again, it is difficult to attribute that to regime complexity at this moment). Yet, future work should pay close attention to whether growing complexity and increasing number of institutional structures, as well as external political dynamics, lead to greater inefficiency, competition and division within the regime.

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References

- Abraham, Itty. 2018. "Decolonizing Arms Control: The Asian African Legal Consultative Committee and the Legality of Nuclear Testing, 1960–64." *Asian Journal of Political Science* 26 (3): 314–330. <https://doi.org/10.1080/02185377.2018.1485588>
- Alter, Karen J., and Kal Raustiala. 2018. "The Rise of International Regime Complexity." *Annual Review of Law and Social Science* 14 (1): 329–349. <https://doi.org/10.1146/annurev-lawsocsci-101317-030830>
- Alter, Karen J., and Sophie Meunier. 2009. "The Politics of International Regime Complexity." *Perspectives on Politics* 7 (1): 13–24. <https://doi.org/10.1017/S1537592709090033>
- Anderson, Kelso R., Mark S. Bell, and Cheyenne Tretter. 2023. "The End of Inhibition? Why US Nonproliferation Policy Is Becoming Less Effective." *The Washington Quarterly* 46 (3): 127–147. <https://doi.org/10.1080/0163660X.2023.2259255>
- Anstey, Isabelle. 2018. "Negotiating Nuclear Control: The Zangger Committee and the Nuclear Suppliers' Group in the 1970s." *The International History Review* 40 (5): 975–995. <https://doi.org/10.1080/07075332.2018.1449764>
- Bandarra, Leonardo. 2021. "Nuclear Latency and the Participation Puzzle: Constructing the International Non-Proliferation Regime." Unpublished PhD diss., Georg-August University of Göttingen.
- Barkawi, Tarak, and Mark Laffey. 2006. "The Postcolonial Moment in Security Studies." *Review of International Studies* 32 (2): 329–352. <https://doi.org/10.1017/S0260210506007054>
- Blondel, Vincent D., Jean-Loup Guillaume, Renaud Lambiotte, and Etienne Lefebvre. 2008. "Fast Unfolding of Communities in Large Networks." *Journal of Statistical Mechanics: Theory and Experiment* 2008 (10): P10008. <https://doi.org/10.1088/1742-5468/2008/10/P10008>
- Böhmelt, Tobias, and Gabriele Spilker. 2016. "The Interaction of International Institutions from a Social Network Perspective." *International Environmental Agreements: Politics, Law and Economics* 16 (1): 67–89. <https://doi.org/10.1007/s10784-014-9248-3>
- Brosig, Malte. 2017. "Regime Complexity and Resource Dependence Theory in International Peacekeeping." In *Palgrave Handbook of Inter-Organizational Relations in World Politics*, edited by Joachim A. Koops and Rafael Bierman, 447–470. Houndmills: Palgrave.

- Burr, William. 2014. "A Scheme of 'Control': The United States and the Origins of the Nuclear Suppliers' Group, 1974–1976*." *The International History Review* 36 (2): 252–276. <https://doi.org/10.1080/07075332.2013.864690>
- Carcelli, Shannon, Jeff Kaplow, Erik Gartzke, and Rebecca Gibbons. 2014. "The Nuclear Non-Proliferation Regime Complex: A New Dataset." ISA Annual Conference, Toronto, Canada.
- Dee, Megan. 2023. "EU Orchestration in the Nuclear Weapons Regime Complex." *Politics and Governance* 11 (2): 39–48. <https://doi.org/10.17645/pag.v11i2.6323>
- Drezner, Daniel W. 2007. "Institutional Proliferation and World Order: Is There Viscosity in Global Governance?." <http://danieldrezner.com/research/viscosity.pdf>
- Egel, Naomi. 2022. "Weapons Governance by the Weak (Unpublished Working Paper)." Accessed 18 October. https://naomiegel.com/wp-content/uploads/2022/01/Egel_JMP.pdf
- Egeland, Kjøl. 2021. "The Ideology of Nuclear Order." *New Political Science* 43 (2): 208–230. <https://doi.org/10.1080/07393148.2021.1886772>
- Eilstrup-Sangiovanni, Mette. 2023. "The Instability of the Nuclear Nonproliferation Regime Complex." *Review of International Political Economy* 30 (6): 2094–2121. <https://doi.org/10.1080/09692290.2023.2238732>
- Fahmy, Nabil. 2020. *Egypt's Diplomacy in War, Peace and Transition*. London: Palgrave.
- Fields, Jeffrey, and Jason S. Enia. 2009. "The Health of the Nuclear Nonproliferation Regime: Returning to a Multidimensional Evaluation." *The Nonproliferation Review* 16 (2): 173–196. <https://doi.org/10.1080/10736700902969646>
- Gehring, Thomas, and Benjamin Faude. 2013. "The Dynamics of Regime Complexes: Microfoundations and Systemic Effects." *Global Governance: A Review of Multilateralism and International Organizations* 19 (1): 119–130. <https://doi.org/10.1163/19426720-01901010>
- Gheorghe, Eliza. 2019. "Proliferation and the Logic of the Nuclear Market." *International Security* 43 (4): 88–127. https://doi.org/10.1162/isec_a_00344
- Gibbons, Rebecca Davis. 2018. "The Humanitarian Turn in Nuclear Disarmament and the Treaty on the Prohibition of Nuclear Weapons." *The Nonproliferation Review* 25 (1-2): 11–36. <https://doi.org/10.1080/10736700.2018.1486960>
- Goddard, Stacie E. 2018. *When Right Makes Might: Rising Powers and the Challenge to World Order*. Ithaca, NY: Cornell University Press.
- Hafner-Burton, Emilie M. 2009. "The Power Politics of Regime Complexity: Human Rights Trade Conditionality in Europe." *Perspectives on Politics* 7 (1): 33–37.
- Hafner-Burton, Emilie M., and Alexander H. Montgomery. 2006. "Power Positions: International Organizations, Social Networks, and Conflict." *Journal of Conflict Resolution* 50 (1):3–27. <https://doi.org/10.1177/0022002705281669>
- Hafner-Burton, Emilie M., Miles Kahler, and Alexander H. Montgomery. 2009. "Network Analysis for International Relations." *International Organization* 63 (3): 559–592. <https://doi.org/10.1017/S0020818309090195>
- Henke, Marina E. 2017. "The Politics of Diplomacy: How the United States Builds Multilateral Military Coalitions." *International Studies Quarterly* 61 (2): 410–424. <https://doi.org/10.1093/isq/sqx017>
- Herzog, Stephen. 2021. "After the Negotiations: Understanding Multilateral Nuclear Arms Control." Unpublished PhD diss., Yale University.
- Horowitz, Liviu. 2015. "Beyond Pessimism: Why the Treaty on the Non-Proliferation of Nuclear Weapons Will Not Collapse." *Journal of Strategic Studies* 38 (1-2): 126–158.
- Horsburgh, Nicola. 2015. *China and Global Nuclear Order: From Estrangement to Active Engagement*. 1st ed. Oxford, UK: Oxford University Press.
- Hurrell, Andrew. 2007. *On Global Order: Power, Values, and the Constitution of International Society*. Oxford: Oxford University Press.
- Knopf, Jeffrey W. 2022. "Not by NPT Alone: The Future of the Global Nuclear Order." *Contemporary Security Policy* 43 (1): 186–212. <https://doi.org/10.1080/13523260.2021.1983243>
- Knopf, Jeffrey W., ed. 2018. *International Cooperation on WMD Nonproliferation*. Athens, GA: University of Georgia Press.
- Krepon, Michael. 2021. *Winning and Losing the Nuclear Peace: The Rise, Demise, and Revival of Arms Control*. Stanford, CA: Stanford University Press.

- Kreps, Sarah E. 2018. "The Institutional Design of Arms Control Agreements." *Foreign Policy Analysis* 14 (1): 127–147.
- Kühn, Ulrich. 2020. *The Rise and Fall of Cooperative Arms Control in Europe, Demokratie, Sicherheit, Frieden No.224*. Baden-Baden: Nomos.
- Kutchesfahani, Sara Z. 2019. *Global Nuclear Order*. Abingdon: Routledge.
- Mallard, Grégoire. 2014. "Crafting the Nuclear Regime Complex (1950–1975): Dynamics of Harmonization of Opaque Treaty Rules." *European Journal of International Law* 25 (2): 445–472. <https://doi.org/10.1093/ejil/chu028>
- Mathy, Espen. forthcoming. "Why Do States Commit to the Treaty on the Prohibition of Nuclear Weapons?" *The Nonproliferation Review*. <https://doi.org/10.1080/10736700.2023.2175994>
- Morse, Julia C., and Robert O. Keohane. 2014. "Contested Multilateralism." *The Review of International Organizations* 9 (4): 385–412.
- Mpofu-Walsh, Sizwe. 2020. "Obedient Rebellion: Nuclear-Weapon-Free Zones and Global Nuclear Order, 1967–2017." Unpublished PhD diss., Oxford University.
- Onderco, Michal. 2019. "Variation in Delegation Size in Multilateral Diplomacy." *British Journal of Politics and International Relations* 21 (2): 421–438.
- Onderco, Michal. 2020. "Collaboration Networks in Conference Diplomacy: The Case of Non-Proliferation Regime." *International Studies Review* 22 (4): 739–757.
- Onderco, Michal. 2022. *Networked Nonproliferation: Making the NPT Permanent*. Stanford, CA: Stanford University Press.
- Onderco, Michal, and Clara Portela. 2022. "External Drivers of EU Differentiated Cooperation: How Change in the Nuclear Nonproliferation Regime Affects Member States Alignment." *Contemporary Security Policy* 44 (1): 150–175.
- Padgett, John F., and Christopher K. Ansell. 1993. "Robust Action and the Rise of the Medici, 1400–1434." *American Journal of Sociology* 98 (6): 1259–1319. <https://doi.org/10.1080/13523260.2022.2146336>
- Patton, Tamara, Sébastien Philippe, and Zia Mian. 2019. "Fit for Purpose: An Evolutionary Strategy for the Implementation and Verification of the Treaty on the Prohibition of Nuclear Weapons." *Journal for Peace and Nuclear Disarmament* 2 (2): 387–409. <https://doi.org/10.1080/25751654.2019.1666699>
- Pauwelyn, Joost. 2015. "The Rule of Law without the Rule of Lawyers? Why Investment Arbitrators Are from Mars, Trade Adjudicators from Venus." *American Journal of International Law* 109 (4): 761–805. <https://doi.org/10.5305/amerjintlaw.109.4.0761>
- Perkovich, George. 2008. *Principles for Reforming the Nuclear Order*. Paris: Institut français des relations internationales.
- Potter, William C. 2023. "Behind the Scenes: How Not to Negotiate an Enhanced NPT Review Process." *Arms Control Today* 53 (8):18–23. <https://doi.org/10.1111/rego.12377>
- Quaglia, Lucia, and Aneta Spendzharova. 2022. "Regime Complexity and Managing Financial Data Streams: The Orchestration of Trade Reporting for Derivatives." *Regulation & Governance* 16 (2): 588–602.
- Raustiala, Kal, and David G. Victor. 2004. "The Regime Complex for Plant Genetic Resources." *International Organization* 58 (02): 277–309. <https://doi.org/10.1017/S0020818304582036>
- Ritchie, Nick. 2019. "A Hegemonic Nuclear Order: Understanding the Ban Treaty and the Power Politics of Nuclear Weapons." *Contemporary Security Policy* 40 (4): 409–434. <https://doi.org/10.1080/13523260.2019.1571852>
- Rodriguez, J. Luis, and Elizabeth Mendenhall. 2022. "Nuclear Weapon-Free Zones and the Issue of Maritime Transit in Latin America." *International Affairs* 98 (3): 819–836. <https://doi.org/10.1093/ia/iia055>
- Ruzicka, Jan. 2018. "Behind the Veil of Good Intentions: Power Analysis of the Nuclear Non-Proliferation Regime." *International Politics* 55 (3-4): 369–385. <https://doi.org/10.1057/s41311-017-0086-0>
- Sarkar, Jayita. 2019. "U.S. Policy to Curb West European Nuclear Exports, 1974–1978." *Journal of Cold War Studies* 21 (2): 110–149. https://doi.org/10.1162/jcws_a_00877
- Scheinman, Lawrence. 2016. *The International Atomic Energy Agency and World Nuclear Order*. Abingdon: Routledge.

- Senn, Martin, and Carmen Wunderlich. *forthcoming*. "The Complexity of Nuclear (Dis)Ordering: A Research Agenda." *Cambridge Review of International Affairs*.
- Smetana, Michal, and Joseph O'Mahoney. 2022. "NPT as an Antifragile System: How Contestation Improves the Nonproliferation Regime." *Contemporary Security Policy* 43 (1): 24–49. <https://doi.org/10.1080/13523260.2021.1978761>
- Smetana, Michal, and Michal Onderco. 2018. "Bringing the Outsiders in: An Interactionist Perspective on Deviance and Normative Change in International Politics." *Cambridge Review of International Affairs* 31 (6): 516–536. <https://doi.org/10.1080/09557571.2018.1549021>
- Sommerer, Thomas, and Jonas Tallberg. 2019. "Diffusion Across International Organizations: Connectivity and Convergence." *International Organization* 73 (02): 399–433. <https://doi.org/10.1017/S0020818318000450>
- Souravlas, Stavros, Angelo Sifaleras, Maria Tsintogianni, and Stefanos Katsavounis. 2021. "A Classification of Community Detection Methods in Social Networks: A Survey." *International Journal of General Systems* 50 (1): 63–91. <https://doi.org/10.1080/03081079.2020.1863394>
- Spektor, Matias. 2023. "Michal Onderco, Networked Nonproliferation: Making the NPT Permanent (Review)." *European Review of International Studies* 10 (1): 100–102.
- Stärk, Franziska, and Ulrich Kühn. 2022. "Nuclear Injustice: How Russia's Invasion of Ukraine Shows the Staggering Human Cost of Deterrence." *Bulletin of the Atomic Scientists*. <https://thebulletin.org/2022/10/nuclear-injustice-how-russias-invasion-of-ukraine-shows-the-staggering-human-cost-of-deterrence/>
- Stefancic, David. 1987. "The Rapacki Plan: A Case Study of European Diplomacy." *East European Quarterly* 21 (4): 401.
- United Nations. 2023. "Revised Draft Declaration of the Second Meeting of States Parties to the Treaty on the Prohibition of Nuclear Weapons: "Our Commitment to Upholding the Prohibition of Nuclear Weapons and Averting Their Catastrophic Consequences"." <https://reachingcriticalwill.org/images/documents/Disarmament-fora/nuclear-weapon-ban/2msp/documents/CRP4-Rev1.pdf>
- Vabulas, Felicity, and Duncan Snidal. 2013. "Organization without Delegation: Informal Intergovernmental Organizations (IIGOs) and the Spectrum of Intergovernmental Arrangements." *The Review of International Organizations* 8 (2): 193–220. <https://doi.org/10.1007/s11558-012-9161-x>
- Walker, William. 2000. "Nuclear Order and Disorder." *International Affairs* 76 (4): 703–724. <https://doi.org/10.1111/1468-2346.00160>
- Walker, William. 2007. "Nuclear Enlightenment and Counter-Enlightenment." *International Affairs* 83 (3): 431–453. <https://doi.org/10.1111/j.1468-2346.2007.00630.x>
- Walker, William. 2012. *A Perpetual Menace: Nuclear Weapons and International Order*, Routledge Global Security Studies. London: Routledge.
- Williams, Heather. 2018. "A Nuclear Babel: Narratives around the Treaty on the Prohibition of Nuclear Weapons." *The Nonproliferation Review* 25 (1-2): 51–63. <https://doi.org/10.1080/10736700.2018.1477453>
- Winecoff, William Kindred. 2015. "Structural Power and the Global Financial Crisis: A Network Analytical Approach." *Business and Politics* 17 (3): 495–525. <https://doi.org/10.1515/bap-2014-0050>
- Wisotzki, Simone, and Ulrich Kühn. 2021. "Crisis in Arms Control: An Introduction." *Zeitschrift für Friedens- und Konfliktforschung* 10 (2): 183–194. <https://doi.org/10.1007/s42597-022-00074-8>