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ARTICLE

Introducing the Sounds of Data to the Study of Politics: A Choir of Global Legitimacy Crises

Hans Agné,[a] Thomas Sommerer,[a] and David G. Angeler[b]

[a]Department of Political Science, Stockholm University, Stockholm, Sweden; [b]Department of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, Uppsala, Sweden

ABSTRACT

This article introduces an innovative method to describe data with sounds in political science. The method, known in ecology, physics, and musicology as "sonification," operates by linking sound signals to quantifiable observations. We us it to compose a choir of legitimacy crises in global governance from 1994 to 2014, and to negotiate a familiar divide in research on how legitimacy should be measured. Scholars predominantly prefer one of two approaches to measure legitimacy quantitatively, either looking at political trust or public contestation of political institutions. We illustrate the usefulness of sonification to subsume both positions in this divide. More generally, we argue that sonification can enhance public communication of scientific results and extract meanings from observations that go unnoticed in visual and verbal representations, in particular with relevance to describing time series data on anything from the spread of pandemics to violent conflicts and economic inequalities.

Introduction

Synergies of arts and sciences are increasingly recognized for their potential to encourage intuitive and creative thinking, and therefore also as helpful for increasing public literacy and social engagement with political issues.[1] The potential in art-science approaches to politics and the study of political science stems from the interactions between two psychological domains that both influence learning: the cognitive (thinking) and the affective (emotion) domains that are related to the sciences and the arts, respectively.[2] Exploratory work suggests that stimulating both learning domains, for example, public art programs engaging environmental issues, can be more effective in influencing

community life and private decisions than expert-based communications of academic knowledge.[3]

Among such art-science approaches is *sonification*, an emergent approach rooted in the production of sounds on the basis of scientific data.[4] Literally understood, sonification is a process of giving a sound to something that does not yet have a sound. In our application of sonification in this article, the concept captures processes of linking non-verbal sound signals to quantifiable observations, or measurements, of objects of scientific study. Thus understood, sonification is already used in the natural sciences, for example, in ecology, medicine, and physics.[5] The early appearance of sonification in these disciplines is no coincidence. Because sonification works by linking sounds to quantitative data, it has been relatively easy for the method to find interested users in the natural sciences, where quantitative means for description are more commonplace and less contested than anywhere else. Sun radiation, the temperature of planet Earth, and the melting of icebergs are objects of study that natural scientists have measured and sonified. One purpose then is to draw public attention to urgent or complex matters that would otherwise risk escaping the public attention which they might deserve. The many sonifications made of global warming and related matters, like changing water levels, are an illustration of this purpose.[6] But sonification is also used to discover new natural phenomena. For example, take our physicists claim having discovered the role of carbon as a diagnostic for solar wind by listening to the sound of their data.[7]

In the study of politics, the situation looks very different from that in the natural sciences: sonification appears to be completely absent. While quantitative methods are widespread in political science as well, some characteristics of the methodological debates in this discipline may still explain the absence of sonification. The use of quantitative methods, experimental designs, computer simulations, machine learning, and other research techniques originating from the natural sciences has, in political science, oftentimes emerged in opposition to an equally strong tradition of using qualitative, interpretative, and historical methods with origin in the humanities. The tension, sometimes hostility, between users of these methodologies indicate why political science is late in picking up on sonification – for sonification requires an openness toward describing politics in both qualitative and quantitative ways that is uncommon in this discipline. In any case, this article takes a holistic approach to methods, rejecting unnecessary choices

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[3]Eleri Evans. "How Green is My Valley? The Art of Getting People in Wales to Care about Climate Change," *Journal of Critical Realism* 13 (2014), pp. 304–325.

[4]Thomas Hermann, "Taxonomy and Definitions for Sonification and Auditory Display," *Proceedings of the 14th International Conference on Auditory Display*. (Paris, FR: International Community for Auditory Display, 2008). David Worrall, "An Introduction to Data Sonification," in R. T. Dean (ed.). *The Oxford Handbook of Computer Music* (Oxford, UK: Oxford University Press, 2009), pp. 312–333.

[5]David Worrall, "An Introduction to Data Sonification," in R. T. Dean (ed.) *The Oxford Handbook of Computer Music* (Oxford, UK: Oxford University Press, 2009), pp. 312–333; Dorien Herremans, Ching-Hua Chuan, and Elaine Chew, "A Functional Taxonomy of Music Generation Systems," *ACM Computing Surveys* 50:5 (2017), p. 69; Mark Ballora, "Sonification, Science and Popular Music: In Search of the 'Wow,'" *Organized Sound* 19:1 (2014), pp. 30–40; Hermann, "Taxonomy and Definitions for Sonification and Auditory Display."

[6]For example, David G. Angeler, Miguel Alvarez-Cobelas, and Salvador Sánchez-Carrillo, "Sonifying Social-Ecological Change: A Wetland Laments Agricultural Transformation," *Ecology and Society* 23:2 (2018). Outside the peer-reviewed literature, a Google search for videos with the term "sonification and climate change" yields 2580 returns as of August 2021.

[7]Enrico Landi, et al., "Carbon Ionization Stages as a Diagnostic of the Solar Wind," *The Astrophysical Journal* 744: 100 (2011), p. 3. For another example, Robert L. Alexander et al., "The Bird's Ear View of Space Physics: Audification As a Tool for the Spectral Analysis of Time Series Data," *Journal of Geophysical Research: Space Physics* 119:7 (2014), p. 5259–5271.

between qualitative and quantitative methods. We demonstrate how sonification can be fruitfully applied to represent quantifiable observations of legitimacy in global governance through sound structures that appear as music to the human ear. Our aim is to introduce sonification in political science and to explore its usefulness in the discipline as well as political communication more broadly.

Looking at the questions that are asked in political science, not the peculiarities of its methodological debates, sonification is particularly worthwhile. Political science asks questions which are important also for a broader public to contribute to solving social and environmental problems. For democratic politics to come to grips with, for example, climate change, economic inequalities, military conflicts, and global pandemics, the public will need some basic understanding of how those problems come about and can be addressed in politics. Depending on the definition of democracy, this observation may be more or less self-evident. Democratic politics differs regarding how much of the decision content is shaped by direct involvement of citizens or by their elected representatives alone. On standard definitions of the term, however, no political system that alienates an inclusive conception of the demos from political power may qualify as democratic.[8] For social or environmental problems to be solved in democratic politics, some general features of the problems must, therefore, be recognized and debated in the public. In that process of communication, sonification can play an important role. For political scientists, it is a tool to transmit their knowledge on matters like those noted above and many others – violent conflicts, economic inequalities, reactions to pandemics, as well as the varying amounts of political effort made by different political actors to address like issues. Facilitating the public uptake of such knowledge, sonification holds the potential to make political science more relevant to stimulate social and environmental progress in any decision-making system where the broader public plays just some role.[9]

Beyond the usefulness of sonification for practice in democratic politics, it may also stimulate creative and critical thinking within political science itself. Visual arts, including film and painting, are commonly used to explore both substantive and methodological problems in this field.[10] In this article, we illustrate a similar creative potential of sonification. We do so by addressing a particular challenge in research on global governance, namely to establish valid empirical measures of legitimacy. While research on legitimacy in global governance is increasingly quantitative and large-scale, the accumulation of

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[8]Robert Dahl. "Procedural Democracy" in Robert E. Goodin and Philip Pettit (eds) *Contemporary Political Philosophy* (Oxford, UK: Blackwell, 1998 [1979]) pp. 109–27. Hans Agné, "Democratism: Towards an Explanatory Approach to International Politics," *Review of International Studies* 44:3 (2018), pp. 547–569.

[9]The communicative effectiveness of sonification may depend on how familiar the audience is with the method, and it may currently be more likely to work in some public contexts than in others, for example, in movies, art galleries, and university courses where concentrated listening is supported by the norms of those social contexts. But even for audiences who lack experience with sonification altogether, it can be used to surprise and stimulate learning by shock. A key way for learning processes to being, in the sciences and more broadly, is by an individual's confrontation with an unusual, strange or troubling situation.

[10]Cynthia Weber, "The Highs and Lows of Teaching IR Theory: Using Popular Films for Theoretical Critique," *International Studies Perspectives* 2:3 (2001), pp. 281–287; Chantal Mouffe, "Art and Democracy: Art as an Agonistic Intervention in Public Space," *Open* 14 (2008), pp. 6–15; Stefan Jonsson, *Crowds and Democracy: The Idea and Image of the Masses from Revolution to Fascism* (New York, NY: Columbia University Press, 2013); Richard Swedberg, *The Art of Social Theory* (Princeton, NJ: Princeton University Press, 2014); Jason Frank, "The Living Image of the People," *Theory & Event* 18:1 (2015); Lisa Bogerts, "Mind the Trap: Street Art, Visual Literacy, and Visual Resistance," *Street Art & Urban Creativity Scientific Journal, Knowledge Transfer* 3:2 (2017), pp. 6–10.

results and construction of general theory are lagging because scholars lack measurements of legitimacy that are acceptable to all of them. Specifically, research on legitimacy is divided on whether to measure it by observing citizens' trust in global institutions[11] or by examining crises of legitimacy as manifested in public contestation of the institutions.[12] We argue that sonification can bring a deeper understanding of this debate by representing legitimacy in a single and unified musical experience.

Still, our application of sonification is different from the more familiar use in political science of films and paintings, noted above, which have been created for aesthetic purposes. Scholars across the social sciences use art work to illustrate political ideas in imaginative ways – look at the book covers around you, or search for scholarly contributions on politics and art, and there will be plenty of examples. But again, our principal aim is not to illustrate or explore ideas with pre-existing music, let alone explore the role of music in politics.[13] Instead, our principal aim is to create music, or mere sounds depending on the listener, to understand real phenomena in global politics more deeply, specifically how legitimacy in global governance develops over time. By the same token, our approach is different from the current uses of artificial intelligence to create music within existing genre conventions.[14] The aim of musical composition through machine-learning is to create music that comes as close as possible to music that exists already and which has been fed into a computer to begin with. In contrast, the application of sonification presented in this article aims to provide an epistemological added value in political science by extracting meanings from data that are difficult to grasp in other ways, for example, through visualization of data in diagrams or verbal interpretation. All human senses come with unique uses and limitations. Hearing, as activated by sonification, can complement verbal, numerical, and visual representations[15] and effectively integrate them into a single whole. Still, sonification is a complement to, not a competitor of, existing methods to represent and give meaning to data

To illustrate more concretely the potentials of sonification in political science, we develop the method to create a musical representation of how legitimacy has developed in global governance over twenty years. Because both music and time series have duration and sequences, sonification is particularly worthwhile to represent time-series data.[16] We represent trends of legitimacy in global and regional international organizations, for example, the International Monetary Fund and the European Union (EU), in the

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[11]Martin S. Edwards, "Public Support for the International Economic Organizations: Evidence from Developing Countries," *Review of International Organizations* 4:2 (2009), pp. 185–209; Lisa Maria Dellmuth and Jonas Tallberg. "The Social Legitimacy of International Organisations: Interest Representation, Institutional Performance, and Confidence Extrapolation in the United Nations," *Review of International Studies* 41:3 (2009): pp. 451–475.

[12]Matthias Ecker-Ehrhardt, "International Organizations 'Going Public'? An Event History Analysis of Public Communication Reforms 1950–2015," *International Studies Quarterly* 62:4 (2018), pp. 723–736; Klaus Dingwerth, et al., *International Organizations Under Pressure: Legitimating Global Governance in Challenging Times* (Oxford, UK: Oxford University Press, 2019).

[13]Marianne Franklin (ed.), *Resounding International Relations: On Music, Culture, and Politics* (New York, NY: Palgrave Macmillan, 2005).

[14]Dorien Herremans, Ching-Hua Chuan, and Elaine Chew, "A Functional Taxonomy of Music Generation Systems," *ACM Computing Surveys* 50:5 (2017), p. 69.

[15]Roland Bleiker, "Of Things We Hear but Cannot See. Musical Explorations of International Politics," in Marianne Franklin (ed.), *Resounding International Relations: On Music, Culture, and Politics* (New York, NY: Palgrave Macmillan, 2005), pp. 179–195; David G. Angeler, Miguel Alvarez-Cobelas, and Salvador Sánchez-Carrillo, "Sonifying Social-Ecological Change: A Wetland Laments Agricultural Transformation," *Ecology and Society* 23:2 (2018), p. 20.

[16]Mark Last and Anna Usyskin, "Listen to the Sound of Data," in A. K. Baughman, J. Gao, J-Y. Pan, and V. A. Petrushin (eds), *Multimedia Data Mining and Analytics* (New York, NY: Springer, 2015), pp. 419–446.

last decades. The composition is based on observations of three variables in a new dataset: survey data on citizen confidence in selected international organizations, critiques and contestation in global mass-media against these organizations, and street-level protests directed against them, also as reported in global mass-media. As one can see and hear, representing observations of these variables through music allows for a novel and alternative way of describing how global legitimacy has developed in recent decades. This method may inspire new ways to overcome the divide between measuring legitimacy by observing either citizen trust or public discontent, respectively. It also highlights traits and meanings in quantitative data that easily go unnoticed in verbal, numerical, and visual representations. Finally, the composing of music for the purpose of addressing methodological problems is a worthwhile project regardless of the precise meaning that is communicated in the music. We might not at this early stage in research have a sufficiently developed understanding of what a musical expression means in terms of empirically observable political developments. But even puzzlement and provocation can be useful to exploit new opportunities to observe and understand the political world through "big data," for instance. With this article we provide a sufficiently strong case for sonification in political science for others to take it seriously and identify ways in which our approach can be developed or need revision.

The article is structured in four sections. First, we introduce the topic of legitimacy in global governance, its conventional quantitative measurements, and discuss how legitimacy has developed during the last twenty years in key institutions. Second, we describe how sonification is applied to legitimacy data and how a choral, entitled "A Choir of Crises in Global Governance," is composed through the application of this technique. Third, we make a brief qualitative interpretation of the music and point to its usefulness for the purposes outlined above. Fourth, we summarize and discuss future research possibilities of data sonification in political science.

Legitimacy and Its Measures in Global Politics

It is common to distinguish between legitimacy in a normative and a descriptive sense.[17] Legitimacy, in a normative sense, refers to the right to rule of a political institution or a system of power. Legitimacy, in a descriptive sense, refers to a belief among relevant people that a system of power has the right to rule, or put differently: that it is legitimate in the normative sense of the term.[18] The distinction does not hold in every stage of research. Scholars of descriptive legitimacy need a normative concept of legitimacy when they clarify which beliefs and groups of people are relevant to observe empirically to conclude descriptive legitimacy.[19] Still, the distinction is useful to emphasize the primary concern in this article with empirical research and descriptive legitimacy. It is common in the literature to refer to legitimacy pure and simple – which gives limited guidance for

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[17]Ian Clark, "Legitimacy in a Global Order," *Review of International Studies* 29:S1 (2003), pp. 75–95; David Beetham, *The Legitimation of Power* (London, UK: Palgrave Macmillan, 2013).

[18]The same distinction is made in terms of legitimacy and perceived legitimacy by Allen Buchanan and Robert O. Keohane, "The Legitimacy of Global Governance Institutions," *Ethics & International Affairs* 20:4 (2006), pp. 405–437.

[19]Allen Buchanan, "Political Legitimacy and Democracy," *Ethics* 112:4 (2002), pp. 689–719; Hans Agné. "Legitimacy in Global Governance Research: How Normative or Sociological Should it be?" in Jonas Tallberg, Karin Bäckstrand and Jan Aart Scholte (eds) *Legitimacy in Global Governance: Sources, Processes, and Consequences* (Oxford, UK: Oxford University Press), pp. 20–34.

readers on the aims of a study. When using the term descriptive legitimacy we indicate our main concern with describing societal believes rather than describing the normative principles which make those beliefs relevant to describe in the first place.

In this vein, our approach to researching legitimacy is Weberian and sociological, not philosophical and based on argumentation in normative theory alone.[20] Following others who take a Weberian approach, the descriptive legitimacy of an institution is not merely about it being created and regulated by law, and legitimacy need not be about legality at all.[21] That is, a claim to the legitimacy of an institution involves more than a suggestion that it is created and regulated by law, and from some perspectives the question of legality need not even be raised to say whether an institution has legitimacy. A claim to descriptive legitimacy of an institution first and foremost involves an assertion of normatively based support for the right to rule of the institution within a relevant audience.[22] While legality is thus never sufficient for descriptive legitimacy in a Weberian sense, some scholars may still see it as conceptually necessary.[23] For our purpose in this article, however, the latter possibility can be usefully bracketed. Our research is limited to institutions that are established under the auspices of international law, which means that a minimal criterion of legality would be fulfilled, if indeed legality would be posited as a necessary condition for legitimacy. Still, we make no claims to cover all possible institutions that have descriptive legitimacy in politics beyond the state. Hence readers can supplement our discussion with either one of the following two alternative conceptual assumptions, that descriptively legitimate powers are always grounded in (domestic or international) law, or that some legitimate institutions are not grounded in law, and may even conflict with some laws.

Regardless of the exact definition of descriptive legitimacy with regard to legality, however, legitimacy is commonly assumed to be central for the effectiveness of political institutions.[24] The institutions that exist in global and regional politics are no exceptions: legitimacy is commonly seen as a key resource for international organizations to solve problems of conflict, economic growth, and environmental pollution.[25] Still, little is known about over-time patterns of legitimacy across international organizations. This lack of knowledge is grounded in a number of methodological challenges that we explain in the following section, and motivates our application of sonification later in the article.

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[20]Max Weber, *Economy and Society: An Outline of Interpretive Sociology*. Guenther Roth and Claus Wittich (eds), (Berkeley, CA: University of California Press, [1922] 1978).

[21]Ian Clark, "Legitimacy in a Global Order," *Review of International Studies* 29:S1 (2003), pp. 75–95; Hans Agné "Legitimacy in Global Governance Research: How Normative or Sociological Should it be?" in Jonas Tallberg, Karin Bäckstrand and Jan Aart Scholte (eds) *Legitimacy in Global Governance: Sources, Processes, and Consequences* (Oxford, UK: Oxford University Press), pp. 20–34.

[22]Hans Agné, "Legitimacy in Global Governance Research: How Normative or Sociological Should it be?" in Jonas Tallberg, Karin Bäckstrand and Jan Aart Scholte (eds) *Legitimacy in Global Governance: Sources, Processes, and Consequences* (Oxford, UK: Oxford University Press), pp. 20–34.

[23]For example David Beetham, *The Legitimation of Power* (London, UK: Palgrave Macmillan, 2013), although Beetham' explicitly social-scientific conception of legitimacy also differs and is presented as a critique of Weber's.

[24]David Beetham, *The Legitimation of Power* (London, UK: Palgrave Macmillan, 2013); Ian Hurd, *After Anarchy: Legitimacy and Power in the United Nations Security Council* (Princeton, NJ: Princeton University Press, 2008); Bruce Gilley, *The Right to Rule: How States Win and Lose Legitimacy* (New York, NY: Columbia University Press, 2009). For an alternative view on the effects of legitimacy, see Hans Agné and Fredrik Söderbaum, "The Costs of Legitimacy for Political Institutions" (manuscript under review).

[25]Jonas Tallberg, Thomas Sommerer, Theresa Squatrito, and Christer Jönsson, "Explaining the Transnational Design of International Organizations," *International Organization* 68:4 (2014), pp. 741–774.

Empirical Measurements: A Divided Field

Fueled by the increasing availability of large datasets in the study of international organizations, quantitative approaches to legitimacy have followed suit and today dominate this scholarship. While quantitative methods have advantages in this field,[26] no unified approach to measuring legitimacy has emerged. Whether this situation is problematic and should be overcome may be debated in light of different perspectives on what social science is and can do. Still, the plurality of approaches adds to the problem of existing data collections being limited in time and space and thus prevents scholars from capturing patterns and processes fully. Specifically, researchers have divided the field into two camps that aim for empirical measurements of legitimacy and legitimacy crises, respectively, that is, the positive and the negative sides of the same conceptual dimension. In this section, we describe each approach, notice why both sides are insufficient on their own, and identify the conceptual difficulty that has prevented the emergence of a unified approach so far. Our purpose then is to prepare the ground for illustrating how scholars of legitimacy who are currently segregated by the usage of different methods may identify a common ground for research by listening to a unified musical representation of empirical observations coming from both sides. In our view, the sonification of quantitative data also has the potential to open up new opportunities for a conversation with scholars who look at quantitative methods more critically.

The first approach to measure legitimacy is to pose survey questions to citizens about their trust, or confidence, in international organizations. The World Values Survey (WVS), conducted by a worldwide network of social scientists, is a primary data provider for scholars that applies this approach.[27] The WVS is the only survey that includes items of relevance to the legitimacy of a larger number of international organizations over time. The method combines the strength of broad representation with several weaknesses. Individual citizens are disconnected from power in global governance. Acquiring knowledge on global governance demands more cognitive and economic resources than it does to acquire knowledge on domestic institutions. From the perspective of individual citizens, institutions of global governance are more remote than national governments, and individuals may be largely unaware of international policy-making as a result. The expected knowledge gap on international governance, supported also in empirical research, can make mass publics more susceptible to elite manipulation,[28] and attitudes based on limited knowledge may reflect private interests rather than on publicly justifiable norms. Moreover, even the WVS as the most comprehensive survey available offers little continuity in the coverage of international organizations while including citizens from a limited number of countries in each survey.

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[26]Yoram Z. Haftel and Alexander Thompson, "The Independence of International Organizations: Concept and Applications," *Journal of Conflict Resolution* 50:2 (2006), pp. 253–275.

[27]Martin S. Edwards, "Public Support for the International Economic Organizations: Evidence from Developing Countries," *Review of International Organizations* 4:2 (2009), pp. 185–209; Matthias Ecker-Ehrhardt, "Why Do Citizens Want the UN to Decide? Cosmopolitan Ideas, Particularism and Global Authority," *International Political Science Review* 37:1 (2016), pp. 99–114; Lisa Maria Dellmuth "Individual Sources of Legitimacy: Theory and Data" in Jonas Tallberg, Karin Bäckstrand and Jan Aart Scholte, (eds), *Legitimacy in Global Governance: Sources, Processes, and Consequences* (Oxford, UK: Oxford University Press, 2018) pp. 37–54.

[28]Lisa Maria Dellmuth, "The Knowledge Gap in World Politics: Assessing the Sources of Citizen Awareness of the United Nations Security Council," *Review of International Studies* 42:4 (2016), pp. 673–700. Thomas Sommerer and Hans Agné, "Consequences of Legitimacy," in Jonas Tallberg, Karin Bäckstrand, and Jan Aart Scholte (eds), *Legitimacy in Global Governance: Sources, Processes, and Consequences* (Oxford, UK: Oxford University Press, 2018) pp. 153–167.

The second approach measures crises of legitimacy and builds on publicly visible statements and actions of activists and politicians. For example, legitimacy has been estimated by global media coverage of public discontent with international organizations – including the voices of heads of states and governments, cosmopolitan elites as well as street protests of grassroots movements that target international organizations.[29] An advantage of this approach is that it gives scholars some chance to get back in time to create time-series, that it measures actions and utterances intended for the public rather than private attitudes, and that it captures social groups of relevance to international organizations. The main downside, however, is the risk of over-representing highly motivated and resourceful activists from the Global North in the measurement of legitimacy and underestimating protests or demonstrations from other parts of the world as well as tacit support for political institutions.[30]

The fact that both measures have drawbacks, as well as complementary strengths, is an argument in favor of constructing a joint measure of legitimacy or – at least – to account for results of both measurements in a holistic qualitative assessment of the development. After all, the measures are both intended to capture the same concept and, therefore, are not mutually exclusive. Still, it is not evident how to integrate two measurements that are defined by the minimal and the maximal degrees of a property, respectively. While the maximum score on a scale of trust in a survey instrument is indicative of, simply, trust, the meaning of a minimal score on the same scale is ambiguous. The absence of reported trust can refer either to a situation in which audience beliefs maximally oppose the institution on normative grounds or to a situation in which the audience lacks trust while thinking that trust is an unimportant feature of an unimportant institution. Hence a legitimacy measure defined by trust is ambiguous when it comes to describing lower levels of legitimacy. For the measures of public discontent, on the other hand, the same vagueness appears at the opposite end of the scale. While the minimal level of legitimacy is defined by observations of maximal protests and critiques in the public, it remains unclear how to interpret the absence of public discontent. It may imply either full trust based on normative principles or the absence of an engaged attitude in relation to an institution. It is unclear, therefore, how the two measurements adopted in legitimacy research could, or should, be integrated with a single measure. The middle-ground, where either of the two scales should lead over to the other, is under-defined by each of the two approaches.

On top of these conceptual difficulties, there is little knowledge of how citizen trust and public critique and streets protests relate to each other empirically. Is it justified to expect a low level of trust in political institutions to correspond to high levels of protests? Does the absence of public challenges accompany high trust? Do citizen attitudes lag behind elite criticism? Before applying sonification to assess the possibility and meaning of bringing together the different ways to measure legitimacy, we overview the empirical patterns based on them.

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[29]Jonas Tallberg, Thomas Sommerer, Theresa Squatrito, and Christer Jönsson, "Explaining the Transnational Design of International Organizations," *International Organization* 68:4 (2014), pp. 741–774; Matthias Ecker-Ehrhardt, "International Organizations 'Going Public'? An Event History Analysis of Public Communication Reforms 1950–2015," *International Studies Quarterly* 62:4 (2018), pp. 723–736; Klaus Dingwerth et al., *International Organizations Under Pressure: Legitimating Global Governance in Challenging Times* (Oxford, UK: Oxford University Press, 2019).
[30]Mark Herkenrath, and Alex Knoll, "Protest Events in International Press Coverage: An Empirical Critique of Cross-national Conflict Databases," *International Journal of Comparative Sociology* 52:3 (2011), pp. 163–180.

Empirical Patterns

Figure 1 provides an overview of the trend of citizen trust in international organizations based on responses from the World Value Surveys distributed between 1994 and 2014. It shows little variation across the observation period. The average score for organizations included in the survey ranges between the middle categories of "quite a lot of confidence" and "not very much confidence." Trust in international organizations thus seems to be rather stable. The only change is a negative trend after the turn of the millennium, which is emphasized with the minimum and maximum trust scores for different countries. These patterns do not vary dramatically between organizations, as the four examples of the African Union, European Union, the North Atlantic Treaty Organization (NATO), and United Nations illustrate (Figure 1, right panel). Finally, it may be noted that trust in international organizations is a phenomenon on its own; it may be related but is empirically distinct from trust in key political institutions such as national governments.

Alternative measures of legitimacy focusing on public critiques and protests differ relative to trust in international organizations. We draw on an original dataset that captures media coverage on critical statements by governmental representatives, civil society, and other IOs (Authors, unpublished). Figure 2 illustrates a leptokurtic distribution, with sharp increases and decreases for both elite critique and mass protests over time. An all-time high of legitimacy challenges appears around 2000, followed by a clear downward trend after that. During the crisis years, international organizations such as the International Monetary Fund, the World Trade Organization, and the World Bank were targeted by protests of civil society and the anti-globalization movements, and other organizations were criticized by foreign leaders for their military involvements, such as NATO in Kosovo. In further contrast to the picture of legitimacy yielded by the trust measurement, individual organizations show idiosyncratic patterns. Figure 2 (right panel) shows variation across international organizations regarding the level of public challenges. It also shows differences in the sequence, amplitude, and timing of the variability.
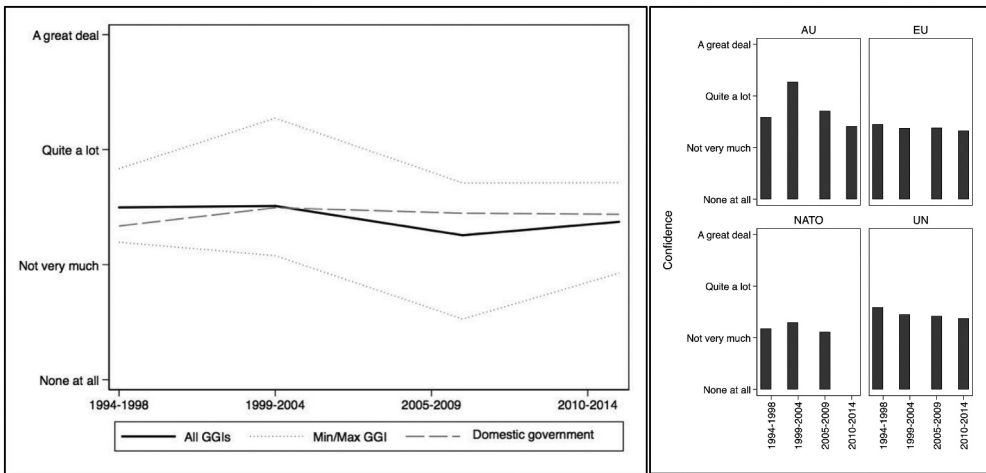

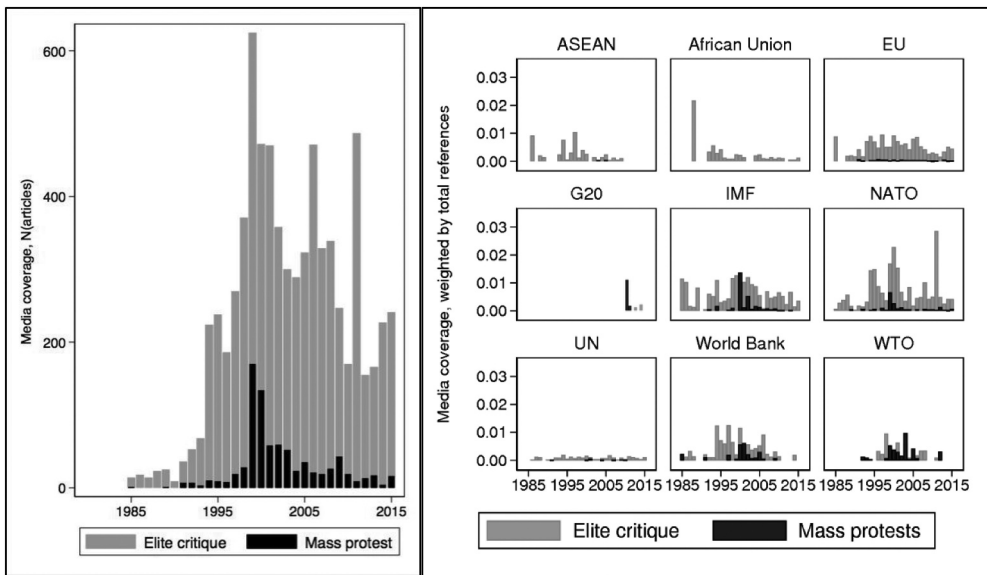**Figure 1.** Trust in International Organizations, World Value Survey.

Figure 2. Critique and Protest against International Organizations, Media Coverage.

In summary, no clear picture of the nature and development of legitimacy emerges when applying both approaches to measure international organizations. The two approaches reveal different and partially contradicting aspects of legitimacy. One highlights a relatively constant trend with minor shifts in trends and variation across institutions. The other shows higher variability, including abrupt changes, and a clear peak in legitimacy challenges, while patterns at the level of individual organizations highlight asynchronous waves of protest and critique. As we will argue, sonification has the potential to integrate these heterogeneous phenomena into a coherent sound structure that provides a novel way of representing variability within and between the variables. This can help to draw new attention to how these variables jointly contribute to a more complete understanding of legitimacy.

Approach: From Graphs to Sounds

Time series data can display rhythm without any sounds having been added to it. Supplement 1 illustrates this possibility with a dynamic diagram (video) of the data that we described earlier in Figures 1 and 2. The rhythm that emerges through the purely visual Supplement 1 illustrates why sonification is particularly worthwhile to describe time-series data. It is motivated, therefore, to apply sonification to compose and perform music based on the time-series data visualized before. We do so by composing "A Choir of Crises in Global Governance." The music can be listened to in Supplement 2 (sound-file) or red in Supplement 3 (scores). The music can also be heard while watching a video with a dynamic diagram (Supplement 6) or while reading the scores (Supplement 7).

A Choir is based on three variables: citizen trust in international organizations; public critique of international organizations as reported in global media; and street protests against international organizations, also as reported in global media. The decision to compose a choral, rather than, say, a piano trio or a guitar solo, is motivated by our object of inquiry. Legitimacy is a belief in the normative justifiability of a political institution by a concrete audience or group of people. The blending of different voices in singing their experiences of global politics is one way of reflecting this conceptual meaning of legitimacy in music. Moreover, the natural blending of voices in a choir simplifies for listeners to explore, with music, how competing approaches to measuring legitimacy work together.

While motivated, the decision to compose a choir is not neutral from political and theoretical viewpoints. One may ask whether it makes sense to speak of a "choir" in global governance, as may suggest a sense of unity and a "singing together." We cannot provide a direct test of the ontological assumptions of ours that individual and corporate actors who express their beliefs about the justifiability of global institutions are all part of a structure that is worthwhile to research as a meaningful whole (neither could any alternative ontological assumption be directly tested, such that individuals belong first and foremost to their nations, to their classes, or to their genders). However, we notice the empirical fruitfulness of actors in global governance being represented as a choir. For as we will see in the following section, one of the interpretations of global legitimacy that is generated by our sonification finds corroboration in empirical research that have emerged without any assumption of there being a "global choir." But let us not race ahead to results and instead use this section to explain the composition process.

Three different voices represent the variables in A Choir. Citizen trust, mass protests and public critique in the mass media are sung by a bass, a tenor and a soprano, respectively. This allocation of voices corresponds to differences among the variables. Citizen trust shows the least variation over time and across organizations, which corresponds to the conventional role played by the bass in music, namely to provide a reference point that allows the melody to be heard more easily. Public critique and street protests both display more variation than citizen trust does, which motivates their location in a higher register. Among these variables, public critique shows the most conspicuous variation within and between octaves, which is represented through the voice of a soprano.

Observations over the longest period for which the WVS provides relevant data, from 1994 to 2014, generate the music. We include all information in the entire survey for our first variable: trust in international organizations. The selection of countries and international organizations varies across years, while patterns across international organizations are similar (Figure 1), and people of all countries are relevant to assess their legitimacy. For the two other variables in the composition, public critique and protests, the estimates are more dependent on the choice of organizations (Figure 2). We, therefore, select five organizations that vary in their regional orientation, policy domain, and degree of institutionalization, namely: The International Monetary Foundation, the World Trade Organization, the Group of Twenty, the European Union, and the Association of East Asian Nations. Some of these organizations also appear in the WVS data, for example, the European Union and the Association of East Asian Nations.

To prepare our data for translation into sound, we first change the average trust variable so that it has the same time-unit as the two other variables. While empirical observations of trust originate from yearlong waves of public opinion surveying, the

constituent parts of the surveys at the country level can be assigned to a particular year within each wave. For instance, during the 6th wave of the WVS (2010–2014), the interviews for Japan were conducted in 2010, in New Zealand in 2011, in Pakistan in 2012, in Germany in 2013, and in Algeria in 2014. We thus disaggregate the data to country level, and following that operation, we then generate estimates of average citizen trust for individual years, which is the time-unit at which public critique and mass protest have been measured already. We also invert the citizen trust variable, so that high variable values indicate illegitimacy for all three variables for all variables. Higher values of illegitimacy will be represented by higher pitches and lower values with lower pitches.

Some further steps are motivated by our aim to generate music-like sounds. Listening to the same tone for several minutes may not appear as music among conventional listeners. Pitches in the extreme upper range can be painful, and very low pitches are difficult for most people to distinguish. When seeking to avoid those problems of "nonmusical" sounds, our purpose is to exploit the greater potential of music to stimulate creativity, communication, and critical attention to changes. To this end, we prepare the variables so that the variable ranges are neither too big nor too small. Specifically, we *rank* individual years in the time series based on their values on the three variables. This procedure allows us to treat all variables in broadly the same way, compressing some variable ranges and expanding others. Ranking also has the advantage of accommodating a musical convention. Melodies often consist of stepwise changes upwards or downwards a musical scale. A change in a ranked variable approximates such stepwise alterations more closely than a change in continuous variables do.

In light of the need to prepare variables for sonification and the many possible ways of doing so, we also decide some steps in the application based on the sound of the output. Among the many chorales that have been composed during the research phase for this article, the one that we interpret here is selected because it enlightens issues of legitimacy more easily than the others. The (dis)trust variable used in A Choir was defined by one decimal, while the other variables had no limitations in their numbers of decimals when ranked. Compositions that observe the same rule of ranking do not sound radically different. Supplement 4 includes the sound file of a variant of A Choir for which the number of decimals was the same for all variables at the moment of ranking. To illustrate a possibility of a more subjective approach, Supplement 5 includes a sound file where we add strings to the three voices in A Choir (violin, viola, and contrabass respectively) and increase the tempo, which results in a more emotional representation. Having considered these alternatives and others, we concentrate on results of sonification that bear most directly and clearly on issues of legitimacy in political science (Supplements 2, 3, 6, and 7) to facilitate for others to grasp more easily the potential of the method in political science.

To simplify the presentation, we denote the composition in A minor, which has no flats or sharps (A, B, C, D, E, F, and G). An A represents the year with the lowest rank value, but in different octaves depending on the variable. A in the great octave is used for citizen distrust (bass). A in the small octave is used for mass protest (tenor). A in the first octave is used for mass-media critique (soprano). All other tones are allocated to individual years depending on the position of an individual year in the rank order of all years based on a specific variable. The choice to denote the composition in minor may emphasize normatively problematic aspects in the real political situation, in contrast to the more lively expressions sometimes associated with major keys, in particular among western

listeners. If so, our choice of a minor key will conform to the earlier decision to represent illegitimacy with higher pitches (that appear more prominently in music than low pitches do) in conjunction with the fact that illegitimacy is normatively problematic by definition. However, because our data determines the order of tones, the difference between major and minor is one of notification, not of musical expression. The difference between A minor and C major comes about through the order of tones that are generated by the data and which we do not control.

The time signature is set to three quarters, and the tempo to 60 beats per minute. Our motivation is to arrive at a composition that lasts approximately one minute, the time we hope that our readers will devote to listening. Each year in the time-series lasts for three seconds in the music. Except for extending the last note in the song we conserved the structure of the data in the music as much as possible. While each year in the data is represented by a single measure that lasts for three seconds, the tones, or chords, for each year will ring during two measures by overlapping with the tones, or chords, for the following year. We use this "reverb" to highlight the time structure of our data in a way that is difficult to do in verbal, numerical, and visual representation. The legitimacy of global institutions in one year is never independent of but influenced by, their legitimacy in the preceding years. Sonification can naturally integrate the data from several points in time in a single and unified sound, and we exploit that feature. We used the freeware *Musescore 2.3.2* to compose the music and to create the scores as well as to perform the composition in the Supplementary Materials.

Hearing Legitimacy Crises in Global Governance

Listening to the music both supports and deepens our understanding of how legitimacy in global governance has developed over time. Indicating the tempo of A Choir, the sound-file in Supplement 2 begins with six beats (over two ¾ measures). After the first four measures in A Choir (seconds 6–17 in the sound file approximately), the tenor and soprano voices raise to a maximum that is sustained for two measures, while the bass (citizen trust) is shifting in a seemingly unrelated way and distracts somewhat from the intensity of this moment (seconds 18–29 approximately in the sound file). In Supplements 6 and 7, which support the sound with visual markers in diagrams and scores, respectively, the points of highest intensity are heard in the years 1999, 2000, and 2001. This is the peak of the legitimacy crisis that characterized global governance toward the end of the millennium, most emblematic in the "Battle of Seattle," the street protests that targeted the 1999 summit of the World Trade Organization and brought public attention to the global justice movement. There is no equally intense moment in the later part of the composition, but shorter outbreaks of critique or protest appear with some regularity. The bass represents increasing discontent in the last measures, contributing to a musical expression between tenderness and fragility.

Beyond this confirmation of the empirical patterns described in diagrams already, the music also draws attention to new aspects of the data. The music that follows the crises in 1999–2001 expresses a sense of relief and beauty as the painfully high human voices give place to a more familiar chord (see measures 6–8 in Supplement 2 or listen to the relevant years in the visualized sound files of Supplements 6 and 7). The identification of such passages in music brings attention to structures of potential importance for

understanding legitimacy in real politics. A generalized implication of this particular observation in the music is that the meaning and effects of legitimacy at one point in time depends on the levels of legitimacy at an earlier point of time. The relevance of such a dynamic understanding of how legitimacy operates in global governance also seems to be supported by empirical research. According to a large-scale empirical study, the effects of legitimacy crises, measured by public contestation, on the effectiveness of inter-governmental organizations are dynamic and changing depending on the time frame chosen to observe legitimacy crises and their effects: there is a "need to think of legitimacy's effect as following a dynamic or dialectical script. The first reaction to a legitimacy crisis will itself become a cause with own and perhaps opposite effects in the next time sequence," according to the scholars behind the empirical study.[31] The correspondence between this empirically based conclusion and our musical interpreta-tion gives some initial support for the potential in sonification to reveal real dynamics in data that easily go unnoticed in visual representations. The same observation also corroborates the fruitfulness of composing a choir instead of treating each variable separately.

The hearing of legitimacy also gives meaning to the possibility of measuring legitimacy in a unified approach that includes political trust as well as public discontent (as described in the first section in the article). In the musical experience, the problem of undefined end-points for the two measures that we clarified in a previous section is mitigated in two ways. First, vocal parts that are based on the different measures give meaning to each other (soprano and bass complement each other and make it easier to appreciate and listen to both). Hence the music prepares scholars for conceiving of measures of both trust and public discontent as relevant and helpful in relation to each other. Second, the music illustrates the meaningfulness of listening to contradictory interpretations of the same historical development. The time after 2001 in A Choir may be seen to illustrate either a partly regained legitimacy or a continually low legitimacy in global governance, or both of those political situations at the same time. A music that focuses the attention of the listener to the possibility of such contradictory interpretations of the data is likely to stimulate the emergence of new perspectives and deeper knowledge about its content. Identification of paradoxes or contradictions is an important step to bring any research forward.

Furthermore, our sonification is helpful to spell out preconceptions of legitimacy developments in global governance as useful to improve legitimacy measurements. For example, listeners may find A Choir too static and regular for the purpose of representing the dynamic development of global legitimacy 1994–2014 (in particular perhaps after having listened to the emotionally stronger variant in Supplement 5). In the musical understanding of the terms, the composition lacks rhythm and nuances. Such critical reactions, insofar as they emerge among listeners, may indicate that empirical measures of legitimacy should aim for a dynamic and rhythmic approach. All empirical measure-ments will not be equally successful in the regard. The creation, for example, of an additive or multiplicative index that integrates the different measures of legitimacy is unlikely to capture the preconceptions about this phenomenon insofar as sonification has revealed those preconceptions to be dynamic and rhythmic. A more accurate and

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[31]Bart Bes, Thomas Sommerer, and Hans Agné, "On Legitimacy Crises and the Resources of Global Governance Institutions: A Surprisingly Weak Relationship?" *Global Policy* 10:3 (2019), p. 322.

promising first step in the construction of valid empirical measurements would then be to examine in detail how rhythm and nuance can be observed in real legitimacy and create measurements on that basis. Identification of this avenue for research on global legitimacy is an example of how sonification can inspire and motivate methodological developments in political science.

Critical reactions to the music, informed by its purpose to represent developments of legitimacy crises, may also be useful to develop music itself. To illustrate, the research reported in this article involved a process of reiterated composition to gain insight into a particular methodological problem in political science clarified in an earlier section. The research process thus illustrates how the critique of a particular musical composition, as informed by empirical precepts of the object of study, can lead to a number of different musical compositions. In short, the critique serves the important purpose of creating better music. Critical reactions to A Choir from wider audiences will likely illustrate the inspirational potential of sonification in similar ways. If our sonification is found not to describe global legitimacy in epistemologically useful ways according to others, while we as composers are entrusted to hear that critique and incorporate it in further refined application of sonification, the potential in sonification to improve musical composition will have been illustrated in yet one case. A similar logic applies also to music composed and enjoyed primarily for aesthetic aims. Just like composers from Beethoven to Dylan have been inspired in their compositions by lay or personal observations of politics and social matters, ranging from armed battles to public protests to peace celebrations,[32] music may in the future draw inspiration also from the more specialized observations of politics made by political scientists, should sonification become more widely practiced. Sonification can thus extend the relevance of political science beyond politics to become a source of inspiration for people who are concerned in the first place with music.[33]

Conclusion

In this article, we have developed and applied sonification to represent time-series data on legitimacy in global governance. We composed a choral named, "A Choir of Crises in Global Governance," and have used the music strategically to address problems in empirical research on legitimacy in global governance. We find that the musical representation of legitimacy illustrates the usefulness of the method for several wider purposes. These include the integration of discrete empirical observations into a single experience; the stimulation of intuitive and creative thinking in research; the inspiration for musical compositions by knowledge in political science; the exploitation and understanding of big data in social science; and enhanced usefulness of political science to its end-users in the wider society.

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[32]For more examples, see Roland Bleiker, "Of Things We Hear but Cannot See: Musical Explorations of International Politics" in Marianne Franklin (ed.) *Resounding International Relations: On Music, Culture, and Politics* (New York, NY: Palgrave Macmillan, 2005), pp. 179–195.

[33]Good music may also be important for politics and public administration. For an interesting example, see Phillip Bimstein, "Composing a Community: Collaborative Performance of a New Democracy," *New Political Science* 32:4 (2010), pp. 593–608.

In a broader exchange between political and natural sciences and public audiences, interdisciplinary approaches can be used to integrate different knowledge domains as well as to provide opportunities to link the generation of knowledge with transforming societies.[34] Our choral showcases the application of sonification as a tool to represent and potentially communicate political challenges as described in political science through music in those exchanges. Public awareness and engagement are needed to address issues such as economic inequalities and human rights violations in a fast-changing world. This article, together with work in natural science[35] highlight the potential of sonification to represent such issues. Implementing this approach for communicating social risks and awareness, which hinges to a large degree on politics, can be highly valuable as societies move rapidly to an uncertain future.

To exploit the potential in sonification more fully in political science, it is important first of all to increase the number of applications of the method and the openness to using it. To evaluate its limitations and opportunities, we need an array of examples for listening. Researchers in political science who share their applications of the method should, therefore, be seen in the future as having made important contributions to the development and assessment of this method. Scholars with fewer opportunities to apply the method in their own research may also contribute to its development by merely knowing that it exists. Strictly qualitative scholars, whose analyses do not allow or benefit from quantifiable observations, will not have much opportunity to apply sonification as presented in this article. But awareness of the method can still be important to further broader scholarly conversations. For example, next time that you review a quantitative paper for publication, you may well find it appropriate to ask for the sound file to assess the structure and validity of the data.[36]

Supplementary Material

Supplement 1. Rhythmic diagram (video) on time-series data without sounds. Can be accessed at: https://doi.org/10.1080/07393148.2020.1809760
Supplement 2. Sound file for A Choir of Crises in Global Governance. Can be accessed at: https://doi.org/10.1080/07393148.2020.1809760
Supplement 3. Scores for A Choir of Crises in Global Governance. Can be accessed at: https://doi.org/10.1080/07393148.2020.1809760
Supplement 4. Sound file for variant B of A Choir of Crises in Global Governance (completely ranked data for all variables). Can be accessed at: https://doi.org/10.1080/07393148.2020.1809760
Supplement 5. Sound file for variant C of A Choir of Crises in Global Governance (same as in Supplements 2, 6, 7, 8, but adding strings to voices and higher tempo). Can be accessed at: https://doi.org/10.1080/07393148.2020.1809760
Supplement 6. Rhythmic diagram (video) on time-series data with sounds
Supplement 7. Video on scores and sounds. Can be accessed at: https://doi.org/10.1080/07393148.2020.1809760

The videos (1, 6, 7) are best played with the programs Quicktime or Windows Media Player (the program VLC Media Player works less well). The sound files (Supplements 2, 3, 4, and 5) can be played with any of these programs and many others.

Supplementary Material also available at: www.statsvet.su.se/the-sounds-of-data-in-political-science

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Notes on contributors

Hans Agné is a political scientist at Stockholm University, with a background in music and performing art criticism. Beyond his interest in sonification, he currently researches democracy at global scale to explain foreign policy and international developments; the conditions for peace and conflict in relation to agents with general artificial intelligence; and the nature and effects of a global legitimacy crises.

Thomas Sommerer is a political scientist at Stockholm University. He is interested in the study of global governance and political science methodology. His recent work focuses on the design of international organizations and the role of legitimacy and democracy in world politics.

David G. Angeler is an ecologist at the Swedish Agricultural University in Uppsala. He collaborates regularly with scholars from the social, economic and medical sciences to address the challenges that humanity faces on a fast changing planet. His most recent work is carried out at the intersection between the sciences and the arts and includes the sonification of ecological time series.