Jerusalem Papers in Regulation & Governance

Working Paper No. 67
September 2014

THE GOVERNANCE OF GOAL-DIRECTED NETWORKS: AN EMPIRICAL ANALYSIS OF EUROPEAN REGULATORY NETWORKS

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ISSN: 2079-5882

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The governance of goal-directed networks: an empirical analysis Of European Regulatory Networks

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Abstract: In this research paper we answer the research question What determines the structural complexity of network administrative organizations (NAOs)? The question warrants further research due to the lack of empirical studies on the topic. We design a quantitative study of the structure of all 38 European regulatory networks. Using Bayesian statistics we analyze the new dataset and test hypotheses-derived from the literature – regarding determinants of the structural complexity of network administrative organizations. We find that older networks and networks capable of sanctioning members have administrative organizations which are structurally more complex. As do those networks in the network economies. We conclude that interdependence, physical and politically, seems to have an effect on NAO complexity, as does age: a classic structurally contingent factor.

The governance of goal-directed networks: an empirical analysis of European regulatory networks

I. Introduction

Why do goal-directed networks set up different network administrative organizations (NAOs, or central secretariats) to govern themselves? Scholars report on different types of NAOs, some of which make decisions through consensus, others by voting; some involve eight staff, others up to 20; some have a single board where networks members sit, others have a plenary and an executive board (Agranoff 2007; Saz-Carranza and Ospina 2011). A key theoretical and practical question is why do these NAOs differ? What determines structure of a NAO? This is the research gap we empirically address in this article.

As public goal-directed networks become increasingly popular (Agranoff, 2007), they have attracted growing scholarly attention (Turrini et al, 2009; Isett et al, 2011). However, some crucial dimensions remain still to be explored (Provan, Fish, and Sydow, 2007).

Among them, the governance of goal-directed networks requires further research. Few scholars have taken on from Provan and colleagues' initial work in this area (Provan and Milward 1995; Provan and Kenis 2008).

While Provan and Kenis' (2008) triad of governance ideal types – shared, lead-member, and network administrative organization (NAO) – represents a sound first attempt at theorizing goal-directed network governance, there is still much to uncover about the design of the mechanisms and structures enacted to effectively govern, manage, and operate these interorganizational sets. Only two studies have in part tested Provan and Kenis (2008) network governance typology (Kenis, Provan, and Kruyen 2009; Raab, Mannak, and Cambre 2013).

Our aim is precisely to contribute to the advancement of existing knowledge on the governance form of goal-directed networks, yet we differ from the two previous studies in that we zero in on the NAO form. Thus, instead of exploring when and why do networks adopt one of the three ideal governance forms proposed by Provan and

Kenis (2008), we research how and why NAOs differ in the complexity of their structural design

NAOs are by nature purposively designed and set up by the network members. The structure of the NAO is of great relevance since, as Greenwood and Miller (2010) pose, (organizational) structure is a driver to successfully formulate and implement (organizational) strategies. In goal-directed networks, then, NAO design sets the preconditions to attain the collective aim of the collaborative.

The precise research question is *What determines the structural complexity of NAOs?* To address it we create a new dataset of all 38 European regulatory networks: public goal-directed networks composed of European national regulatory authorities.

The paper goes on as follows: The first section of the paper is devoted to develop our theoretical frame. The section concludes with a series of hypothesis related to the drivers of the structural complexity of NAOs. Prior to present our methods and results, we provide information on our dataset and the criteria followed to build it. Lastly, we report our results and discuss them in the light of previous literature.

II. Theoretical framework

1. The governance of goal-directed networks

Following Provan and Kenis' (2008), we define inter-organizational goal-directed networks as: "groups of three or more legally autonomous organizations that work together to achieve not only their own goals but also a collective goal" (Provan & Kenis 2008). Scholars have studied several such networks: for example, Agranoff and McGuire (2003) studied economic development networks, Isett and Provan (2005) mental health services delivery networks, Raab, Mannak, and Cambre (2013) Dutch networks managing crime prevention services.

Such goal-directed networks must be governed precisely because they aim at achieving a collective goal (Saz-Carranza & Ospina 2011). Specifically, the governance of goal-directed networks is "the use of institutions and resources to coordinate and control joint action across the network as a whole" (Provan and Kenis

2008, 231). While the network governance has both a behavioral and a structural dimension (Saz-Carranza & Ospina 2011), this research article refers to the latter.The governance of whole goal-directed networks can take one of the three ideal structural forms: shared governance among network members; the network governed by one of its members (i.e. lead organization); and delegation of its governance to a network administrative organization (NAO) (Provan & Kenis 2008). Provan and Kenis (2008) also identify the key predictors of network governance forms: namely, trust, number of participants, goal consensus, and need for network-level competencies. In essence, low trust, low consensus, large membership, and need for network-level competencies all increase transaction costs related to governing the network, thus making a central broker far more efficient than multilateral coordination and implementation (Williamson, 1975).

Choosing between both brokered forms – the NAO and the lead organization – will depend on number of network members and need for network level competencies. When high values are found on both factors, the NAO will be the optimal form.

Two studies have looked into network governance forms drawing on large or medium N samples. Raab and colleagues test which are the factors contributing to effectiveness among Dutch mandated information sharing networks in the field of crime prevention. They find that effective networks have high age, system stability, centralized integration and either resource munificence or a NAO governance form (as opposed to lead member).

Kenis, Provan, and Kruyer (2009) do a literature review meta-analysis of network research and do not find any relationship between task (whether exploitative/explorative and/or ambiguous/unambiguous) and governance form. They however, find that trust among parties may substitute for a NAO.

This paper is related to both of the above but deviates from both in that it zeroes in on the particularities of the NAO form.

The structure of network administrative organizations

Provan and Kenis' (2008) valuable typology stops short of going in detail in the variations within each of the three governance modes. It does not distinguish between differences among NAOs, nor does it characterize a NAO. Yet, empirical qualitative research on NAO-governed networks (Agranoff, 2007; Saz-Carranza, 2012; Saz-Carranza & Ospina, 2011; Saz-Carranza & Longo, 2012) casts light on the components of the NAO's structure and acknowledges the differences among them.

In exploring the structure of NAOs, our starting point is the traditional definition of organizational structure, defined as the recurrent set of organizational units composing the organization, relationships between them, the rules affecting behaviors, and the decision-making and communication patterns (Galbraith, 1987; Pennings, 1992; Greenberg, 2011). The study of traditional organizational structure is primarily concerned with aspects such as number of units (Modarres, 2010; Blau, 1973; Blau and Shcoenherr, 1971); degree of departamentalization (Aiken et al, 1980); specialization (Christensen and Laegreid, 2011); and degree of differentiation (Hage and Aiken, 1967; Damampour, 1987). However, the research on the structure of NAOs must acknowledge the importance of its organizational apex. It is at the NAO's apex where network members come together – in a governance board or equivalent – to make decisions and monitor the NAO's staff (Agranoff 2007; Graddy & Chen, 2006; Rodríguez, Langley, Beland & Denis, 2007). The decision-making among the NAO's multiple principals (Miller, 2005) and their relationship with their broker agent, the NAO's management and staff, is central to the NAO's functioning.

Compared to a traditional organization, the governing bodies of the NAO – a plenary composed by the network members and, sometimes, an additional "executive" board – are disproportionally relevant in comparison to the NAO's management and staff, which tend to be small in numbers. For example, Saz-Carranza (2011) studies four goal-directed networks whose NAOs plenary bodies bring together all their members – ranging from 16 to 164 – but whose NAO staff headcount goes from 4 to 19. In other words, NAOs are organization with oversized apices in relation to their management and staff.

Given the relevance of the apex in the NAO's functioning, we build on corporate governance scholars, Bedchuck and Weisbach (2010) and Larker and Richardson (2004), who identify three relevant levels in organizations: shareholders, corporate directors (i.e. Board of Directors) and top management (Hermalin & Weisbach 2003; Adams, Hermalin, & Weisbach, 2009).

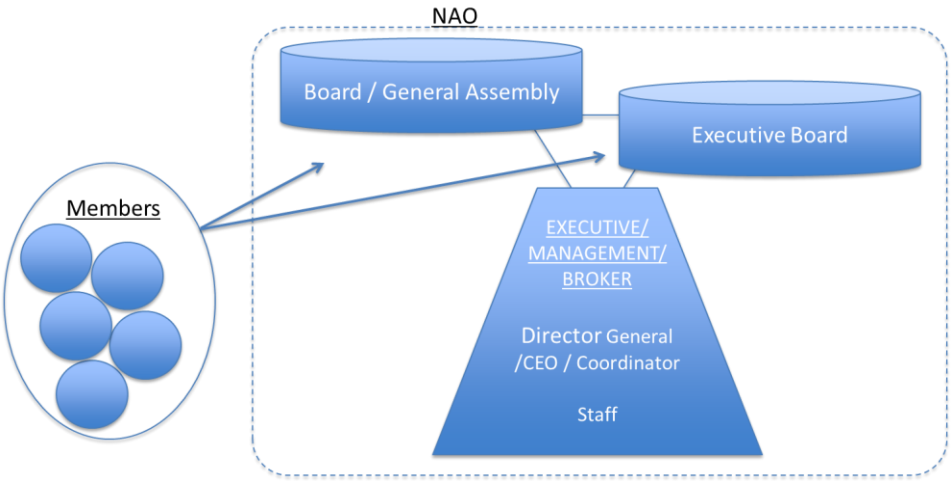
Consequently, NAO-governed networks will have a NAO with at a minimum one governance board (sometimes called general assembly or plenary), which groups all members and which is the network's highest decision-making body. Oftentimes, there is a second executive board governing the NAO's day-to-day operations, which may be a subgroup of the general assembly or may even include external parties – such as experts or representatives of a mandating party.

NAOs also have an executive or management component (i.e. the actual broker), which may be headed by a director or coordinator and includes the staff dedicated to supporting the boards' work and executing its decisions (if decisions are not to be executed by each member separately).

In addition, NAOs face a collective action situation, involving a multiple principals scenario (Miller, 2005) in their governing bodies. Collective decision-making among members in the board(s) is of great importance in a NAO (Agranoff, 2007). Researchers propose that in networks, decision-making occurs by consensus rather than by voting (Agranoff, 2007; Saz-Carranza, 2012). Saz-Carranza and Ospina (2011), however, do find that some networks with deep-rooted democratic and town hall-meeting culture function via voting. And in multi-organizational settings with a large number of members – such as European regulatory networks (Saz-Carranza & Longo, 2012) and international governmental organizations (IGOs) (Lockwood Payton, 2010) – voting is often the norm.

A NAO's structure, therefore, must provide an adequate decision-making arena to overcome collective action problems and cope with the principal-agent dilemma between members and NAO staff, while keeping co-ordination costs at minimum. Figure 1 shows a NAO prototype with its basic structural units.

Figure 1. NAO prototype (own)



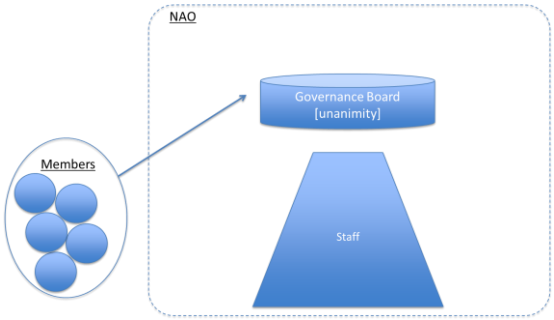
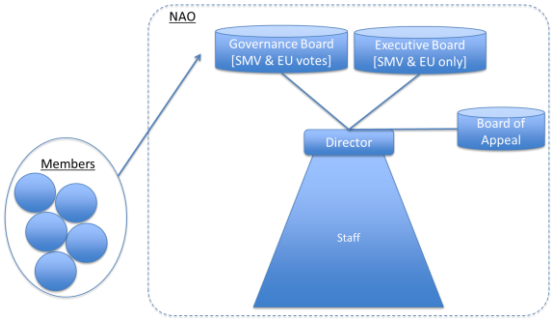
As aforementioned, qualitative studies have pointed out the differences in NAO structures (Saz-Carranza and Ospina 2011, Saz-Carranza 2012). Some NAOs have two boards, others just one. Some have large executives composed of tens of staff, while others merely have a one-person broker. Thus, NAOs may be more or less elaborate (i.e. more differentiated jobs and units, more developed administrative and governance components, more sophisticated decision-making rules) – just as any other organization (Mintzberg, 1983).

Taking stock of Mintzberg's definition of structural organizational elaborateness (Mintzberg, 1983), we build on Rescher (1998) to develop our conceptualization of structural complexity of NAOs. In this paper complexity comprises foremost the quantity and variety of constituent elements in the governance structure of the network. The degree of complexity is also related to how these elements are organized (since different arrangements are possible), how they interact and how they are subordinated to each other. Last but not least, complexity reflects also the degree of elaboration of the rules and norms governing a phenomenon. The score of a NAO apex' complexity we develop in this paper represents an attempt to operationalize an aggregate of these different elements (i.e. number and type of units; hierarchy and interrelationships among them; type of norms used in decision-making processes).

For example, a more complex NAO will have: two rather than one board, nonmembers in its boards, a board of appeal, a director general, and sophisticated

decision-making rules – i.e. double majority voting or weighted-voting as opposed to consensus – (see Figure 2 for the two NAO extreme ideal types). The key question driving this research – *What determines the structural complexity of NAOs?* – precisely aims at exploring these differences among NAOs.

Figure 2. Simple and complex NAOs

Simple NAO	Complex NAO
	

2. *Antecedents of NAO structure*

We here examine the potential antecedents of NAO complexity. We identify five variables that are theoretically expected to be associated with higher levels of NAO structural complexity.

Task

Public goal-directed networks are consciously created to attain specific goals and execute certain tasks to that end (Raab & Kenis, 2009). Complex organizations, such as NAO-governed networks, are better understood when the study of their internal structure is linked to the tasks it shall execute and the associated demands (Lawrence & Lorsch, 1967).

Different tasks may imply different degrees of interdependence among members and, therefore, will have an impact on co-ordination costs and transactions-costs that will affect how the NAO is structured (Bensaou & Venkatraman, 1995; Dussauge, Garrette & Mitchell, 2000; 2004; Lawrence & Lorsch, 1967; Provan & Kenis, 2008). We expect therefore, the tasks the network is due to perform to affect the NAO's structure (Provan & Kenis, 2008).

Agranoff (2007) identifies different types of public management networks which incrementally deal with exchange, concerted action, and joint-production (Alter & Hage, 1993). Agranoff (2007) distinguishes at one end networks that only exchange information, and at the other end interagency adjustments that formally adopt collaborative courses of action. In between, his typology sets those networks that deal with information exchange, produce member services, sequence programming, exchange resource opportunities, and pool client contacts.

Agranoff finds that networks institutionalize as they move along the continuum towards joint-production. He builds on organization theory-based work by Alter and Hage (1992), who explain the increasing institutionalization of collaborative ventures based on the interdependencies implied by their purpose. Thus, joint production networks imply far greater interdependencies than those simply sharing information.

Specifically focusing on regulatory networks – the empirical matter of this research – Slaughter (2004) identifies three basic network functions: information-sharing, harmonization, and cross-national enforcement of regulatory policies. In a similar vein, and particularly focusing on EU regulatory networks, Coen and Thatcher (2008) distinguish regulatory networks along a 'soft' - 'hard' continuum, which goes from coordination to drafting secondary legislation at EU level. Thus, as the network moves from simply proposing rules, towards setting rules, and even enforcing rules on regulates, the more complex we expect its NAO to become.

In addition, Saz-Carranza and Longo (2011) in a qualitative study of regulatory networks, find that whether a network has sanctioning power over its members has effects on the network's governance. International affairs scholars have identified "obligation" as a key dimension of an international institution (Abbot 2000). "Obligation means that…actors [i.e. members] are bound…by a set of rules or commitments (401)." They conceptualize this dimension as a continuum that goes from voluntary guidelines to binding rules. Saz-Carranza and Longo (2011) suggest that whether a network is tasked with delivering binding sanctions or instructions to a non-complying member is expected to affect the network governance form.

From the above, we derive that, at a minimum, all networks involve information-sharing. Some may be charged with jointly produce awareness-raising campaigns, member training, or any other executive tasks. Regulatory networks may propose regulations or even set them, as well as enforcing regulation on third party regulatees directly. Lastly, networks may be capable of sanctioning members if these do not comply with previously agreed commitments. Thus, we develop three task-related hypotheses:

> *Hypothesis 1a: The NAO's structure is likely to be more complex when the network performs executive tasks.*
>
> *Hypothesis 1b: The NAO's structure is likely to be more complex when the network sets rules and/or enforces rules.*
>
> *Hypothesis 1c: The NAO's structure is likely to be more complex when the network performs sanctioning tasks.*

Size

Size, measured as number of employees, stands as one of the most important predictors of organizational structure (Blau, 1970). The number of staff in an organization has a positive relationship with its structural elaboration in terms of higher departamentalization (Giblin, 2006). In a similar way we expect the number of staff in NAOs to affect its structure (i.e. being consistent with a more elaborate coordination mechanism) due to the higher transactions costs and the higher difficulties in monitoring performance of the NAO staff (Gulati & Singh, 1998).

> *Hypothesis 2a: The large the executive component of the NAO, the more complex its structure.*

Age

As time passes and the network evolves, the relationships among members evolve as well (i.e. partner uncertainty decreases and trust will evolve accordingly). Raab et al. (2013) following Van Raaij (2006) point out that in intra-organizational networks the development of the right monitoring, accountability and control mechanisms takes

time. Young and old networks will therefore differ in terms of the mechanisms used to monitor and lead the network (Hite & Hersterly, 2001; Human & Provan, 2000). Mintzberg (1983) establishes age as a key contingent element affecting the degree of formalization and the enactment of more elaborate structures in organizations over time. Provan and Kenis (2008) also point in such direction since they expect network governance form to develop in a life-cycle manner from shared to NAO-governed with time.[1] In this regard, we expect NAOs to become incrementally complex as they grow older.

Hypothesis 3: The older the network the more complex the NAO

Mandated collaboration

Public goal directed networks may be mandated by a third party (Provan and Kenis, 2008). As a process, mandated collaboration involves a stage of design and a stage of implementation (Rodríguez et al. 2007). In mandated networks, membership, overall goals, and network governance are not solely defined by the network members. During the design phase and prior to formalization, network members and the mandating party interact to frame the design of the network and its governance structures (Saz-Carranza, Albareda, Salvador 2013). During this framing process, the mandating party aims to foster integration among members while the network parties try to influence the design to maintain their individual autonomy or take advantage of the new context (Saz-Carranza and Longo, 2012). Given that membership in a mandated network is obligatory, rather than voluntary, future members are very active in framing the safeguards and collective decision-making rules of the network's governance structures. This is so, because member in mandated networks do not have the option, or the shadow, of "exiting" (Hirschmann, 1970) the network in cases of strong disagreements.

Hypothesis 4: The NAO structure is likely to be more complex when collaboration is mandated.

Policy sector

Underlying the pervasive use of public goal directed networks is the inherent interdependent nature of many policy sectors. Different but interrelated organizations compose a policy sector (Bärh, 2010). However, the characteristics of the interrelations among parties are specific to the policy sector and depend in large part on the interdependencies among them. Interdependence, in turn, has been found to be a good predictor of integration in inter-organizational collaborations (Van de Ven, Walker and Liston, 1979).

The nature and degree of interdependences differ among policy areas. Resource interdependence will increase member integration, as members try to guarantee access to the resources they depend on, cope with the risk of opportunism, and try to reduce coordination costs (Gulati & Singh, 1998; Oxley & Sampson, 2004; Kogut, 1988). When interdependence is high the co-ordination mechanisms enacted will be more complex (Gulati and Singh, 1998). From a resource dependence perspective, the more resource-interdependent the network members, the more incentives they will have to collaborate and integrate together (Hilmann, 2009).

Policy sector plays an important role since different sectors imply different interdependencies. As an illustration, physical operational interdependence among regulators is much higher in the railway and energy sectors than in the environmental sectors. In the former sectors national regulators have to agree on reciprocal intensive investments to construct interconnections. In the environment sector, such interconnections are not necessary.

Theoretically then, the complexity of the NAO structure will be a function of, in part, the intrinsic nature of the interrelations and interdependencies implied by the policy sector in which the goal-directed network operates.

Hypothesis 5: NAOs structure complexity differs among policy areas.

Figure 3: Graphical depiction of hypotheses

We acknowledge other factors may determine NAO structure. Membership size and diversity among members may affect, but our empirical sample based on EU regulatory networks kept both variables constant. While the social relational pattern among parties may affect the network governance form, we did not develop social network analysis of the 38 networks studied due to research limitations. However, Provan and Kenis (2008) do not use social network characteristics as governance predictor. They use trust as a predictor, which we did not measure but may be partially captured by age, since one variant of trust is that based on experience and previous interaction: experience-based trust (Zucker 1986).

III. Methods

To answer our research question and test the above hypotheses we construct a new database of the NAOs of all EU regulatory networks. We then use Bayesian statistics to analyze the results.

1. Sampling

38 European regulatory networks have been taken into account in this study. Our sample is based, firstly, on Levi-Faur's work on European regulatory networks (Levi-Faur 2011) and, secondly, on the European Union's official decentralized agencies' list[2].

Levi-Faur (2011) maps 36 regulatory regimes.[3] "Regulatory regimes encompass the norms, the mechanisms of decision-making, the various institutions, and the networks of actors that are involved in regulation (Levi-Faur 2011, 811)."

Within these regimes, Levi-Faur identifies 28 regulatory agencies and 51 networks. In his study, an agency is defined as "an administrative organization with a distinct, formal identity, an internal hierarchy, functional capacities, and, most important, at least one principal (Levi-Faur 2011, 813)." He focuses on regulatory agencies, those that carry out at least one of the four functional tasks of regulation – information gathering, rule setting, monitoring, and enforcement and does not consider other agencies that deal with planning, administration of services, distribution, and redistribution (Levi-Faur 2011).

He defines a network as "a set of relatively stable relationships of a non-hierarchical and interdependent nature which link a variety of actors (cf. Ahrne and Brunsson 2011: 6; Börzel 1998: 254; Podolny and Page 1998: 58)" (Levi-Faur 2011, 813).

Levi-Faur recognizes that it is far from straight-forward to determine whether an institution is an agency, a network, or something else. Nevertheless, his definitions show that what we have defined as a NAO may also fit Levi-Faur's (2011) definition of agency. A NAO, according to our definition, has distinct identity, internal hierarchy, functional capacities, and principals. However, in this study we distinguish a European-level agency from a NAO on the basis of the unit's relationship with its principals. When the organization under consideration has a governance board, which incorporates all network members – that is all national regulatory agencies or units who are member of the network – and where decisions are taken collectively – via consensus or voting –, we consider it to be a NAO.

On the contrary, when the organization's principals sitting in its governance board are delegates from a European-level institution such as the European Commission, the European Parliament, and/or the Council of the EU, then we consider the organization a European-level agency. Similarly, if the EU agency is accountable solely to the Commission, the Council, or the Parliament, then we do not consider it a NAO.

The official EU list of decentralized agencies includes 32 entities. Again, we neglected those who do not fit our definition of network and/or do not incorporate regulatory members. Thus, from Levi-Faur's (2011) 28 regulatory agencies and 51 networks and the EU's 32 agencies our data set came down to 38 networks. See the

appendix for more information on how we constructed the sample and for a table with key information of all networks studied.

Concretely, our sampling criteria are:

- Following our characterization of NAOs, the units considered in this study include national network members who collectively are the top decisions-makers.
- Networks had to be regulatory in the sense that they bring together national regulatory authorities. The network itself may not have regulatory functions, it may simply aim at sharing information among members, but these members must be regulators themselves. Thus, networks whose members were executive agencies, such as national vocational training centers, were not included.
- Our sample only considers active networks, i.e. we exclude those agencies or networks that have finalized their mandate or that no longer exist for different reasons.

We have ignored terminology when selecting our sample. The diversity in the usage of terms and definitions do not allow using names and terms as selection criteria. The entities studied are named agency, network, body, office, center, authority, foundation, institute, college, council, unit, group, conference, committee, and platform. Provan, Fish, and Sydow (2007) acknowledge that goal-directed networks may be named as: partnership, strategic alliance, interorganizational relationship, coalition, co- operative arrangement, or collaborative agreement (480).

2. Data collection and coding

Our research is organized in two markedly different stages: the data collection phase, which implies an effort to identify the relevant variables to our study and to codify them when necessary using a thematic analysis approach (Boyatzis, 1998); and the statistical analysis of the resulting database.

We constructed the data set on the basis of each network's statutes and legal documents as sources. We complement these sources with publicly available

information from the organizations' websites and by contacting directly the organizations when information was unclear or unavailable. Thematic analysis, a method to identify, analyze and report patterns or themes within qualitative sources of data (Boyatzis, 1998; Braun and Clarke, 2006), is well suited to our research proposal. Previous studies indicate the robustness and suitability of the method to analyze the broad and complex topic of governance (Dooley, 2007; Cicon, Ferris et al., 2010). Data collection was completed during the second semester of 2012 so the information included in our database refers to 2011.

Based on previous research and building on the literature of corporate governance we codify a total of 29 NAO structural characteristics (i.e. outcomes)[4]. The variables were codified mostly as binary (i.e. zero as absence of the characteristic; one as presence of the characteristic). The dataset, however, also contains, among other, information on the number of seats in the governance board, budgets, number of staff, and categorical information as the policy sector of each organization – see Table 1.

During the data collection we also codified the contextual variables that, according to previous literature, we expect to play a role as drivers of NAOs' design. Thus, we collect data on the age (i.e. years passed since inception); number of staff as a measure of size; their mandated or voluntary nature; policy sector; and, their tasks. The final list of tasks included in our analysis emerges as a result of a codification exercise involving two researchers. The initial coding for tasks was performed by one of the researchers based both on the broad categories Agranoff (2007) and Slaughter (2004) propose. Once the first round of codification was finished, the second researcher reviewed the emergent list of tasks and proposed a refinement. The final list was again reviewed by the first researcher who compiled the final list including 7 tasks or functions the organizations include in the analysis perform (Table 2). The functions are codified also as binary variables.

Table 1: Structural design variables included in the analyses

Variable
Representatives at the Governance Board
Observers at the Governance Board
The NAO has an Executive Board
Executive Board composition decided by the Governance Board
Representatives at the Executive Board
Observers at the Executive Board
The NAO has a Board of Appeal
The NAO has a Chairperson
The Governance Board appoints the Chairperson
The Executive Board appoints the Chairperson
The NAO has an Executive Director
The Governance Board appoints the Executive Director
The Executive Board appoints the Executive Director
The Governance Board approves the budget
The Executive Board/Executive Director approves the budget
European Commission contribution
The NAO has a Governance Board
The Governance Board approves the Governance Board
The Executive Board/Executive Director approves the Governance Board
Governance Board voting rule based on simple majority
Executive Board voting rule based on simple majority
The NAO has two governance bodies
The NAO has two leaders
EU presence at the Governance Board
EU presence at the Executive Board
The EU has the right to vote in the Governance Board
Governance Board voting*
Executive Board voting*
The Executive Board is a reduced version of the Governance Board

3. Data analysis

We perform an analysis based on item response modeling technique. We use our binary outcomes (whether a certain institutional characteristics of the NAO's structure is present or absent) to estimate a score of "structural complexity" based on the amount of characteristics each organization has. But instead of adding up all characteristics and counting the raw number, we employ a more refined measure using Item Response Theory. Developed in psychology, item response models allow us to generate a score of "structural complexity" that gives different weights (or discrimination) to each of the characteristics. So instead of assuming that each characteristic matters equal for the score, we let the model estimate the discrimination, based on the amount of NAOs that have such characteristic (difficulty) and their relative position in the final score (discrimination).

Formally, we are interested in ξ_n which represents the "structural complexity" score of each NAO (n) in a standardized scale that has, by definition, mean 0 and standard deviation 1. The two parameters (α for discrimination and β for difficulty) logistic model for data on n NAOs which have different characteristics (x = 1 having the characteristic j and x = 0 not having it) can be expressed as follows:

Equation 1

$$logit\ (\xi_n)=\alpha_j(x_n - \beta_j)$$

Once the scores are obtained we explore their associations to a set of covariates based on the aforementioned contextual and functional variables (i.e. age, staff, task, policy sector, mandated) (table 4). Thus, the main goal is to explain the "structural complexity" score based on the set of common covariates the NAO has.

The second part of the formal model, then, describes the association between the structural complexity score and the covariates XF by means of the θ parameters, which are the ultimate parameters of interest of the paper. Bayesian inference requires specifying a prior distribution for the parameters of the model. In this case, weakly informative priors are chosen, representing a great deal of uncertainty a priori (Gill & Witco, 2013).

Equation 2

$$\xi_n \sim N(\mu_n, \sigma)$$
$$\mu_n = X\theta$$
$$\sigma \sim U(0,5)$$
$$\theta \sim N(0,1000)$$

Table 2, Covariates included in the analysis

Label
Task: propose sanctions on national regulators
Task: authorizations
Task: establish rules and regulations
Task: propose rules and regulations
Task: provide advice to the EC, the EP or to the Council by its own initiative
Task: provide advice at the request of the EC, the EP or the Council
Task: executive capacities (Research, Training, Joint operations or Campaigns)
Staff
Age
Mandated
Sector: Services
Sector: Justice & Law
Sector: Employment, Social affairs & Culture
Sector: Economy & Finance
Sector: Health
Sector: Environment
Sector: Energy & Transport

Each NAOs score on complexity is explained by a linear sum of the effects of the function (F), controlling for contextual variables (X). The equation for the model can be read as follows: the matrix of outcomes for each of the NAOs (N) is distributed normally with a parameter μ and standard deviation σ. μ is a linear combination of the covariates (XF), that include the functions and the contextual control variables,

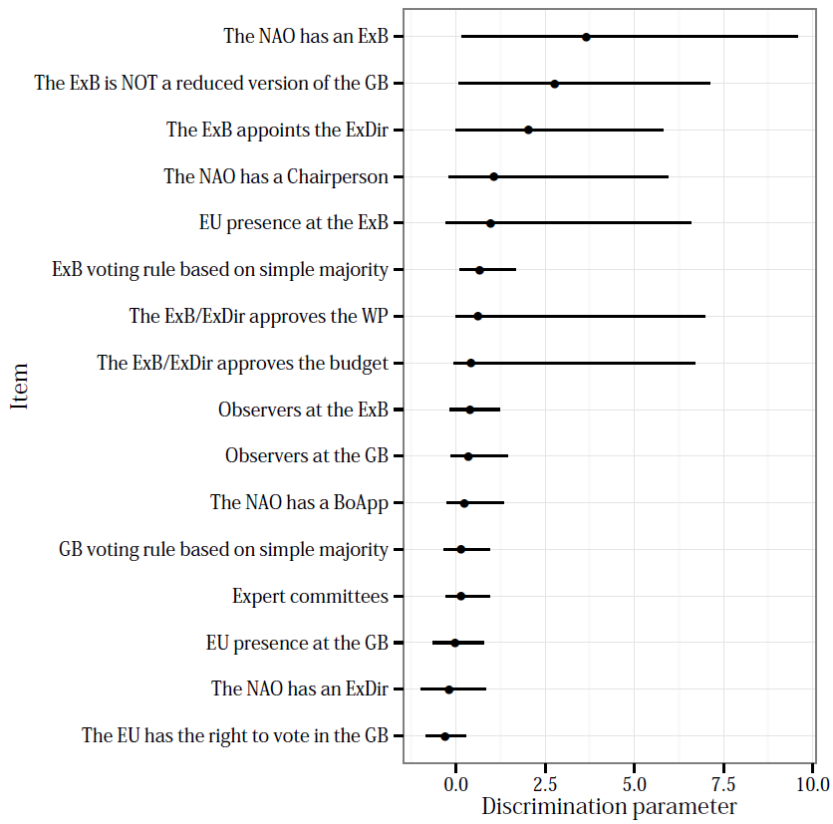
multiplied by the parameters of interest θ. Continuous variables in XF are standardized to half standard deviation to be able to directly compare their effect with binary variables.

IV. Findings

1. Item response modeling

As aforementioned using the thirty structural characteristics included in our analysis (see table 3 above) we develop a score of "structural complexity" for each NAO. As mentioned, by "structural complexity", we refer to how many governance units does it have in addition to a governance board (executive board, board of appeal, executive director), whether it departs from unanimity decision-making (simple majority voting), and whether the mandating party is present and votes in the governance units. The aim of the study presented in this section is to identify the effect of the contingent elements we include in the analysis (i.e. age, staff, tasks, mandated nature, and policy sector) on the complexity score of the network

Figure 3, Discrimination weight assigned to each item in the model



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Discrimination parameters (X) for each of the items that compose the score of NAO complexity. The dot represents the median point estimate, and the line highlights the 95 percent credible interval. The values of the discrimination parameters can be understood as follows: a positive and high value means that such characteristic is usually present in NAOs that score high and positive in the complexity score. On the contrary, negative values imply that such characteristics are present in NAOs that score low in the complexity score.

Figure 3 shows the median of the estimated discrimination value, along with the 95 percent credible interval.[5] The median value of the parameters indicates whether how strongly does having that item increase (or decreases if negative) the complexity of the NAO. High discrimination means that they convey more information about the complexity of a NAO. In other words, if we were to select a single indicator to inform us about the complexity of a NAO, the best single indicator would be whether the NAO has an Executive Board. This indicator is the best one to provide information about whether a NAO can be considered of high or low complexity.

The results show that the discrimination values can be divided in three groups. A first group of highly discriminant parameters includes having an executive board, the executive board not being a reduced version of the governance board, and the executive board appointing the executive director.

These three parameters convey a lot of information to make a NAO score high or low in the latent trait of complexity. In fact, the single most indicative item of being a complex NAO is achieved by having an executive board.

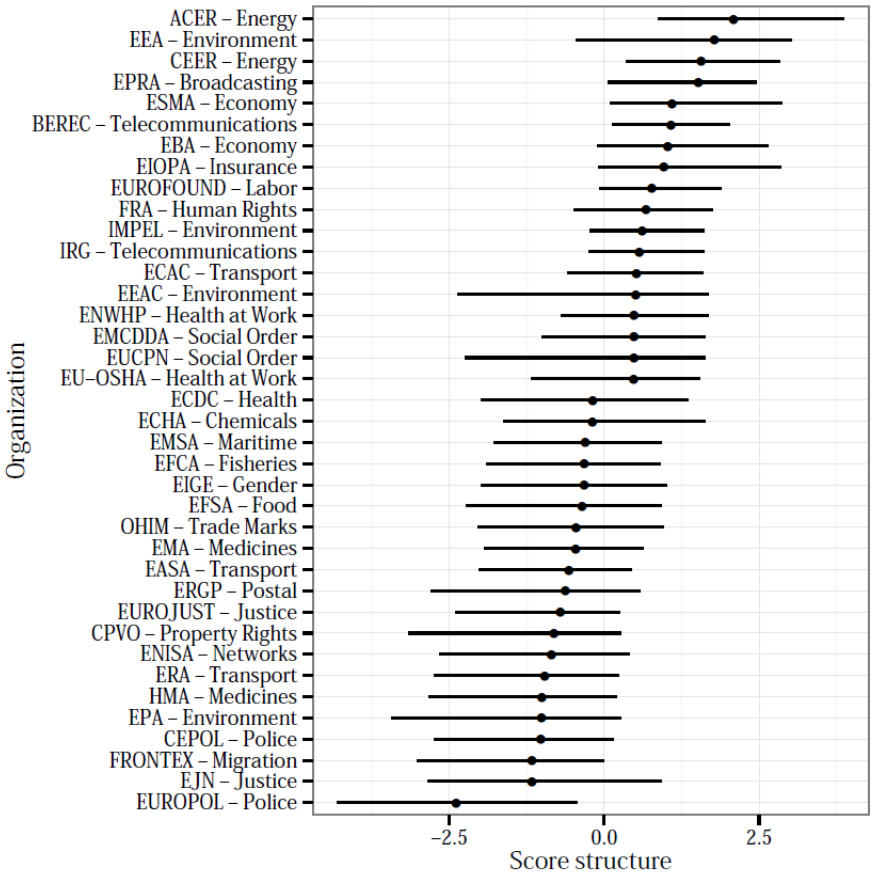
A second group of weakly discriminant traits includes having a chairperson, the EU being present at the executive board, the executive board voting via simple majority, and when the executive board or executive director approves the work program and the budget.

Finally, a third group contains the rest of the items: having observers at the executive or the governance boards or having expert committees; the EU being present at the governance board or having the right to vote there; the governance board deciding by simple majority; the NAO having an executive director; and the NAO having a board

of appeal. This group of items does not convey any significant information to guess whether the NAO will be complex or not.

By applying the discrimination scores to the items that each NAO has, the model produces scores for the estimated latent complexity of the NAO (Figure 8). The Figure shows the median of estimated complexity along with the 95 percent credible interval. Recall that the score has an arbitrary scale restricted to have a mean of zero and standard deviation one.

Figure 4, Networks ranked according to their NAO complexity[6]



There are four NAOs with substantially higher complexity, namely ACER, EEA, CEER and EPRA.

The most complex NAO according to our analysis is ACER's (Agency for the Cooperation of Energy Regulators) governance structure. ACER is a two-tier

structure with a governance board (the Board of Regulators) and executive board (the administrative board).

The board of regulators gathers together a senior representative of each European national regulatory agencies and a representative of the EU Commission, the mandatory party. However, the Commission has not the right to vote in the governance board. Its central role in the governance structure of ACER is noticeable in its main tasks as both the appointment of the executive director and the work program must be approved by the Board of Regulators.

The administrative board, in turn, is in charge of supervising the administrative and budgetary activities of ACER. Interestingly enough this second board is not a reduced version of the plenary but a significantly different structure whose members are appointed by the EU institutions. As stated in ACER founding documents the administrative board is the governing body of the organization including the appointment of its executive director.

ACER's structure is completed with a Board of Appeal. This third board, composed by 6 members selected from senior NRAs staff, shall independently decide on appeals presented by national regulatory agencies, individuals or legal persons.

Decision-making in ACER is not by single majority. Both the board of regulators and the administrative board act by two-thirds majority of the members present. The board of appeal decides by qualified majority.

On the other side, EUROPOL is the least complex NAO, significantly lower than the rest.

Europol is governed by the management board, a single body, comprising a representative of each member state and one representative of the European Commission. The management board gives strategic guidance and also decides on the budget and work programme. Its decisions are taken by two-thirds majority. The Europol's head is its executive director. The director is not appointed by the management board, but by the European Council. Europol has a network of national liaison units and two liaison offices in located in Washington DC and Lyon.

Figure 5, Results per parameter (contingency) on NAO complexity[7]

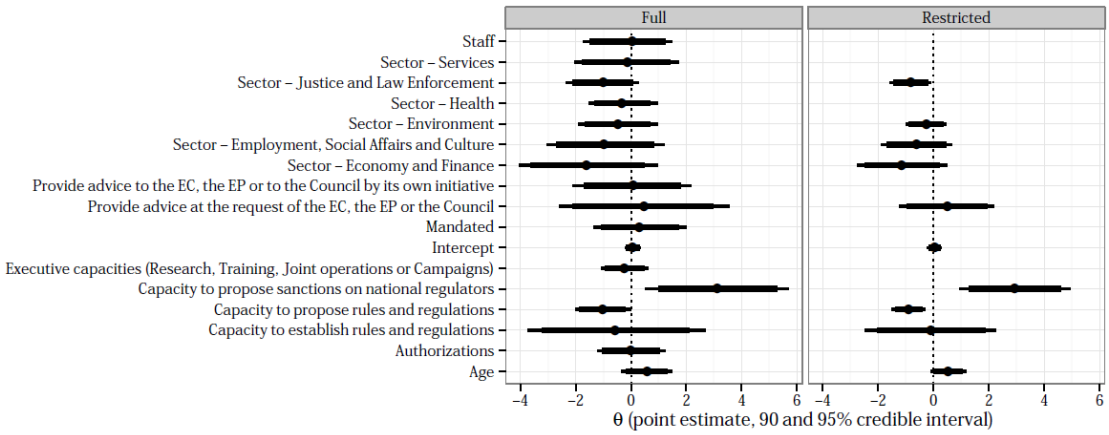


Figure 5 shows the values for the θ parameters in Equation 2. The full model includes all variables, whereas the restricted model includes only the variables that show values markedly different from zero (beyond half inter-quartile range away from zero in the absolute scale). The dots represent the median of the posterior density and the thick and thin lines correspond to the 90 and 95 percent credible intervals (or highest posterior densities). Given that all variables have been standardized, the values of the parameters are directly comparable between them. For the full model, the stronger effect corresponds to the task to propose sanctions on national regulators, because it has the highest point estimate. But this variable has also a high uncertainty associated with it.

Recall that there are 38 NAOs (information points) and 17 parameters – one for each covariate – to be estimated, which represents a low ratio of information in the data with respect to a relatively high number of parameters to estimate. It is not surprising, therefore, that most of the effects' densities clearly overlap zero, which indicates that the effect (if any) is weak or hard to estimate with so little information in the data. In order to clarify the results the restricted model shows a similar picture than the full model, but with less uncertainty for the parameters that convey information, and not noise.

The strongest effect is also the task to propose sanctions to national regulators. But in this case the uncertainty of the location of the parameter has decreased due to a lower number of covariates in the model. The effect is centered close to 3. This means that

having such a capacity produces and expected increase in the complexity of three quarters of the range of the outcome variable, which is a huge difference.

There are other variables that show a clear association with complexity. With regards to sector, and taking Energy and Transport as the reference category, the NAOs in the Justice and Law Enforcement sector are significantly less complex. Also less complex are the NAOs in the Environment; the Employment, Social Affairs and Culture; and the ones in the Economy and Finance sectors. The results also show that older NAOs are significantly more complex than the new ones. Finally, it is also worth mentioning that having the task to propose rules and regulations is associated with simpler NAOs.

In classical or frequentist statistics, hypotheses are either accepted or rejected. In Bayesian statistics the researcher has not to rely on arbitrarily chosen thresholds and radically decide whether a hypothesis is supported or not (see Gill & Witko 2013: 8-9) but can directly report its degree of support. In terms of the support for the hypotheses the full model is used. This implies that the degree of support will be quite conservative, because the full model has much more uncertainty in its estimates than the restricted one.

Support for hypotheses 1a, 1b and 1c (executive, regulatory and member-sanctioning tasks, respectively, increase complexity) is mixed. While support for the fact that a network carries out executive tasks increasing complexity is only 29 percent, support for sanctioning tasks is 99 percent. Enforcing and setting regulations does not seem to relate to increase complexity, but that networks proposing rules (the weakest of the regulatory functions) have less complex NAOs is supported by 99%.

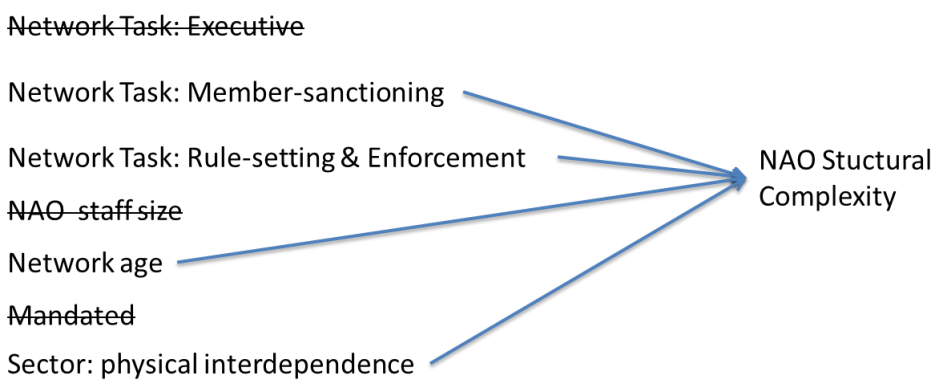
Surprisingly, networks that advice the EU on policy and regulations – either by request or by own initiative – does not affect NAO complexity. We would have expected it to be related to low structural complexity.

There is weak support for hypothesis 2 (size increases complexity), which is found to be 52 percent, which indicates that it is more or less equally likely that size increases complexity than it decreases it. With regards to hypothesis 3 (age increases complexity), the model shows that its support is 90 percent. Support for hypothesis 4 (mandated NAOs are more complex) is weak, at 64 percent.

Finally, hypothesis 5 (policy areas are associated with different supports) is quite strong in particular relating to Justice and Law networks, which tend to have low complexity at 90%. In fact, all sectors tend to be weakly associated with lower complexity as opposed to the Energy and Transport sector – which is not shown in figure 5 because it is the reference point against which the other sectors are compared.

To sum up, there is support for hypotheses, 1b (rule-setting and enforcement), 1c (sanctioning tasks), 3 (age) and 5 (policy sector).

Figure 6: Graphic illustration of relations between covariates and complexity score



V. DISCUSSION

1. Interdependence

From the above, interdependence seems to be a relevant factor in predicting NAO structural complexity. Among regulatory functions, proposing sanctions has an effect on NAO design. It tends to complexify it. Proposing sanctions is the only task that actually directly affects the network members. Thus, the dependence of network members on the network's output is in such cases very high, since they may be sanctioned by it.

Networks whose task include sanctioning its members, will have to (a) depart from unanimity decision-making to guarantee that sanctions are proposed, (b) will have an Executive Board where powerful members monitor closely the staff, (c) and will have an appeals unit (Board of Appeal) to insure a due-process. In essence, as the network is more "obligational" on its members, it will tend to have a more elaborated and complex NAO.

Similar logic applies to networks that have rule-setting and enforcement tasks: as the network is more binding for third-party regulatees, it will tend to have a more complex NAO. In such networks, the members are in fact pooling their regulatory functions, thus becoming more interdependent among all – therefore a more complex network (with respect to decision-making, governance structures and safeguards). To the contrary, if networks simply propose rules – as opposed to setting rules – will tend to have less complex NAOs.

While hypotheses above indicate that political interdependence among members and the network – pooling rule-making and enforcement, and self-sanctioning – is related to NAO complexity, executive tasks did not seem to affect NAO complexity. Thus, operational interdependence seems to have less of an effect on NAO structure.

The analysis cannot explain causality. It is unclear from our analysis whether networks which have developed a complex NAO decide to acquire more challenging tasks – such as sanctioning members – or whether networks that aim at sanctioning members design more complex NAOs.

Transport & energy as a reference, justice sector networks will tend to have simpler NAOs. This may be due to physical interdependency among members. The telecoms and energy sector networks have less simple NAOs. This may be due to the fact these are network industries, where physical interdependence is relevant. European coordination in these sectors require close integration of electrical grids, gas pipelines, telephone lines or telecommunication antennas interoperability.

Another interpretation of the fact that justice and law networks have the least complex NAO may be due to the fact that these issues are the closest to sovereignty of a nation, and are in fact the lagging issues with respect to European integration: precisely because of member states unwillingness to delegate such powers to the European institutions.

Network age

Age comes out to be also important. Classic contingency posits in relation to traditional organization structure that organizations grow more complex with time.

This is also aligned with Provan and Kenis' (2008) proposal that their development of governance of goal-directed networks evolve following a lifecycle. Moreover, this resonates with the idea that trust increases with time among organizations (Kanter, 1994), making them more prone to integrate and delegate more intensely to a NAO.

Unsupported and untested hypotheses

Carrying out executive tasks does not affect NAO complexity. This is surprising, and may be due to the specificity of the networks studied, which are primarily regulatory. Thus, their executive tasks are secondary in importance and may not relate to NAO complexity.

Interestingly, whether a network is mandated does not have strong effect on NAO complexity. This contradicts previous qualitative research (Saz-Carranza and Longo 2011).

NAO staff neither correlates with complexity. This runs counter to organizational structure received wisdom, which has traditionally postulated that large organizations have more sophisticated and elaborated structures.

Lastly, we were not able to analyze the effect of membership nor diversity due to constant in our sample – Provan and Kenis (2008) draw on classical transaction costs economics (Williamson, 1975) when developing contingency factors of the network governance forms: in particular, when they predict that networks with more members – i.e. with higher coordination costs – are best governed by a NAO.

VI. Conclusions

This paper is a large-N analysis of network administrative organizations. Interdependence seems to have an effect on complexity: both tasks and sectors tell us so. Age, again is well supported.

This paper has not been able to disentangle causality relations – the methods applied here do not allow this. This would be another avenue of future research. Does that task drive structure, or vice versa?

EU regulatory networks have specificities which affect the generalizability of this study. International regulatory networks are more politically sensitive than the service provision (Isett and Provan 2005) or economic development (Agranoff 2007) networks – the traditional objects of public management networks scholars. Provan and Kenis' (2008) and Agranoff's (2007) propositions positing that structure increases in complexity as more interdependent tasks are assumed by the network still require further testing.

Additionally, the sector effect may be importantly affected by EU context. Justice is one of the least delegated policy sectors to the EU. Networks in this sector require less integration, thus will have less structurally complex NAOs.

As the world becomes more fragmented and interrelated, goal-directed networks will continue to increase in their relevance, as such a form will be used to coordinate public organizations. It is thus fundamental to understand how best to govern such networks. This research is another early building block in better understanding this crucial topic.

Appendix

Networks included in the analysis

Sector	Networks	Year of Establishment	Staff	Budget 2011 (€)
Economy & Finance	European Banking Authority (EBA)	2009	100	12683000
	European Insurance and Occupational Pensions Authority (EIOPA)	2010	46	10667000
	European Securities and Markets Authority (ESMA)	2009	101	16962000
	Office for Harmonization in the Internal Market (Trade Marks and Designs) (OHIM)	1994	730	50000000
Employment, Social affairs & Culture	European Foundation for the Improvement of Living and Working Conditions (EUROFOUND)	1975	113	20440000
	European Institute for Gender Equality (EIGE)	2006	23	5819800
Energy & Transport	Agency for the Cooperation of Energy Regulators (ACER)	2009	40	5119000
	Council of European Energy Regulators (CEER)	2000	150	1025000
	European Aviation Safety Agency (EASA)	2002	600	139554113
	European Civil Aviation Conference (ECAC)	1993	14	2200000
	European Railway Agency – promoting safe and compatible rail systems (ERA)	2004	500	25983000
Environment	Community Plant Variety Office (CPVO)	1995	43	12000000
	European Environment Agency (EEA)	1990	217	50330092
	European Environmental and Sustainable Development Advisory Councils (EEAC)	1993	n/a	n/a
	European Fisheries Control Agency (EFCA)	2005	56	11013000
	European Maritime Safety Agency (EMSA)	2009	101	16962000
	European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL)	1992	1	726000
	Network of the Heads of Environment Protection Agencies (EPA)	2003	1	n/a
Health	European Agency for Safety and Health at Work (EU-OSHA)	1994	70	15372768
	European Food Safety Authority (EFSA)	2002	460	76958000
	European Medicines Agency (EMA)	2002	600	208863000

	European Monitoring Centre for Drugs and Drug Addiction (EMCDDA)	1993	100	15400000
	European Network for Workplace Health Promotion (ENWHP)	1996	6	1085155
	Heads of Medicines Agencies (HMA)	1996	n/a	n/a
	European Centre for Disease Prevention and Control (ECDC)	2004	270	58107183
	European Chemicals Agency (ECHA)	2006	129	86481700
Justice & Law	European Agency for the Management of Operational Cooperation at the External Borders (FRONTEX)	2004	272	88410000
	European Crime Prevention Network (EUCPN)	2001	3	296552
	European Judicial Network (EJN)	2001	5	522000
	European Police College (CEPOL)	2005	32	8300000
	European Police Office (EUROPOL)	1995	700	83949000
	The European Union's Judicial Cooperation Unit (EUROJUST)	2002	186	31700000
	European Union Agency for Fundamental Rights (FRA)	2007	7	20000000
Services	Body of European Regulators for Electronic Communications (BEREC)	2009	18	5500000
	European Network and Information Security Agency (ENISA)	2004	47	8102920
	European Platform of Regulatory Authorities (EPRA)	1995	n/a	n/a
	European Regulators Group for Postal Services (ERGP)	2010	2	n/a
	Independent Regulators Group (IRG)	1997	2	472500

Notes

[1] However, the reverse argument is also possible. In fact, partner uncertainty is reduced by mutual experience and the creation of experienced-based trust among partners (Colombo, 2003; Kale, Dyer & Singh, 2002; Nooteboom, 1999; Stuart & Podolny, 1996; Zucker, 1986). Furthermore, some empirical findings show that when partner uncertainty is reduced, non-equity arrangements are preferred (Gulati, 1995) since the less partner uncertainty, the less monitoring and control are needed.

[2] http://europa.eu/agencies/regulatory_agencies_bodies/index_en.htm

[3] Regimes identified are not water tight independent compartments; they often overlap and boundaries are usually blurred. "The railway safety regime also deals with the interoperability of railways, which has direct and immediate implications for economic issues. The aviation and maritime safety regimes have more subtle implications for competition among airlines and producers of aviation equipment (Levi-Faur 2011, 815)."

[4] Although in the present study our focus is on the structural characteristics, we also collected information on 28 accountability variables allowing us not only to use this information if necessary, but also to capture the specificity of our data set – European regulatory networks of national regulators – that, to a greater or a lesser degree, maintain links to the EU institutions (European Commission, European Parliament and European Council).

[5] Bayesian credible intervals can be understood as frequentist confidence intervals

[6] Scores of the NAO complexity (ξ) as computed by the model. The dot represents the median point estimate, and the line highlights the 95 percent credible interval.

[7] Highest posterior density of θ parameters for the full and the restricted models. The dot represents the median point estimate, and the thick and thin lines the 90 and 95 percent credible intervals.

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