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Article

The Science–Policy Interface as a Discourse Network: Finland's Climate Change Policy 2002–2015

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Abstract
In this article, we argue that the science–policy interface can be understood as a discourse network constituted by discursive interaction between scientific organizations and other actors that both use scientific arguments in conjunction with other policy arguments. We use discourse network analysis to investigate the climate change policy process in Finland between 2002 and 2015, focusing on the role of and relationships between scientific actors and arguments in the discourse networks. Our data consist of policy actors' written testimonies on two law proposals, the ratification of the Kyoto Protocol (2002) and the enactment of the Finnish Climate Law (2015). Our results show that two competing discourse coalitions have influenced the development of climate change policy in the 2000s. In 2002, the dominant coalition was economic, prioritizing economic growth over climate change mitigation. In 2015, the climate coalition that argued for ambitious mitigation measures became dominant. The majority of scientific actors were part of the dominant economy coalition in 2002 and part of the dominant ecology coalition in 2015. The centrality of scientific arguments increased over time, and both discourse coalitions used them progressively more. These developments reflect the increasingly central position of science in Finnish climate policymaking. We contribute to the literature on the science–policy interface by operationalizing the interface as a set of connections in a discourse network and by showing how the analysis of discourse networks and their properties can help us understand the shifts in the role of science in policymaking over time.

Keywords
climate change; economy; Finland; public policy; science–policy interface

Issue
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1. Introduction

Climate change is a policy sector in which the role of scientific information is particularly salient. The Intergovernmental Panel for Climate Change, established in 1988 to provide policymakers with information about climate change, has produced a tremendous amount of knowledge on the various impacts of anthropogenic climate change. However, there has been a discrepancy between the amount of scientific knowledge and the policy responses to climate change. The reasons for this mismatch are manifold, but one factor is particularly important in climate policymaking: Environmental policies, such as climate policy, are ultimately about reconciliation between different values and interests (Hoffman, 2015; Hulme, 2009; Layzer, 2016). Consequently, climate science cannot dictate policy action nor escape the social world: Policy actors tend to make their own interpretations of scientific knowledge and use it selectively in congruence with their own values and preferences (Pielke, 2002).

The literature on the science–policy interface examines this exact dilemma—that is, the often-complicated

relationship between science and policy. This literature has identified many contextual factors that complicate the functioning of this interface (Bremer & Glavovic, 2013; Dilling & Lemos, 2011; Lacey, Howden, Cvitanovic, & Colvin, 2018; Lahsen, 2009; Pielke, 2010; Runhaar & Nieuwaal, 2010). One of these factors—the politicization of science—is particularly salient for the climate science–policy interface (Brown, 2015; Pielke, 2010; Sarewitz, 2004; Weingart, 1999; Wesselink, Buchanan, Georgiadou, & Turnhout, 2013). By politicization, we refer to the process whereby science becomes part of general value and power struggles in society (Pielke, 2010; Sarewitz, 2004). In keeping with this definition, politicization does not necessarily mean that scientific facts are denied or scientific actors confronted on political grounds, even though such things do take place in climate change politics, particularly in the US (McCright & Dunlap, 2011). Instead, the politicization of science is a wider discursive process whereby policy actors interpret scientific knowledge and assess its policy implications in varied ways, and they use it selectively in public debates to support their own political and ideological goals (Bremer & Glavovic, 2013; Runhaar & Nieuwaal, 2010; Sarewitz, 2004; Weingart, 1999). Scholars have argued that the politicization of science has paradoxically accelerated as the role of science and scientific actors has strengthened in policymaking in recent decades (Pielke, 2002; Weingart, 1999).

This article examines the science–policy interface from a novel perspective, using discourse network analysis (DNA; Leifeld 2019). DNA examines political discourse as a network in which policy actors group into competing discourse coalitions based on shared discourses. Our relational approach offers a novel tool to systematically analyze the science–policy interface. Using DNA, we can zoom in on the role and relationships of scientific actors and arguments in the policy debate by examining questions such as the following: Which discourse coalitions are scientific actors a part of? How central are scientific actors and arguments, compared to other policy actors and arguments, in the policy debate? We argue that by analyzing these relational properties, we can better understand the science–policy interface.

Our empirical case is Finland, where scientific knowledge has enjoyed a relatively strong position in policy processes. According to recent studies, however, science in relation to climate change policy has become politicized in Finland in the 2000s (Hildén, 2011; Kerkkänen, 2010; Leipola, 2018). Our data consist of 86 written testimonies given by policy actors in official consultation processes regarding two key events in Finnish climate policymaking—the ratification of the Kyoto Protocol (2002) and the enactment of the Finnish Climate Law (Finnish Government, 2015).

2. Literature and Research Questions

The literature on the science–policy interface analyzes the relationship between science and policy by examining the configuration of actors that are "involved in the production, mediation, and application of [scientific] information" (Kettle, Trainor, & Loring, 2017, p. 2). Based on the early models, the science–policy interface was conceptualized as a linear process whereby science and policy formed a close partnership in regard to the resolution of political problems (Weingart, 1999). However, this model has since experienced a significant reversal. Some scholars have concluded that the availability of scientific knowledge alone does not guarantee effective or desirable policy outcomes (Lahsen, 2009; Pielke, 2010; Wesselink et al., 2013).

In this literature, many factors that intervene in the interface resulting from the science and policy end have been identified. Intrinsic factors related to the production of scientific information itself can complicate the interface. These factors include the relevance of scientific information to policymakers, the ineffective communication of scientific uncertainty to policymakers and the scientists' inadequate understanding of the decision-making context (Dilling & Lemos, 2011; Runhaar & Nieuwaal, 2010). Contextual factors related to the policymaking environment are also numerous and include institutional and financial barriers, such as having few collaborative structures between scientists and policymakers or having too few resources (Bremer & Glavovic, 2013; Dilling & Lemos, 2011). With regard to climate change policymaking, some scholars have identified numerous crucial factors that influence the functioning of the science–policy interface. For instance, they have looked at how scientific information flows in climate policy networks between the producers and users of scientific knowledge (Kettle et al., 2017; Wagner et al., 2020) and how political and cultural factors, such as political culture and geopolitics, impede the use of scientific knowledge in climate policymaking (Lahsen, 2009). Having too little or too much trust in the climate–science policy interface can also complicate the use of scientific knowledge in policymaking (Lacey et al., 2018).

One strand of this literature examines the politicization of science in discursive processes. Discourse is defined as "an ensemble of ideas, concepts and categories through which meaning is given to phenomenon" (Hajer & Versteeg, 2005, p. 75). Discursive approaches to the science–policy interface note that scientific and technical knowledge is always interpreted in a specific social and political context (Dryzek, 2005; Jasanoff, 2004; Wesselink et al., 2013). Policy actors play a crucial role in how they frame and selectively use scientific results (Jasanoff, 2004; Weingart, 1999; Wesselink et al., 2013). According to these perspectives, science tends to be politicized in discursive processes: Policy actors construct differing, often competing discourses about scientific knowledge and its policy implications based on their different values and interests (Forsyth, 2012; Pielke, 2010; Sarewitz, 2004).This literature also suggests that as science and scientific actors become an important part of the policy process, this simultaneously leads

to the increased politicization of science (Pielke, 2002; Weingart, 1999).

However, previous studies on the politicization of science rarely offer systematic tools to analyze these discursive processes, and when they do, they often downplay the fact that political discourse is a relational phenomenon: Policy discourses involving scientific organizations and actors are formed in the interactions between policy actors. We aim to fill this gap by using DNA, which is a combination of qualitative content analysis and quantitative network analysis (Leifeld, 2017). DNA offers a systematic tool to analyze several properties of the science–policy interface, such as the existence of competing discourse coalitions and the centrality of scientific actors and arguments in discourse networks in relation to other policy actors and arguments. A discourse coalition is a group of political actors in the public sphere whose members share a similar empirical or normative interpretation of a policy issue (Hajer, 1993). Studies argue that discourse coalitions have a significant impact on policy processes by shaping policy priorities and framing policy problems in different ways (Bulkeley, 2000; Hajer, 1993; Kukkonen, Ylä-Anttila, & Broadbent, 2017; Kukkonen et al., 2018; Leifeld & Haunss, 2012; Rennkamp, Haunss, Wongsa, Ortegad, & Casamadrid, 2017). Centrality, in turn, is a network property that demonstrates the importance of a node in the whole network. In our case, it indicates whether scientific actors are central in the climate policy discourse and how widely scientific arguments are used to support other policy arguments.

Discourse network properties such as these have an important impact on policy processes (Leifeld & Haunss, 2012). We argue that analyzing these properties and their changes is useful for understanding the science–policy interface and the shifts in the use of science in policy processes over time. Our research questions are as follows:

RQ1: What kind of discourse coalitions are present in the Finnish climate change policy process between 2002 and 2015, and how central are scientific actors?

RQ2: How central are scientific arguments, and what other types of policy arguments are they used in conjunction with?

3. Case, Data, and Methods

Studies have suggested that in regard to climate policymaking in Finland, science has become a target of political battles in the 2000s (Hildén, 2011; Kerkkänen, 2010; Leipola, 2018). According to these studies, political actors have used scientific knowledge selectively and to advance their own political goals. In 2017, for instance, the Finnish Climate Change Panel published a report in which it warned the government that the plans to increase logging would decrease carbon sinks for decades (Seppälä et al., 2017). However, the report was interpreted in contradictory ways, and the Finnish government even used it to defend additional logging (Leipola, 2018). In general, climate change policymaking has been controversial in Finland. Finnish climate policy has been influenced to a great extent by the heavy industry, whose lobby has been able to hinder effective climate policymaking by framing climate change in an unfavorable way, namely by arguing that climate change mitigation will hurt economic growth and national competitiveness (Hildén, 2011; Kerkkänen, 2010). Finland is economically reliant on the success of its export industry, such as the forest and metal industry, which explains the significant influence of these industries. Research has also shown that the Finnish government has strong collaborative ties to the heavy industry in regard to climate policymaking and few ties to NGOs and research organizations (Gronow & Ylä-Anttila, 2019; Gronow, Ylä-Anttila, Carson, & Edling, 2019; Teräväinen, 2010).

In this article, we examine the role of science in Finnish climate change policymaking between 2002 and 2015, which is a key period in the formation of Finnish climate policy. Based on the literature reviewed above, we expect to find that the role of science in climate change policy discourse has become increasingly central over the course of these years.

Our data consist of 86 written testimonies given by policy actors from different sectors regarding two law proposals: the ratification of the Kyoto Protocol in 2002 and the enactment of the Finnish Climate Law in 2015. We chose to analyze these two events because they constitute major landmarks in Finnish climate change legislation. Both law proposals have undergone an official consultation process, providing us with testimonies from policy actors and thereby enabling us to investigate the role of scientific actors and arguments over time.

Finland ratified the Kyoto Protocol in 2002. Finland's obligation under the protocol was to keep its greenhouse gas emissions at the 1990 level. As part of the EU's climate change legislation, Finland has been obliged, for instance, to join the EU's Emissions Trading System, reduce greenhouse gas emissions in non-Emissions Trading System sectors according to the EU's joint burden-sharing agreement, and increase the share of renewable energy in its energy production).

The Finnish Climate Law came into force in June 2015. It is a framework law that sets up a system to plan, coordinate, and track Finnish climate change policymaking in non-Emissions Trading System sectors. The Finnish Climate Law does not include any substantive legislation for different policy sectors, businesses, or citizens, but it includes a binding long-term emission target for Finland—that is, an 80% reduction by 2050, compared to the 1990 emission levels. The law strengthens the role of the Finnish Parliament, enhances different stakeholders' participation in Finnish climate policymaking, and establishes and identifies the role of the Finnish Climate Change Panel as an advisory body to the government in climate policymaking. The Finnish Climate Law changed the division of labor between the different ministries

to some extent. The Ministry for Economic Affairs and Employment is still responsible for the implementation of EU's climate change legislation in Finland, which has been carried out via national climate and energy strategies since 2001. The Ministry of Environment is responsible for the coordination of UN and EU climate negotiations, as well as sectors such as land use, waste management, and construction. Along with the Finnish Climate Law, the Ministry of Environment's mandate for climate and energy policy was expanded to include the responsibility for coordinating the medium-term climate policy plan. The Ministry for Agriculture and Forestry remains responsible for issues related to the use of forests.

During the official consultation procedures linked to most major legislative processes in Finland, the responsible ministry sends requests for a written testimony to a group of policy actors that represent the most important stakeholders in Finnish climate change policy. These include business and trade organizations, NGOs, and scientific organizations. Table 1 lists the organizational affiliations of the policy actors that gave written testimonies in 2002 and 2015.

The testimony is a free-form text in which the policy actor expresses support for or opposition to the law proposal at hand and justifies its position. These testimonies are publicly available from the government's electronic archives (Finnish Government, 2019). The responsible ministry collects the testimonies and considers them when preparing the law. In the case of the Kyoto Protocol, we have no information on how many requests for testimony were sent, but 30 policy actors delivered written testimonies. In the case of the Finnish Climate Law, 81 policy actors were contacted and 69 delivered written testimonies. In their testimonies, some policy actors merely stated that they had no comments or they expressed support for the law proposal without justifying their position. These testimonies are excluded from the final data set because they do not include any policy arguments for analysis. The final data set includes 22 testimonies from 2002 and 64 from 2015. The Supplementary File includes the list of policy actors that delivered testimonies.

Using the DNA software (Leifeld, 2019), we coded all the policy statements that were included in the testimonies. These statements represent general arguments that policy actors use to defend or oppose/raise concerns over the law proposal. The arguments could deal with causes, definitions, or solutions related to the law proposal at hand. We distinguished between general policy arguments and scientific arguments. Scientific arguments differ from other policy arguments in that they draw on scientific research or refer to scientific actors.

We assigned the statements to different argument categories, which were formed inductively during the coding process. For each statement, we coded four attributes: name of the person, name of the organization, the argument category referred to by the organization (called 'concept' in the DNA context), and agreement or disagreement with the argument category. One testimony could include multiple statements.

For example, the following statement belongs to the argument category 'climate science supports the enactment of the Finnish Climate Law':

> Scientific evidence on anthropogenic climate change is strong. The assessments of the impacts of climate change on people, societies, and the environment at different time scales have been done based on the existing scientific knowledge. To avoid the uncontrolled consequences of climate change, actions to reduce GHG [greenhouse gas] emissions are really needed. Enacting the Finnish Climate Law is one way of systematizing the matter. (Ministry of Transport and Communications, 2014)

This is classified as a scientific argument. The following statement, which belongs to the argument category 'Climate Law could weaken economic growth and national competitiveness,' is an example of a nonscientific policy argument: "Well managed commercial forests store carbon most effectively. The Finnish Climate Law could restrict this type of rational action…and lead to unnecessary restrictions for the forest industry" (Forest Owners' Association of Finland, 2014).

Table 1. Organizational affiliations of policy actors giving written testimonies in 2002 and 2015.

	Ratification of the Kyoto Protocol (2002)		Enactment of the Finnish Climate Law (2015)	
	N	%	N	%
Business and trade organization	10	45	19	30
Government	5	23	10	16
Environmental NGO	3	14	7	11
Scientific organization	4	18	11	17
NGO	0	0	9	14
Municipal government	0	0	4	6
Business	0	0	3	5
Other	0	0	1	1
Total	22	100	64	100

Table 2. The final dataset.

	Policy actors	Statements	Concepts (argument categories)
Kyoto Protocol (2002)	22	119	28
Finnish Climate Law (2015)	64	342	29

The coding procedure resulted in 28 argument categories in the case of the Kyoto Protocol and 29 in the case of the Finnish Climate Law (Table 2). However, when exporting the data to the social network analysis software, we included only the most common argument categories (Kyoto ratification: more than three mentions by actors; Climate Law: more than six mentions by actors). This resulted in 17 argument categories in the case of the Kyoto Protocol and 15 in the case of the Finnish Climate Law. The selected argument categories represent 85% of all statements in both cases (for a full list of the argument categories, see the Supplementary File). Tables 3 and 4 list the argument categories and their abbreviations (used in the figures in the results section) for our two data time points, 2002 and 2015.

After coding, we created one-mode co-occurrence networks of policy actors and argument categories using the DNA software. In our case, the co-occurrence of actors and arguments is based on congruence. This means that policy actors share a tie in the discourse net-

Table 3. Argument categories and abbreviations during the ratification of the Kyoto Protocol (2002).

Kyoto Protocol (2002)			
Argument category	Agree/disagree (N)	N	Shortened form
Kyoto Protocol could weaken economic growth and national competitiveness	13/0	13	Economic growth and national competitiveness
Finland should use nuclear energy to reduce GHG emissions	9/2	11	Nuclear energy
Energy efficiency is essential in the reduction of GHGs	8/0	8	Energy efficiency
Finland's emission targets should not be tightened	7/0	7	Emission targets not tightened
Kyoto Protocol promotes the use of renewable energy	6/1	7	Renewable energy
Kyoto Protocol should include large emitters	6/0	6	Large emitters
Climate science supports the ratification of the Kyoto Protocol	6/0	6	**Climate science**
Finland should invest in Research & Development to reduce GHG emissions	6/0	6	**Research and development**
Finnish industry's emissions are as low as possible	5/0	5	Finnish industry has low emissions
The Emissions Trading System is problematic	4/0	4	Emissions Trading System is problematic
Kyoto Protocol creates economic growth	4/0	4	Economic growth
Economic studies support the ratification of the Kyoto Protocol	4/0	4	**Economic studies**
Finland should use the Kyoto mechanisms to reduce GHG emissions	4/0	4	Kyoto mechanisms
Finland should be able to decide independently how it will reduce its GHG emissions	4/0	4	National decision-making
More studies on the economic impacts of the Kyoto Protocol are needed	4/0	4	**Studies on economic impacts**
The law proposal's calculations are incorrect	4/0	4	**Incorrect calculations**
Finland should not ban coal-condensing plants	4/0	4	Coal-condensing plants not banned

Note: Scientific arguments are marked in bold.

Table 4. Argument categories and abbreviations during the enactment of the Finnish Climate Law (2015).

Finnish Climate Law (2005)			
Argument category	Agree/Disagree (%)	N	Abbreviation
Climate Law should include a long-term emission target	23/18	41	Long-term emission target
Climate science supports the enactment of the Finnish Climate Law	27/2	29	**Climate science**
Climate Law improves the coordination and planning of Finnish climate policymaking	24/0	24	Coordination and planning
Climate Law strengthens transparency and participation in Finnish climate policymaking	23/1	24	Transparency and participation
Climate Law could weaken economic growth and national competitiveness	23/0	23	Economic growth and national competitiveness
Finnish Climate Change Panel should have legal status	16/4	20	**Legal status of the climate change panel**
Energy policy should be the focus of climate policy	19/1	20	Energy policy
Climate Law is unnecessary and overlaps with current legislation	19/0	19	Law Is unnecessary
Climate Law burdens the administration	19/0	19	Administrative burden
Emissions Trading System should be included in the long-term emission target	13/4	17	Inclusion of Emissions Trading System
More studies on the economic impacts of the Finnish Climate Law are needed	14/0	14	**Studies on economic impacts**
Climate Law creates economic growth	13/0	13	Economic growth
Climate Law improves the image of Finnish climate policy	11/0	11	Image of Finnish climate policy
Social scientific studies support the enactment of the Finnish Climate Law	8/0	8	**Social scientific studies**
Finnish Climate Change Panel should include representation from different scientific fields	7/0	7	**Scientific representation of the climate change panel**

Note: Scientific arguments are marked in bold.

work if they both agree or both disagree with an argument. Argument categories share a tie if a same policy actor uses these two argument categories in a testimony, agreeing or disagreeing with both categories. Edge weights are often normalized to better identify coalitions from media discourse networks in which there is a significant degree of conflict present and the actors' levels of activity differ (Leifeld, 2017). Our data, in contrast, consist of written testimonies in which policy actors usually express their perspectives without criticizing others, and each actor gives only one testimony, resulting in a network with few conflict ties. Consequently, we did not normalize edge weights. Additionally, we did not use threshold values due to the relatively small size of the data.

Using the Gephi software package, we analyzed the positions and relationships of scientific organizations and scientific arguments in the discourse networks. We used two techniques of social network analysis: the Louvain clustering algorithm and the measuring of closeness centrality. First, we used the Louvain algorithm to divide the network into communities. The algorithm counts a modularity score with a value of between −1 and 1, which measures the density of the links inside communities compared to the links between them (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008). Clustering the actor networks allowed us outline the competing discourse coalitions and to determine which coalitions the scientific organizations are a part of. Clustering the argument network, in turn, made it possible to examine which types of arguments are grouped together—that is, used by the same actors in their testimonies. This indicated what type of policy arguments scientific arguments are most strongly connected to.

Second, we used closeness centrality to analyze the network position of the policy actors and arguments. We chose this measure because it takes into account how central a node is in the whole network, calculating the average number of steps that must be taken for a node

to reach all the other nodes in the network (Freeman, 1979). To control for the size of the network, closeness scores were normalized so that their values lie between zero and one. The closeness centrality score indicates how central the actor/argument is in the whole network across its subgroups. Bearing the limitations of the research design in mind, an actor or argument with a high centrality score can be interpreted as having an important role in the policy discourse (for alternative methods of analyzing the position of different actors and arguments in a discourse network, see, e.g., Buckton, Fergie, Leifeld, & Hilton, 2019; Fisher, Waggle, & Leifeld, 2013).

4. Results

In this section, we present and analyze four network diagrams that illustrate the position and relationships of scientific organizations and arguments in the discourse networks—first in 2002 and then in 2015. The closeness centrality of an actor/argument is reported as a number in parentheses after the name of each actor/argument.

Figure 1 illustrates the actor network during the ratification of the Kyoto Protocol in 2002. We identified two competing discourse coalitions in the network using modularity. Based on their arguments (Figure 2), we refer to them as the economy coalition and the climate coalition. The economy coalition is dominant: It includes 14 actors while the climate coalition has 8. It also includes the majority of the most central actors in the network.

Among the most central actors in the network are two scientific actors, and they belong to the dominant economy coalition. These are the VTT Technical Research Center of Finland (0.95) and the VATT Institute

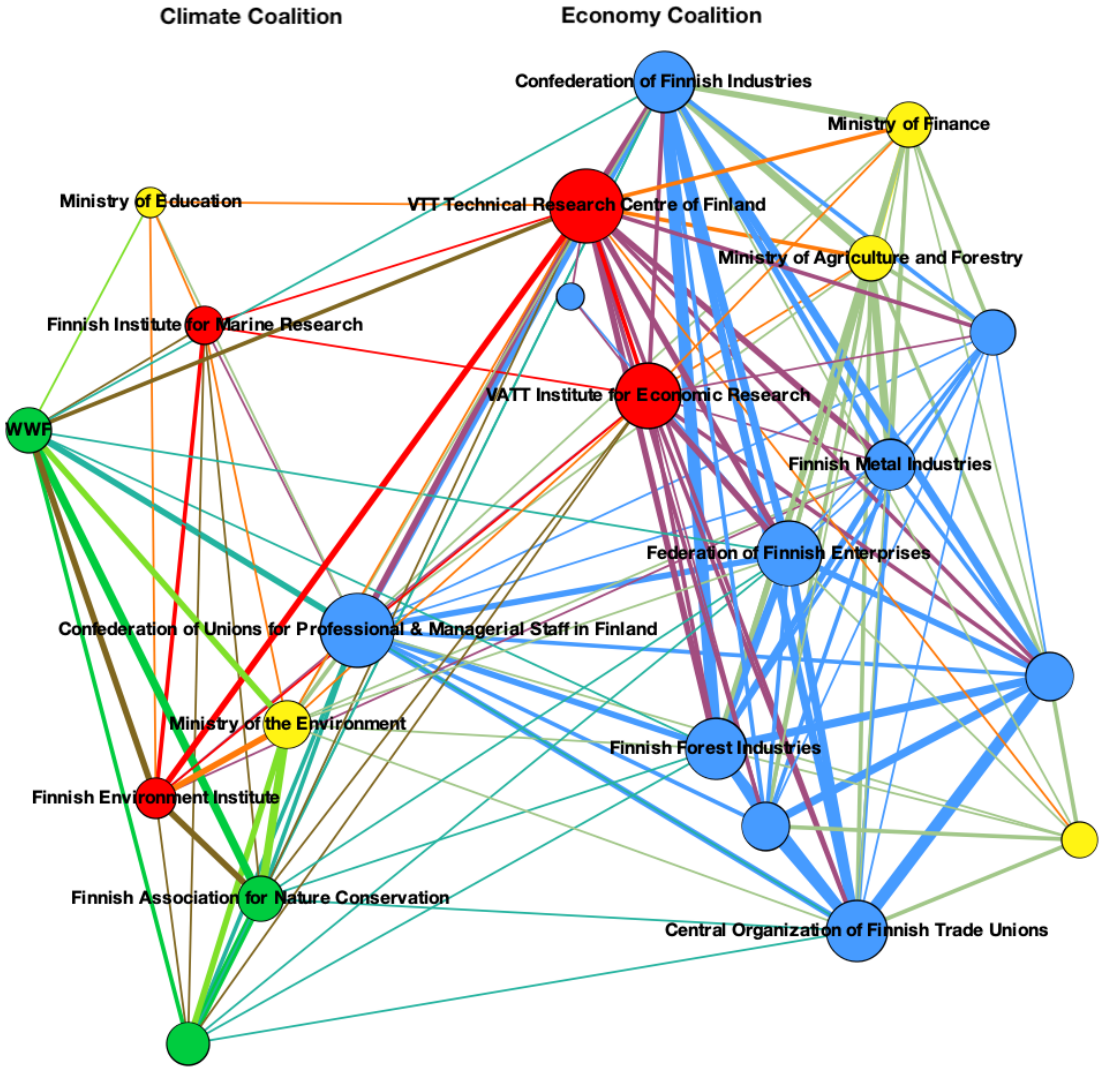

Figure 1. One-mode network of actors via argument categories during the ratification of the Kyoto Protocol (2002). Notes: Node size adjusted based on closeness centrality; ties based and weighted according to congruence. Modularity: 0.203. Red: scientific organization; blue: business organization/trade union; yellow: government; green: environmental NGO; brown: NGO; orange: municipal organization; purple: business; pink: others. Selected actors are labeled to ensure readability of the figure. The color of each edge is the average of the colors of the two nodes that the edge connects.

for Economic Research (0.88). These scientific actors are sectoral research institutes that have an established role in Finnish legislative processes, providing background reports and calculations for the government. Based on agreement, they are allied with business and trade organizations, such as the Confederation of Finnish Industries (0.84), Finnish Forest Industries (0.84), and the Central Organization of Finnish Trade Unions (0.84). Earlier research has demonstrated that these organizations are among the most powerful in regard to climate change policy processes in Finland (Gronow & Ylä-Anttila, 2019; Gronow et al., 2019). The economy coalition also includes ministries, such as the Ministry of Finance (0.7) and the Ministry of Agriculture and Forestry (0.7).

Scientific actors are also represented in the competing, less dominant climate coalition, but they are not as central as the scientific actors in the economy coalition. The scientific actors in the climate coalition are the two environmental research institutes, the Finnish Environment Institute (0.66) and the Finnish Institute for Marine Research (0.64). These scientific actors form the climate coalition together with organizations such as the Ministry of Environment (0.72), the Ministry of Education (0.57), and the Confederation of Unions for Professional and Managerial Staff (0.95), as well as environmental NGOs such as the Finnish Association for Nature Conservation (0.7) and the World Wildlife Foundation Finland (0.7). These organizations play a less powerful role in Finnish climate change policymaking than the organizations belonging to the economy coalition (Gronow & Ylä-Anttila, 2019; Gronow et al., 2019).

Figure 2 shows what types of arguments are central in the network and how their use is divided between the two coalitions. Scientific arguments (red nodes) are not

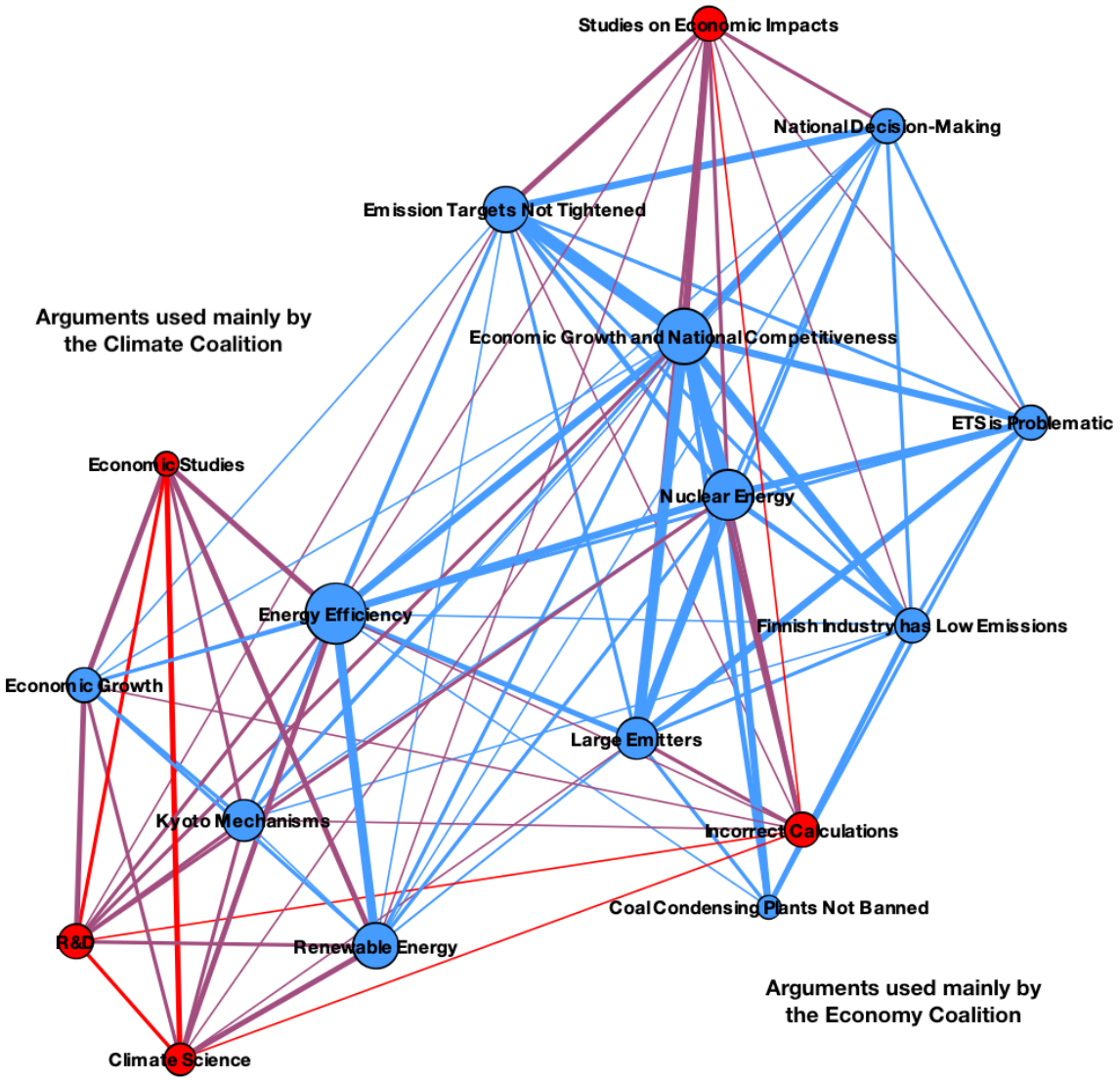

Figure 2. One-mode network of arguments via actors during the ratification of the Kyoto Protocol (2002). Notes: Node size adjusted based on closeness centrality; ties based and weighted according to congruence. Modularity: 0.225. Red: scientific argument; blue: other policy argument. The color of each edge is the average of the colors of the two nodes that the edge connects.

central in the network. Policy actors mainly use policy arguments other than scientific arguments to defend the Kyoto Protocol (climate coalition) or raise doubts about its implementation in Finland (economy coalition). The most central arguments of the economy coalition are that the Kyoto Protocol could weaken economic growth and national competitiveness (0.94), that the required reduction of GHG emissions can only be achieved by increasing the use of nuclear energy (0.89), and that the protocol should include the largest emitters, such as the US and developing countries (0.8).

The economy coalition uses two types of scientific arguments; however, as noted earlier, they do not have a central position in the network. First, the economy coalition argues that more studies are needed on the economic impacts of the Kyoto Protocol (0.73), fearing that the protocol could induce unbearable costs for businesses and consumers. Second, the coalition argues that the law proposal includes incorrect or unclear calculations about Finland's emission targets and demands that these calculations be corrected (0.73).

The most central argument in the network is that the Kyoto Protocol will support plans to increase energy efficiency (1.0). The climate coalition uses this argument more than the economy coalition. The climate coalition's other central arguments are that the protocol will speed up Finland's shift to renewable energy (0.84) and, contradicting the economy coalition's argument, that it will support economic growth, especially in the long run (0.73). Three types of scientific arguments are used to back up the other policy arguments, but again, they occupy a less central position than the other policy arguments. First, the climate coalition argues that the protocol will increase funding for research and development to reduce GHG emissions (0.73). Second, the climate coalition draws on climate science and evidence on the anthropogenic nature of climate change to support the protocol. Third, it argues that current economic studies, such as the impact assessments of the policy options included in the law proposal, support the implementation of the protocol (0.62).

Figure 3 illustrates the actor network during the enactment of the Finnish Climate Law in 2015. Compared to 2002, the number of actors giving testimonies increased significantly, from 22 to 64. In addition, while two competing discourse coalitions remain in the discourse network, the coalitions are now more evenly sized. The climate coalition includes 33 actors and is now bigger than the economy coalition, which has 31 actors.

Whereas in 2002, the two most central actors were scientific, all scientific actors are now moderately central. Specific ministries, business organizations, and trade unions are now the most central actors, reflecting a more widespread involvement of organizations from different sectors. In addition, the scientific actors have now shifted from the economy coalition to the climate coalition, sharing more arguments with the latter than with the former. The climate coalition comprises nine scientific actors. The VTT Technical Research Center (0.72) and the VATT Institute for Economic Research (0.77), the two research institutes that belonged to the economy coalition in 2002, have changed sides and now belong to the climate coalition. Other scientific actors in the climate coalition include the Finnish Climate Change Panel (0.82) and the Finnish Institute for Health and Welfare (0.75). The scientific actors are aligned with ministries, including the Ministry of Transport and Communications (0.9); the Prime Minister's Office (0.78); and some business-initiated organizations, such as the Finnish Bioenergy Association (0.83) and the Solid Waste Association (0.86). The climate coalition now also includes a large number of environmental and other NGOs, such as the Finnish Association for Nature Conservation (0.82) and the development NGO Kepa (0.76). Overall, the scientific organizations of the environment coalition now have a broader and more powerful set of allies in the climate coalition than they did in 2002 (cf. Gronow & Ylä-Anttila, 2019; Gronow et al., 2019).

The economy coalition comprises only two scientific organizations, which are not central: the Forest Research Institute (0.65) and MTT Agrifood Research Finland. These sectoral research institutes are aligned with business organizations and trade unions, of which 16 belong to the economy coalition. These include the Central Organization of Finnish Trade Unions (0.91), the Union for Agricultural Producers and Forest Owners (0.76), and the Forest Owners' Association of Finland (0.79). The coalition also includes ministries, such as the Ministry for Economy and Employment (0.93), which is the most central actor in the network; the Ministry of Agriculture and Forestry (0.74); and the Ministry of Finance (0.74). In addition, the economy coalition includes one denialist organization, a small NGO called the Climate Forum (0.68).

While the centrality of scientific arguments was relatively low in 2002, in 2015, they were among the most central arguments in the discourse network (Figure 4). The climate coalition uses three types of scientific arguments to support the Finnish Climate Law. First, it appeals to climate science (0.93), arguing that climate change legislation should be based on the latest scientific evidence on climate change. Second, the climate coalition supports giving the Finnish Climate Change Panel a legal status (0.88), arguing that this will strengthen the role of scientific knowledge in Finnish climate policymaking. Third, actors in the climate coalition appeal to recent social scientific studies that point to the need to enact the Finnish Climate Law (0.82). These studies include scientific reports that have been based on the social, political, and economic aspects of climate policy. These reports speak to the benefits of implementing the Finnish Climate Law.

The climate coalition uses these scientific arguments to back up other policy arguments. The most central of these other arguments is that the law will improve transparency and participation in Finnish climate policymaking (1.0). The law increases different stakehold-

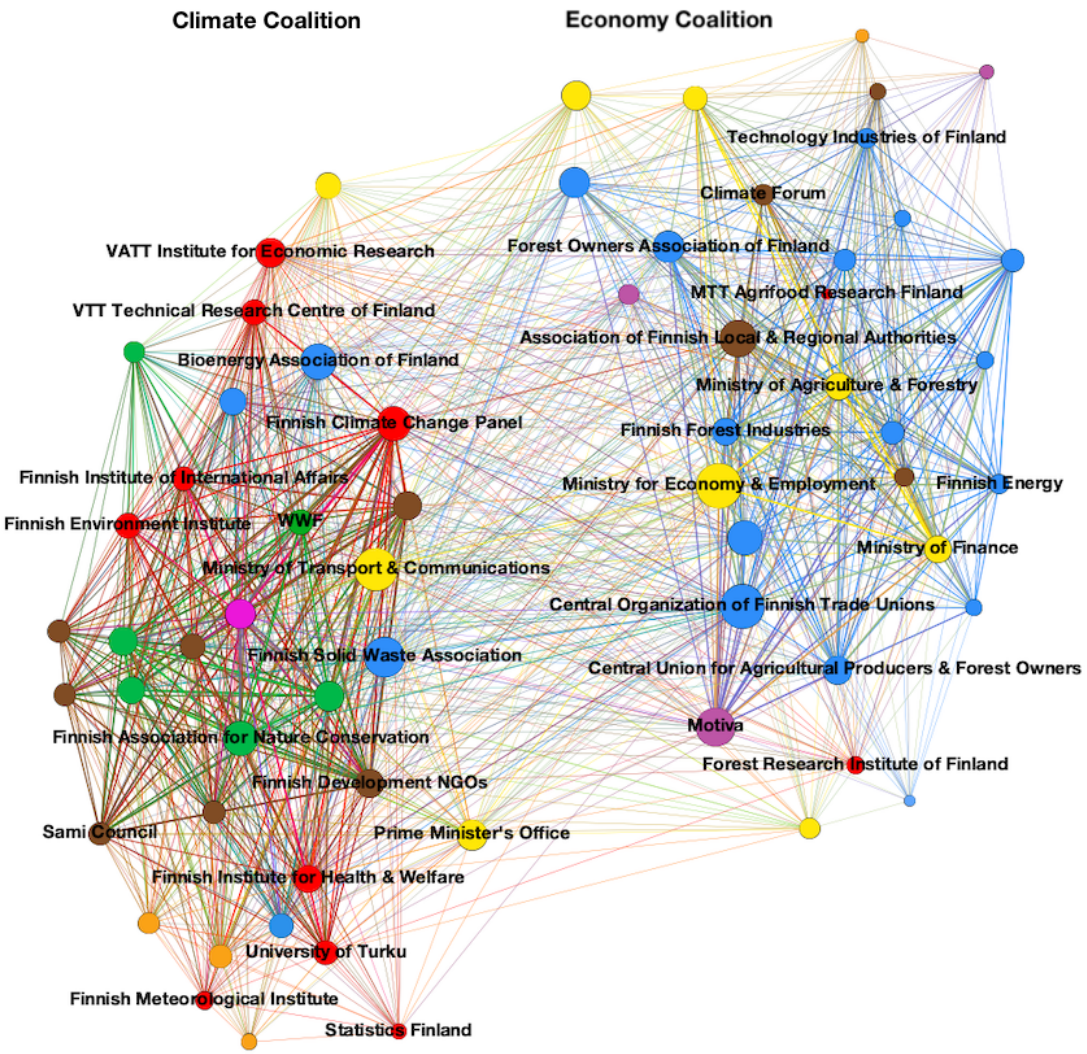

Figure 3. One-mode network of actors via argument categories during the enactment of the Finnish Climate Law (2015). Notes: Node size adjusted based on closeness centrality; ties based and weighted based according to congruence. Modularity: 0.334. Red: scientific organization; blue: business organization/trade union; yellow: government; green: environmental NGO; brown: NGO; orange: municipal organization; purple: business; pink: others. Selected actors are labeled to ensure readability of the figure. The color of each edge is the average of the colors of the two nodes that the edge connects.

ers' possibilities to participate in the climate change policy process, and the climate coalition demands that the background reports and calculations of law proposals and strategies be made public in the future. The climate coalition supports the inclusion of the Emissions Trading System sector in the long-term emission target (0.93) and argues that enacting the Finnish Climate Law will increase economic growth (0.88) by facilitating companies' efforts to make low carbon investments.

The economy coalition opposes the enactment of the Finnish Climate Law. Scientific arguments are also central in the argumentation of this coalition, and there are two types. First, the economy coalition stresses that more studies should be conducted on the economic impacts of the Finnish Climate Law (0.93), as the law could worsen the cost-efficiency of climate policy. Second, the coalition states that the Finnish Climate Change Panel should include wide representation from different research fields (0.67). The coalition emphasizes that the panel should take the business perspective into account in its policy recommendations and should, thus, include representatives from economics and technology studies. The economy coalition uses these scientific arguments in conjunction with other policy arguments that refer to the cost of climate policymaking. As in the case of the Kyoto Protocol, the coalition argues that the law could weaken economic growth and national competitiveness (0.88) and would burden the administration (0.88), which is in contradiction to the plans to streamline the Finnish administration. The coalition also opines that climate policy should mainly be about energy policy (0.88). In Finland, climate policy has traditionally been closely connected to energy policy, as the national climate and energy strategies demonstrate.

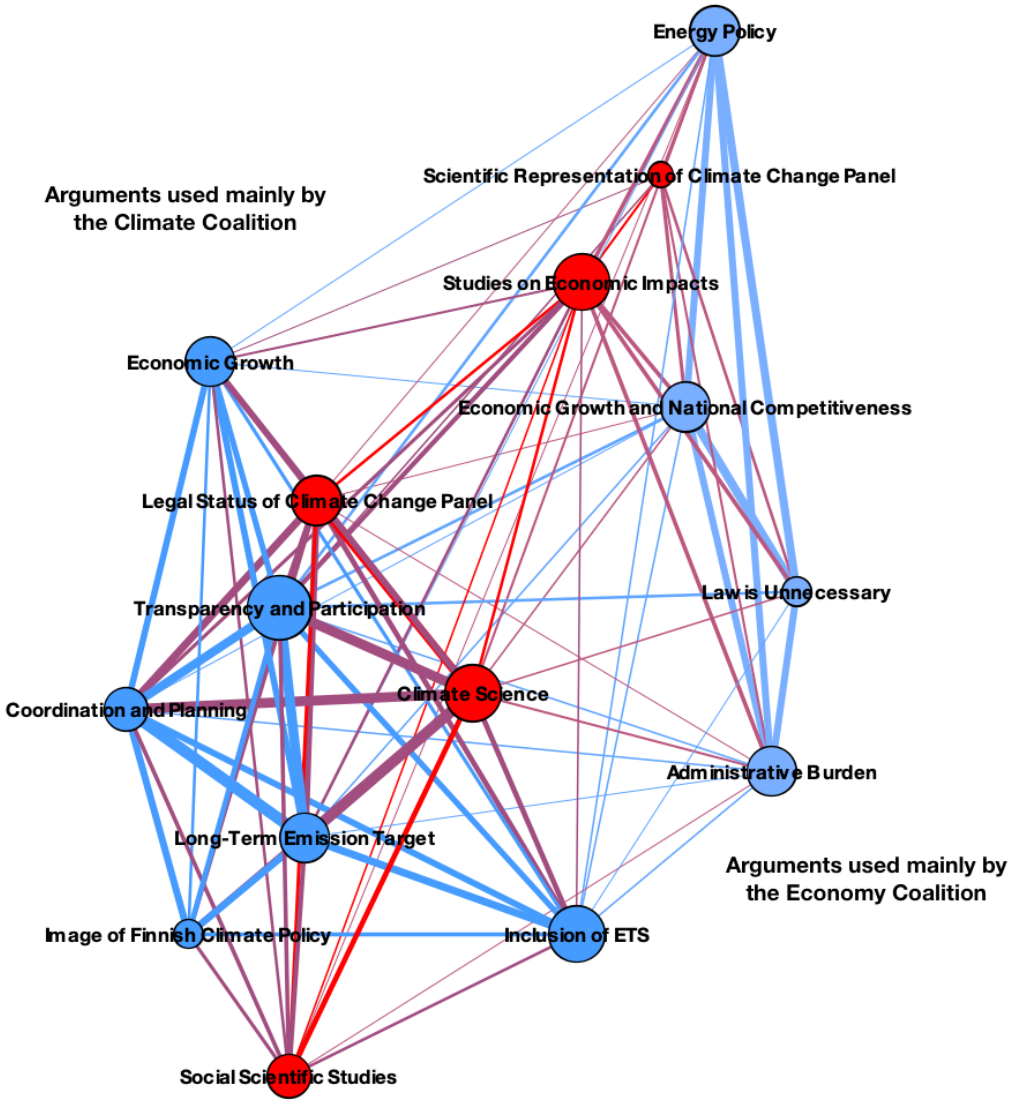

Figure 4. One-mode network of arguments via actors during the enactment of the Finnish Climate Law (2015). Notes: Node size adjusted according to closeness centrality; ties based and weighted according to congruence. Modularity: 0.304. Red: scientific argument; blue: other policy argument. The color of each edge is the average of the colors of the two nodes that the edge connects.

5. Discussion and Conclusion

This article used DNA (Leifeld, 2019) to examine the science–policy interface as a discourse network, focusing on the position of scientific organizations and arguments in the networks.

Our results show, first, that from 2002 to 2015, the Finnish climate change policy process was influenced by two competing discourse coalitions—the economy and climate coalitions. Regarding the role of scientific organizations, we show that they are relatively central throughout the years but that their place in the coalition structure changes. In 2002, the most central scientific organizations were part of the dominant economy coalition and allied with powerful industry interest organizations, ministries, and trade unions. These scientific organizations were research institutes focused on the economy and technology. The environmental research organizations, in turn, were less central and belonged to the weaker climate coalition. By 2015, almost all scientific organizations, including those that had belonged to the economy coalition, shifted to the now dominant climate coalition and, allied with a large number of NGOs and governmental organizations, now support ambitious climate change legislation.

Second, regarding the role of scientific arguments, we show that their centrality in the policy debate increases over time. In 2002, scientific arguments were relatively peripheral. The then-dominant economy coalition's main arguments were that the ratification of the Kyoto Protocol could weaken national economic competitiveness and that the emission reduction target could be

achieved only by increasing nuclear power. These positions were supported by two scientific arguments, as the coalition demanded more studies on economic impacts and argued that the calculations determining Finland's commitments were unclear and should be revised. The smaller climate coalition appealed to climate science in supporting the Kyoto Protocol.

In 2015, scientific arguments were much more central to the debate, and both coalitions used them more than in 2002. Each coalition used the types of scientific arguments that resonated with their values and political goals. The climate coalition that had become dominant argued that the knowledge produced by climate science and the social sciences supports the enactment of the Finnish Climate Law, and it demanded a legal mandate for the scientific Climate Change Panel as an advisory body monitoring the new law. The climate coalition used these scientific arguments to back up its main claims—that is, that the law should include a binding emissions target, including the Emissions Trading System sector, and that it would be beneficial for the economic growth and transparency of, as well as participation in, climate policy. The now weaker economy coalition argued for the need for more studies on the economic impacts of the law and demanded that if the scientific Climate Change Panel is given legal status, it should include not only climate scientists but also economists. These science arguments were used to support the coalition's main claims that the law would be harmful to national economic competitiveness and would constitute an unnecessary administrative burden.

This increase in the centrality of scientific arguments and their use by both coalitions to support their respective political goals reflects a phenomenon that earlier research has called the politicization of science—that is, science becoming fuel for more general value struggles (Brown, 2015; Pielke, 2010; Weingart, 1999; Wesselink et al., 2013). It is not the case, however, that climate science itself would be denied for political reasons by those opposing stronger climate action. Rather, while the proponents of the Finnish Climate Law use climate science to back up their arguments, the opponents' main argument is that economic sciences should also be considered and the economic impacts of the legislation more thoroughly analyzed.

Our main contribution to the literature on the science–policy interface has been to show that it can be fruitful to analyze this interface as a discourse network constituted by discursive interaction between scientific organizations and other actors that both use scientific arguments in conjunction with other policy arguments.

This relational approach has enabled us to go beyond standard techniques, such as quantitative (e.g., counting the appearances of scientific organizations and arguments) and qualitative content analysis of policy testimonies. First, our DNA approach has highlighted the relationship between scientific actors and others, showing that scientific organizations take part in policy processes as part of discourse coalitions. These coalitions and the role of scientific organizations within them can change over time, as evidenced by the gradual shift of the influential economic research institutes from the economy coalition to the climate coalition. The voices of scientific organizations can also be amplified by the other organizations that belong to the same discourse coalition, as evidenced by the marked increase over time in the number of NGOs using scientific arguments to defend ambitious climate change policy.

Second, the relational approach has highlighted the relationships between scientific and other policy arguments, as well as the changes in these relationships over time. Scientific arguments were auxiliary to other policy arguments, such as those defending economic growth and nuclear energy in 2002, whereas in 2015, they had become central in the debate, used in conjunction with arguments such as those demanding long-term emission targets, as well as transparency of and increased participation in climate change policymaking and implementation.

Our results are, broadly speaking, in line with previous research findings on the role of organizational coalitions in climate change politics in Finland, even though these studies used different materials (surveys, media) and did not focus on the role of science specifically (Gronow, Wagner, & Ylä-Anttila, 2019; Gronow & Ylä-Anttila, 2019; Teräväinen, 2010). There is, however, one interesting difference between our results and those obtained earlier, and observing this difference leads to a conclusion that may be of general interest to the increasing number of scholars using DNA to identify advocacy coalitions. Compared to the studies using media material, we found the economy coalition to be larger and stronger. Economic counterarguments to climate change mitigation are often relatively invisible in the media (Lester & Hutchins, 2012). Studies have suggested that their visibility has decreased over time (Ylä-Anttila et al., 2018); however, they figure prominently in our material on parliamentary consultations. Those economically minded actors that are active in the climate change policy domain use strategies such as participating in consultations but do not seek media attention for their arguments (Vesa, Gronow, & Ylä-Anttila, 2020). This shows that the numerous DNA studies using media material (e.g., Buckton et al., 2019; Leifeld & Haunss, 2012; Stoddart & Tindall, 2015) may underestimate the strength of some coalitions because these coalitions use strategies other than speaking to the media. Moreover, DNA studies of congressional hearings on climate change in the US suggest that polarization in the context of a policy debate occurs over the economic implications of climate change and policy measures such as the Clean Power Plan, rather than over climate science (Fisher & Leifeld, 2019; Fisher et al., 2013), even though in the US media, climate science denial is an important strategy of the highly visible climate countermovement (McCright & Dunlap, 2011). This points to a need to tri-

angulate results based on media analysis using other, preferably primary materials, such as the consultation documents used in this article.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Files

Supplementary material for this article is available online in the format provided by the authors (unedited).

References

Blondel, V. D., Guillaume, J., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. *Journal of Statistical Mechanics: Theory and Experiment*, *10*. https://doi.org/10.1088/1742-5468/2008/10/P10008

Bremer, S., & Glavovic, B. (2013). Exploring the science–policy interface for integrated coastal management in New Zealand. *Ocean & Coastal Management*, *84*, 107–118.

Brown, M. B. (2015). Politicizing science: Conceptions of politics in science and technology studies. *Social Studies of Science*, *45*(1), 3–30.

Buckton, C. H., Fergie, G., Leifeld, P., & Hilton, S. (2019). A discourse network analysis of UK newspaper coverage of the "sugar tax" debate before and after the announcement of the soft drinks industry levy. *BMC Public Health*, *19*(1), 1-14.

Bulkeley, H. (2000). Discourse coalitions and the Australian climate change policy network. *Environment and Planning C: Government and Policy*, *18*(6), 727–748.

Dilling, L., & Lemos, M. C. (2011). Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environmental Change*, *21*, 680–689.

Dryzek, J. S. (2005). *The politics of the earth: Environmental discourses* (2nd ed.). Oxford: Oxford University Press.

Finnish Government. (2015). Ilmastolaki (609/2015). Helsinki: *Finnish Government*. Retrieved from https://www.finlex.fi/fi/laki/alkup/2015/20150609

Finnish Government. (2019). Projects and legislation. *Finnish Government*. Retrieved from https://valtioneuvosto.fi/en/projects-and-legislation

Fisher, D. R., & Leifeld, P. (2019). The polycentricity of climate policy blockage. *Climatic Change*, *155*(4), 469–487.

Fisher, D. R., Waggle, J., & Leifeld, P. (2013). Where does political polarization come from? Locating polarization within the US climate change debate. *American Behavioral Scientist*, *57*(1), 70–92.

Forsyth, T. (2012). Politicizing environmental science does not mean denying climate science nor endorsing it without question. *Global Environmental Politics*, *12*(2), 18–23.

Freeman, L. C. (1979). Centrality in networks, I: Conceptual clarification. *Social Networks*, *1*, 215–239.

Gronow, A., Wagner, P., & Ylä-Anttila, T. (2019). Explaining collaboration in consensual and conflictual governance networks. *Public Administration*. https://doi.org/10.1111/padm.12641

Gronow, A., & Ylä-Anttila, T. (2019). Cooptation of ENGOs or treadmill of production? Advocacy coalitions and climate change policy in Finland. *Policy Studies Journal*, *47*(4), 860–881.

Gronow, A., Ylä-Anttila, T., Carson, M., & Edling, C. (2019). Divergent neighbors: Corporatism and climate policy networks in Finland and Sweden. *Environmental Politics*, *28*(6), 1061–1083.

Hajer, M. A. (1993). Discourse coalitions and the institutionalization of practice: The case of acid rain in Britain. In F. Fischer & J. Forester (Eds.), *The argumentative turn in policy analysis and planning* (pp. 43–76). Durham, NC: Duke University Press.

Hajer, M. A., & Versteeg, W. (2005). A decade of discourse analysis of environmental politics: Achievements, challenges, perspectives. *Journal of Environmental Policy & Planning*, *7*(3), 175–184.

Hildén, M. (2011). The evolution of climate policies: The role of learning and evaluations. *Journal of Cleaner Production*, *19*(16), 1798–1811.

Hoffman, A. J. (2015). *How culture shapes the climate change debate*. Stanford, CA: Stanford University Press.

Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge: Cambridge University Press.

Jasanoff, S. (2004). *States of knowledge: The co-production of science and social order*. Abingdon: Routledge.

Kerkkänen, A. (2010). *Ilmastonmuutoksen hallinnan politiikka: Kansainvälisen ilmastokysymyksen haltuunotto Suomessa* [The politics of climate change governance: The handling of the international climate question in Finland.] (Doctoral dissertation). University of Tampere, Tampere, Finland.

Kettle, N., Trainor, S. F., & Loring, P. A. (2017). Conceptualizing the science–practice interface: Lessons from a collaborative network on the front-line of climate change. *Frontiers in Environmental Science*. https://doi.org/10.3389/fenvs.2017.00033

Kukkonen, A., Ylä-Anttila, T., & Broadbent, J. (2017). Advocacy coalitions, beliefs and climate change policy in the United States. *Public Administration*, *95*(3), 713–729.

Kukkonen, A., Ylä-Anttila, T., Swarnakar, P., Broadbent, J., Lahsen, M., & Stoddart, M. C. (2018). International organizations, advocacy coalitions, and domestication of global norms: Debates on climate change in Canada, the US, Brazil, and India. *Environmental Science & Policy*, *81*, 54–62.

Lacey, J., Howden, M., Cvitanovic, C., & Colvin, R. M. (2018). Understanding and managing trust at the climate science–policy interface. *Nature Climate Change*, *8*, 22–28.

Lahsen, M. (2009). A science–policy interface in the global south: The politics of carbon sinks and science in Brazil. *Climatic Change*, *97*, 339–372.

Layzer, J. A. (2016). *The environmental case: Translating values into policy*. Thousand Oaks, CA: CQ Press.

Leifeld, P. (2017). Discourse network analysis: Policy debates as dynamic networks. In J. N. Victor, A. H. Montgomery, & M. N. Lubell (Eds.), *The Oxford handbook of political networks* (pp. 301–325). Oxford: Oxford University Press.

Leifeld, P. (2019). Discourse Network Analyzer manual. *Github*. Retrieved from https://github.com/leifeld/dna/releases/download/v2.0-beta.25/dna-manual.pdf

Leifeld, P., & Haunss, S. (2012). Political discourse networks and conflict over software patents in Europe. *European Journal of Political Research*, *51*(3), 382–409.

Leipola, L. (2018). Päättäjille tarjotaan parasta ilmastotiedettä, mutta vaikuttaako ilmastopaneeli mihinkään? [Decision-makers are provided with the best climate science, but does the Climate Panel have any influence?]. *Vihreä lanka, 3*(5), 2018.

Lester, L., & Hutchins, B. (2012). The power of the unseen: Environmental conflict, the media and invisibility. *Media, Culture, and Society*, *34*(7), 847–863.

McCright, A., & Dunlap, R. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *Sociological Quarterly*, *53*(2), 155–194.

Pielke, R. A., Jr. (2002). Policy, politics and perspective. *Nature*, *416*, 367–368.

Pielke, R. A., Jr. (2010). *The climate fix: What scientists and politicians won't tell you about global warming*. New York, NY: Basic Books.

Rennkamp, B., Haunss, S., Wongsa, K., Ortegad, A., & Casamadrid, E. (2017). Competing coalitions: The politics of renewable energy and fossil fuels in Mexico, South Africa, and Thailand. *Energy Research & Social Science*, *34*, 214–223.

Runhaar, H., & Nieuwaal, K. (2010). Understanding the use of science in decision-making on cockle fisheries and gas mining in the Dutch Wadden Sea: Putting the science–policy interface in a wider perspective. *Environmental Science and Policy*, *13*, 239–248.

Sarewitz, D. (2004). How science makes environmental controversies worse. *Environmental Science and Policy*, *7*, 385–403.

Seppälä, J., Asikainen, A., Kalliokoski, T., Kanninen, M., Koskela, S., Ratinen, I., & Routa, J. (2017). *Tutkijoiden pääviestit metsien käytön ilmastovaikutuksista* [Researchers' main messages on climate impacts of forest use] (Report 1/2017). Helsinki: The Finnish Climate Change Panel. Retrieved from https://www.ilmastopaneeli.fi/wp-content/uploads/2018/10/Ilmastopaneeli_metsavaittamat_final_-2017.pdf

Stoddart, M. C., & Tindall, D. B. (2015). Canadian news media and the cultural dynamics of multilevel climate governance. *Environmental Politics*, *24*(3), 401–422.

Teräväinen, T. (2010). Political opportunities and storylines in Finnish climate policy negotiations. *Environmental Politics*, *19*, 196–216.

Vesa, J., Gronow, A., & Ylä-Anttila, T. (2020). *The quiet opposition: How the pro-economy lobby influences climate policy*. Manuscript submitted for publication.

Wagner, P. M., Ylä-Anttila, T., Gronow, A., Ocelík, P., Schmidt, L., & Delicado, A. (2020). Information exchange networks at the climate science-policy interface: Evidence from the Czech Republic, Finland, Ireland, and Portugal. *Governance*. Advance online publication. https://doi.org/10.1111/gove.12484

Weingart, P. (1999). Scientific expertise and political accountability: Paradoxes of science in politics. *Science and Public Policy*, *26*(3), 151–161.

Wesselink, A., Buchanan, K., Georgiadou, Y., & Turnhout, E. (2013). Technical knowledge, discursive spaces and politics at the science–policy interface. *Environmental Science and Policy*, *30*, 1–9.

Ylä-Anttila, T., Vesa, J., Eranti, V., Kukkonen, A., Lehtimäki, T., Lonkila, M., & Luhtakallio, E. (2018). Up with ecology, down with economy? The consolidation of the idea of climate change mitigation in the global public sphere. *European Journal of Communication*, *33*(6), 587–603.

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