Governance through Global Networks and Corporate Signaling

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Abstract

The article exposes a new form of global governance based on an emergent network of corporate social responsibility (CSR) schemes. Our study is the first to uncover the network structure of this system, based on a dataset that includes 61 transnational CSR schemes and 31,987 firms. We demonstrate that the network exhibits a significant level of cohesiveness, despite having evolved outside the formal framework of the international treaty system. Drawing on social network analysis, we find a positive correlation between the sustainability performance of the firms, their membership in CSR schemes, and their network characteristics. We show that membership in multiple schemes and the firms' position in the CSR-schemes network constitute credible predictors of their sustainability performance, generating a separating equilibrium that distinguishes top CSR performers from low ones. We develop a model that explains the effectiveness of the CSR-schemes network, based on the network synergistic properties and on a distinctive signaling dynamic. Our findings highlight the potential contribution of CSR to the resolution of global governance dilemmas.

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1. Introduction

Global governance is in crisis. The conventional treaty-based system is struggling to cope with the multiple challenges faced by global society (UN-General-Assembly, 2015). This failure is evident in various areas, including climate change (Milman, 2018; Weaver & Kysar, 2017), protection of labor rights across global supply and commodity chains (Locke, Amengual, & Mangla, 2009), global bio-diversity (Cardinale et al., 2012), and the spread of communicable diseases (Gostin et al., 2016). The dependence of the treaty system on inter-state cooperation and its rigid bureaucratic structure have weakened its capacity to effectively respond to mounting global risks (Hale, Held, & Young, 2013). This governance crisis has motivated the creation of multiple private corporate social responsibility (**CSR**) schemes that operate alongside the treaty-based system, and cover many of the issues governed by conventional public international law regimes, from environment to human rights (Barak-Erez & Perez, 2013; Perez, 2007: 54). These transnational CSR schemes include voluntary corporate codes, environmental management systems, various labeling and certification schemes, sustainability reporting standards, and global ranking schemes (Perez, 2016: 163-170). Most CSR schemes include both a normative element (a standard that sets out detailed performance guidelines) and a compliance framework. Through their capacity to directly regulate the behavior of corporations on a global scale, CSR standards offer a way to circumvent the regulatory weaknesses of the international treaty system. The efficacy of CSR schemes as regulatory instruments and their credibility as indicators of sustainability performance constitutes, therefore, an important policy question (Hale, 2016; J. Ruggie, 2017). Various authors, however, have voiced skepticism about the credibility (or trustworthiness) of CSR instruments, arguing that they are nothing more than greenwash or cheap talk (Berliner & Prakash, 2015: 116; Zerbini, 2015: 14-15).[2]

The present study sheds light on this policy dilemma by examining the credibility of CSR schemes, based on a network analysis of a large sample of such schemes and affiliated firms. Our article contributes in several ways to the growing body of literature that examines private transnational regulation through a network or interactionist perspective (Abbott, Green, & Keohane, 2016; Bartley & Smith, 2010; Eberlein, Abbott, Black, Meidinger, & Wood, 2013;

[2] "Credibility" reflects the extent to which the membership or certification of a firm in a CSR scheme provides a trustworthy indication of the firm's sustainability performance. For a similar view, see Ven (2015).

Fransen, Schalk, & Auld; Green, 2013, 2017).[3] First, we conceptualize the authority of CSR schemes, that is their capacity to exert normative force, as an *emergent, network-based property*, dependent on certain structural features of the network. Specifically, we argue that this networked based authority is dependent on the evolvement of a multiplexed (ensemble) structure of closely connected CSR schemes. Multiplex networks exist when actors are connected through more than one type of socially relevant tie (Heaney, 2014: 67; Hu, Ksherim, Cohen, & Havlin, 2011; Pilosof, Porter, Pascual, & Kéfi, 2017). The evolvement of multi-layered connections between the CSR schemes is critical, we argue, to the consolidation of the standards' authority, to the realization of the network's synergistic potential, and to the flow of information within the network.[4] We link this argument to a phenomenon we call "networked signaling," which plays a crucial role in the evolution and operational dynamic of the CSR network. As we elaborate below, our framework connects between the firms' communication strategies and the evolving structure of the network. By studying the regulatory efficacy of CSR schemes from a network perspective our theoretical framework departs from the standard approach in the literature which considered each CSR regime separately (Potoski & Prakash, 2005; Schembera, 2016). Our theoretical framework also goes beyond mere interactionist models (Eberlein et al., 2013; Wood, Abbott, Black, Eberlein, & Meidinger, 2015) by seeking to elucidate the exact institutional pathways through which the network's structure affects its overall regulatory impact.

Second, we test our conceptual framework using a holistic empirical strategy, drawing on social network analysis (**SNA**) techniques. We base our empirical analysis on an original and extensive dataset, which includes 61 environmental and CSR organizations and 31,987 firms. Our holistic empirical approach goes beyond the current literature, which consists mostly of piecemeal studies of single CSR schemes or sectors (Berliner & Prakash, 2015; Dashwood, 2014; Fransen & Burgoon, 2014; Kayser, Maxwell, & Toffel, 2014).[5] Another novelty of our empirical strategy is that it reaches past a mere topological analysis by seeking to examine the regulatory impact of the network as a whole (Bartley & Smith, 2010; Fransen et al., 2018; Green, 2013).

[3] In the literature international relations, the use of social network analysis has been more prevalent, although its effect has started to be felt only in the past ten years (Hafner-Burton & Kahler, 2009; Kim, 2013-14; Maoz, 2010).
[4] For further exploration of this thesis see (Perez & Stegmann, 2018).
[5] See also the studies by (Aravind & Christmann, 2015; Boiral, Heras-Saizarbitoria, & Testa, 2017; Graafland & Smid, 2016), which examine the greenwash question, but similarly focus on single CSR programs.

The article proceeds as follows. Section 2 describes our theoretical framework. Section 3 introduces the methodology. Section 4 describes the results. Sections 5 and 6 conclude with a discussion of the results and policy implications.

2. Theoretical Framework: Ensemble regulation and networked signaling

We base our argument on two key theses: ensemble regulation and networked signaling. We argue that the transnational system of CSR schemes forms a dense and multilayered (multiplexed) network with synergistic properties, constituting what we term an *ensemble regulatory structure*.[6] The network's multiplexed structure is realized through four layers which reflect different types of interactions between CSR schemes: (1) indirect links that are established through the co-affiliation of a single corporation in different schemes; (2) direct links between the organizations that administer the standards of varied institutional forms; (3) cross-referencing between the CSR standards; and (4) common reference to general concepts (e.g., sustainability) in the texts associated with the schemes (Perez & Stegmann, 2018; Pilosof et al., 2017). While the CSR schemes appear (as nodes) in all layers, each layer captures a different manifestation of the scheme. It is thus possible to distinguish between 'elementary nodes', which represent the basic institutional entities, and 'state nodes', which represent the manifestation of a given elementary node on a specific layer (Pilosof et al., 2017). These multiplexed connections have, we argue, a synergistic effect which contributes to the network's regulatory power (Perez, 2011).

The synergistic effect is manifested through cross-supportive and cross-validating interactions between the schemes' normative and compliance frameworks, which are realized across the four layers. The synergistic aspect of the CSR ensemble means that the regulatory impact of the ensemble as a whole is greater than the sum of the individual effects of each CSR regime taken alone (Corning, 2002: 22-23; Luukkanen et al., 2012). In particular, we argue that the normative and compliance complementarities between the CSR schemes make it more difficult for firms that take on the commitments of several schemes to renege on their CSR commitments. A good example of this synergistic effect is the issue of disclosure. Many CSR schemes include

[6] Formally a multiplex, or multilayer network can be defined as a quadruple $M = (A, L, V, E)$, where A is a set of actors (or nodes), L is set of layers, (V, E) is a graph and $V \subseteq A \times L$ (Dickison, Magnani, & Rossi, 2016: 18).

disclosure requirements. For example, Global Compact, Responsible Care, and Equator Principles have developed unique reporting frameworks that are embedded in their institutional structure.[7] As a firm takes on the disclosure requirements of several CSR schemes, which may cover different aspects of its operations, it becomes much more difficult for the firm to cheat vis-à-vis each of the CSR schemes because its organizational structure becomes more transparent as a whole. The synergistic effect represents an emergent property of the network, and it is therefore not easy to quantify.

The ensemble regulation model leaves open the question of why firms should commit to implementing the costly requirements of a variety of CSR schemes, when they are not bound to do so by law. The literature has offered several explanations as to why firms invest in CSR: enhancing the company's brand and image, responding to its managers' ideological preferences, enhancing employees' organizational trust, or providing insurance against reputation loss in the case of adverse events (Berns et al., 2009; Lourenço, Callen, Branco, & Curto, 2014; Minor & Morgan, 2011). Firms may also invest in CSR to preempt or shape future regulation in ways that are not necessarily beneficial for society as a whole (Lyon & Maxwell, 2008). There is broad evidence, however, that reputation is a main factor in firms' CSR decisions (Berns et al., 2009; Reputation-Institute, 2017; Tetrault Sirsly & Lvina, 2016). A recent global survey has found that executives predominantly "cite reputation as a top reason their companies address sustainability" (McKinsey, 2014). Because it is difficult to test directly the reasons that cause firms to join CSR schemes, we test this assumption indirectly in our empirical analysis.

To the extent that firms want to use their commitment to sustainability values as a way to enhance their reputation, they need to find a way to *credibly signal* their commitment. We distinguish between firms that join CSR schemes and are committed to implementing their norms (*genuinely sustainable firms* or *green*) and firms that join CSR schemes but have no intention to implement them (*greenwashers*). By representing themselves as green without changing their behavior accordingly, greenwashers produce false signals (Lyon & Montgomery, 2015: 226). The challenge for genuinely sustainable firms is to find a way to distinguish themselves from

7 Global Compact signatories are required to produce an annual "Communication on Progress" (COP), which is considered a key component of their commitment (www.unglobalcompact.org/participation/report); Article 10 of the 2013 Equator Principles sets out detailed reporting obligations for members (http://www.equator-principles.com/index.php/members-and-reporting**)**; performance monitoring and reporting is also considered a pillar of the Responsible Care program (https://responsiblecare.americanchemistry.com/Performance-Management/).

greenwashers, given the situation of informational asymmetry in which they are situated. The literature refers to the circumstance of firms that obtain certification or membership in a CSR scheme without continuously complying with its requirements as "decoupling:" (Aravind & Christmann, 2015: 73; Graafland & Smid, 2016: 3). Note that greenwashers may also use other signals (e.g., advertisements, logo design, etc.) to falsely represent themselves as green. The challenge for genuinely sustainable firms is to find a simple and credible signal that can distinguish them from greenwashers. Green advertisements offer a simple communication strategy, but their credibility is low (Fernando, Sivakumaran, & Suganthi, 2014; Leonidou, Leonidou, Hadjimarcou, & Lytovchenko, 2014). Sustainability reports (**SRs**) offer an alternative option. By using objective metrics to measure CSR activity, SRs can operate as a signal that distinguishes between green and greenwasher firms. But the complexity of sustainability reports could undermine their capacity to distinguish between firm types, because deciphering the reports may be too costly (KPMG-International, 2014: 10).

A possible solution to the communication dilemma lies in a phenomenon we call *networked signaling.* Firms signal their commitment to sustainability by linking, through certification or membership, to multiple CSR schemes that are part of the CSR network (rather than linking only to a single code). The inspiration for this argument comes from the model of costly signaling that was developed (independently) by the biologist Amotz Zahavi (Zahavi & Zahavi, 1999) and the economist Michael Spence (Spence, 2002). The puzzle at the core of Zahavi and Spence's work is this: why do animals and humans produce costly and potentially detrimental signals? Prominent examples from biology include the stotting behavior of gazelles, the altruistic behavior of the Arabian babbler, and the peacock's tail (FitzGibbon & Fanshawe, 1988; Zahavi & Zahavi, 1999: xiii); examples from the economic literature include the costs of an MBA degree from an ivy league institution or advertising expenditure (Kirmani & Rao, 2000; Kübler, Müller, & Normann, 2008; Yang & Harstad, 2017).[8] Zahavi and Spence explained this seemingly puzzling behavior as a signaling device, in Zahavi's terminology, the "handicap principle." Highly productive workers invest in costly education to distinguish themselves from less productive ones (Bergh & Fink, 2009; Kübler et al., 2008), and high-quality producers spend large sums of money on advertisement to distinguish themselves from low-quality producers (Kirmani & Rao, 2000:69).

[8] The puzzle in the job market context arises because of the assumption that the investment in, for example, an MBA degree, has no productive or intrinsic value (Kübler et al., 2008: 220).

Animals use costly signals to convey their fitness and to distinguish themselves from unfit individuals (Johnstone, 1995; Zahavi & Zahavi, 1999).

In the corporate world, firms use certification or membership in CSR schemes to signal their commitment to sustainability values and to distinguish themselves from greenwashers. What makes certification or membership in CSR schemes a credible signal is the *differential cost structure* of multiple certifications. The cost of reliable quality signals is higher for an untruthful signaler than for an honest one (Laidre & Johnstone, 2013: R832). This is because the costs of maintaining a decoupled or deceitful organizational structure (in which an organization commits to a CSR scheme with no intention of implementing it), increases with the number of certifications or memberships the organization holds. These costs reflect both the direct costs of maintaining a decoupled structure and the expected reputational costs that may accrue if the deceit is exposed (Greyser, 2009).[9] We argue that there is a negative correlation between the sustainability performance of an organization and the *costs of cheating*: organizations that are low sustainability performers need to invest more in presenting themselves as green than those that are better performers (Connelly, Certo, Ireland, & Reutzel, 2011: 45). Note that greenwashers are not merely low-quality implementers (Aravind & Christmann, 2015: 74); they engage in deceit by trying to present themselves as high-quality implementers. For low-quality implementers to design an elaborate system of deceit, tailored to each of the various standards, may end up costing more than implementing these standards outright (Connelly et al., 2011: 45).[10] When the *differential cost* condition is satisfied, a *separating equilibrium* that distinguishes between firms that are truly committed to CSR values and greenwashers emerges (Lyon & Montgomery, 2015: 226). In a *separating equilibrium*, the market can accurately distinguish between the two types (Connelly et al., 2011: 43; Zerbini, 2015).

There is, we argue, a reciprocal and cross-supportive linkage between the firms' signaling dynamics and the networked structure through which the CSR schemes are organized. The first

[9] The organizational costs include the costs of establishing organizational procedures needed to create a façade of implementation without changing in practice the organization's behavior; reputational costs include both external costs associated, for example, with consumers' reactions to brand damage, and indirect costs associated, for example, with reaction of employees to the deceit (De Roeck, El Akremi, & Swaen, 2016; Greyser, 2009).
[10] The costs of implementing a CSR standard includes both 'entry costs' - the initial costs that a firm has to bear in order to join the 'club' and the 'maintenance costs' that are reflect the need to continuously meet the standard's requirements.

aspect of this reciprocal linkage concerns the issue of *signal consistency*. When firms use multiple signals, they face the risk of confusing the receiver through conflicting signals, making communication less effective (Connelly et al., 2011: 54; Gao, Darroch, Mather, & MacGregor, 2008: 13). The network structure provides firms with a pool of potential signals that can be linked together consistently in a way that enhances the force of the signal (Hart, Fox, Ede, & Korstad, 2015: 707; Kudłak & Low, 2015: 218).[11] This is what makes multiple certification a case of *networked signaling*. At the same time, the strategic need for signal consistency also provides an incentive for CSR organizations to expand their ties with other organizations. A second manifestation of this reciprocal connection concerns the influence of the signaling game on the behavior of CSR organizations. Because CSR organizations are mindful of the signaling logic that drives certification, they recognize that they must sustain their credibility, otherwise firms will not join. This implies that CSR organizations have an incentive to develop sound performance rules and credible compliance mechanisms, which jointly make cheating more difficult. The search by companies for credible signals and the capacity of the CSR network to respond to this demand create a self-reinforcing feedback loop that affects positively the efficacy of the regulatory network, creating a positive reciprocal linkage between the signaling dynamic and the regulatory robustness of the network as a whole. Note, however, that this positive reciprocal process is not a necessary phenomenon but rather part of our hypothesis. There could be other potential equilibria where network-driven convergence leads to weaker forms of sustainability.

3. Method

The Induced (Affiliation) CSR Code Network (IACN)

To construct our sample of CSR schemes, we created an initial list of candidate schemes based on a review of the literature (Abbott & Snidal, 2009; Hohnen, 2009; McKague & Cragg, 2003; OECD, 2009), then expanded the list through an Internet search.[12] We included in the sample only CSR schemes that have a certification or membership mechanism (open to firms), which is supported

[11] The linkage between CSR and sustainability is deep and well recognized in the literature (Kudłak & Low, 2015; Lacy, Cooper, Hayward, & Neuberger, 2010; Pistoni, Songini, & Perrone, 2016).

[12] To validate our findings, we sent our preliminary list to several international experts on CSR who commented and pointed out additional codes. The experts we consulted include Kenneth Abbott, Stepan Wood, and Benjamin Richardson. We thank them for their assistance.

by an institutionalized compliance framework (even if a relatively weak one). This restriction produced a sample that enabled us to test the network signaling hypothesis. We therefore omitted from our preliminary sample schemes that have no certification or membership option, such as ISO 26000, schemes that certify only public organizations (e.g., universities),[13] schemes that certify only products (green-label schemes), and CSR-related schemes where the signatories are states.[14] The compliance criterion means that a firm that seeks to make a commitment to that standard would be subject to some form of *ex ante* screening (entry costs) and *ex post* monitoring (continuing compliance costs). For our purposes, it did not matter whether the screening or monitoring process has been institutionalized in the form of certification or membership. For example, to become a member of Global Compact (**GC**), a firm must pledge, among others, to operate responsibly, in alignment with GC principles,[15] and to report annually on its ongoing efforts.[16] In the case of GC, the *ex ante* selection principle is relatively weak (willingness of the firm to formally commit to GC), and so is the *ex post* compliance mechanism, which is based on annual reports. Nonetheless, GC meets our criterion of operating within an elaborated institutional structure. SA 8000 has a different institutional structure: it requires firms that want to demonstrate compliance with it to undergo a process of certification carried out by third-party auditors, and to commit to a process of continuing third-party auditing.[17] GRI, which is also among the standards we cover, is based on a self-declaration that the organization publishes its sustainability reports in accordance to GRI principles, but it includes also an optional stricter form of compliance based on third-party audit.[18]

We collected the data by searching the websites of the schemes and by contacting their governing bodies if data were not available online. We omitted from the final database some relevant schemes for which we have not been able to obtain data about their members or certified

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[13] An example is Worker Rights Consortium, which focuses on universities and their relationship with textile factories; see, http://www.workersrights.org/ (the codes are available here: http://www.workersrights.org/university/coc.asp (U.S. Universities) and here http://www.workersrights.org/university/Model%20Code%20of%20Conduct%20%20for%20British%20Universities.asp (British Universities).

[14] E.g., the Kimberley Process Certification Scheme, OECD Guidelines for Multinational Enterprises (2011), and the Extractive Industries Transparency Initiative (EITI).

[15] See https://www.unglobalcompact.org/participation/join/commitment.

[16] See https://www.unglobalcompact.org/participation/report.

[17] "Certification lasts for three years, with a series of required surveillance audits throughout the three year period;" http://www.saasaccreditation.org/certification.

[18] See https://g4.globalreporting.org/how-you-should-report/in-accordance-criteria/pages/default.aspx.

firms.[19] We collected the data during 2015, a process that took approximately one year. *The final IACN network includes 49 CSR schemes and 31,987 firms*. All the data refer to membership or certification as of *December 31, 2014.*

In our raw data, firms were not identified with a unique identifier, such as the Central Index Key (CIK), used by the U.S. Securities and Exchange Commission (https://www.sec.gov/edgar/searchedgar/cik.htm) or by SEDOL codes, used by the London Stock Exchange (http://www.londonstockexchange.com/products-and-services/reference-data/sedol-master-file/sedol-master-file.htm). As a result, many firms with several certifications had a non-uniform representation in different codes. To eliminate this non-uniformity, we used Fuzzy Lookup (Microsoft), a software that performs fuzzy matching of textual data.[20]

The Institutionally Derived Code Network (IDCN)

To complement the structural analysis of the CSR schemes network, we also studied the direct institutional links between the organizations that run the schemes.[21] The analysis of the IDCN is consistent with our thesis that the socio-legal dynamics of the CSR network can only be fully understood if we study it as a multiplexed network. To construct the IDCN, we used a snowball strategy, based on data we extracted from the websites of the schemes. The snowball strategy, which starts from a set of focal actors, is a common data collection technique in network research (Chan & Liebowitz, 2006; Farquharson, 2005; Fieseler, Fleck, & Meckel, 2010). This analysis produced another mapping of the network, which included 61 schemes, in contrast to the 49 in IACN (Appendix A).[22] Because this analysis focused on the linkages between the organizations that administer the schemes, we also included in it schemes for which we did not have certification data (e.g., ISO), and schemes that do not have firms as members (e.g., UNEP, ISEAL). For the

[19] This ruled out, for example, the following CSR codes: PEFC, FSC, ISO14000, GAP, GOTS, GEO.
[20] See https://www.microsoft.com/en-us/download/details.aspx?id=15011.
[21] We have studied the citation layer of this network in a separate study, see (Perez & Stegmann, 2018).
[22] See the supplementary materials, available in the SSRN version of the paper. For the additional 12 codes (in the IDCN vs. IACN) we could not find data on firm membership, or this data were not relevant (e.g., in the case of UNEP and ISEAL). We applied the snowball strategy based on a single iteration (we did not look for new connections potentially produced by the additional 12 codes).

purpose of the analysis, we developed a taxonomy distinguishing between five types of institutional connections:[23]

- **Governance** covers participation in the governance bodies of other schemes, in the founding of other schemes, and other historical connections. For example, FairTrade International (FI) is a co-founder of ISEAL[24] and is represented on board of directors of ISEAL;[25] Good Weave (GW) is represented on the board of directors of Fair Labor Association (FLA).[26]
- **Partnership** covers partners, collaborators, cooperators, and allies. For example, Global Reporting Initiative (GRI) is an ally of Carbon Disclosure Project (CDP),[27] and Forest Stewardship Council (FSC) maintains a liaison with International Organization for Standardization (ISO).[28]
- **Compliance cooperation** covers schemes that provide traceability or compliance services to other schemes. The only example of such a connection that we found is the UTZ Code of Conduct for the Tea, Coffee and Cocoa Sectors, which provides traceability services to Roundtable on Sustainable Palm Oil (RSPO).[29]
- **Membership** covers schemes that are members[30] of other schemes. For example, Textile Exchange (TE) is a member of Better Cotton Initiative (BCI),[31] and the Union for Ethical Bio-Trade (UEBT) is a full member of ISEAL.[32]
- **Support** covers schemes that support other schemes. The term "support" designates a lower level of institutional linkage than partnership or membership—a signal of ideological affinity. For example, Round Table on Responsible Soy (RTRS) supports United Nations Global

[23] This analysis does not expose all the interactions between schemes. One can go deeper by analyzing major global conferences in which representatives from these organizations meet, personal relations between directors or employees and more (Fransen et al.).
[24] http://www.isealalliance.org/about-us/our-history
[25] http://www.isealalliance.org/about-us/our-governance/our-board
[26] http://www.fairlabor.org/about-us/board-directors
[27] https://www.cdp.net/en-US/OurNetwork/Pages/alliances.aspx
[28] http://www.iso.org/iso/home/about/organizations_in_liaison.htm
[29] https://www.utzcertified.org/en/traceabilityservices/traceability-services
[30] UNGC uses the term "participants" instead of "members." Many codes distinguish between membership and certification. Membership reflects participation in the governance of the code as an organization; certification is provided to organizations that meet the requirements of the standard promulgated by the relevant CSR-Code. In some cases, the two categories overlap. In this analysis, we focused on membership while in the analysis of the affiliation network we focused on certification (or membership that is equivalent in substance to certification).
[31] http://bettercotton.org/wp-content/uploads/2015/09/20160606_BCI-Members-List-Jun.xls
[32] http://www.isealalliance.org/our-members/full-members

Compact (UNGC),[33] and the Coalition for Environmentally Responsible Economies (CERES) is one of the supporting institutions of the Principles for Sustainable Insurance, an initiative of the United Nations Environment Programme (UNEP PSI).[34]

In assessing the presence of any of the above links, we relied exclusively on the characterization of the link on the website of the scheme, and have not examined it independently. Therefore, we lack data about the intensity of any connection (e.g., how involved schemes are in the governance of other schemes).

We analyzed each of the schemes (see **Appendix A** for the exact list; the codes that are part of IDCN but not of IACN are marked with *) by examining its website to determine whether it is connected to any of the other schemes through one of the above organizational paths. Other than partnership, which is reciprocal, all the paths listed above are *directed* and not symmetrical. The analysis was conducted in August-September 2015 and it included a search for information about the members, partners, supporters, governance, and history of each code. The results of the analysis were inserted into a matrix that included all the schemes, which we then analyzed using the SNA tools. For example, if code A was in the governance bodies of code B, an edge pointing to B was drawn.[35]

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[33] http://www.responsiblesoy.org/about-rtrs/members/?lang=en; the codes, which support UNGC, are those that have the "We Support the Global Compact" logo on their websites. This logo is used by codes that participate in the UNGC initiative, and it demonstrates the commitment of these codes to UNGC and its principles. https://www.unglobalcompact.org/participation/getting-started/brand-guidelines

[34] http://www.unepfi.org/psi/supporting-institutions/

[35] Note further that Partnership was marked as symmetrical (mutual) even if one of the partners did not mention the other as a partner or did not have a partners list on its website at all. We also analyzed the membership or representation of the codes in the governance of ISEAL, which is an umbrella organization of CSR codes. If we found relations between codes and local representatives of global codes, we treated the local organizations as identical to the global one. For example, FI: Fair Trade (Fair Trade Organization Kenya, Fair Trade USA, Fairtrade Australia and New Zealand); GAP: Global G.A.P (GLOBAL G.A.P. North America); ETI: Ethical Trading Initiative Base Code (ETI Norway, The Danish ETI); FLA: Fair Labor Association Workplace Code of Conduct (FLA Europe); GRI: Global Reporting Initiative (Global Reporting Sweden).

Descriptive Statistics of IACN and IDCN

The CSR schemes network is not homogeneous. To capture its heterogeneity, we analyzed the network according to a taxonomy we developed for this purpose.[36] Our taxonomy distinguishes between the schemes based on four criteria:

1) *General vs. specific*

General schemes apply to firms across multiple industrial sectors. GRI, UNGC, CDP, WEP, and EMAS are general schemes because their objectives and evaluation criteria (e.g., on sustainability reporting, gender equality, environmental management) are not sector-specific. Although EMAS focuses on environmental management and therefore may be considered to be less general than UNGC (which seeks to establish general sustainability principles that apply to all aspects of corporate behavior), we considered it to be general because it applies to a range of industries. *Specific schemes* apply to individual sectors such as banking, fishery, forests, etc. The different designation of Responsible Care and EMAS is due to the fact that the former applies only to the chemical industry. Examples of specific schemes are WDC, UTZ, and Responsible Care.

2) *Stringency of the compliance regime*

This criterion distinguishes between the schemes based on the stringency of their compliance regime. We divided the schemes into three classes:

a. *Soft*: schemes that have no compliance mechanisms and rely on self-reporting or declaration of commitment (examples: UNGC, WEP).
b. *Intermediate:* schemes that offer various compliance options to firms, including verification by third parties, but leave the final decision as to which option to choose to the firm (examples: GRI, Responsible Care).
c. *Strict:* schemes that have compliance mechanisms with third-party assurance. These mechanisms are integral to the program and non-negotiable. The key element is the presence of an enforcement process that is *external* to the certified firm (examples: SA8000, FSC).

[36] A detailed exposition of the standards and their varied characteristics is provided in **Appendix D**.

Note that the stringency of a CSR scheme can be measured along two dimensions, focusing either on the compliance structure or on the substantive content of its norms. The latter may be analyzed by considering the prescriptiveness of the scheme requirements, its scope (how many issues are covered), and the exigence of the requirements within the domain of each issue (Judge-Lord, McDermott, & Cashore, 2018). But because our sample consists of CSR schemes in various issue domains, it was not possible to empirically analyze the comparative stringency of the CSR standards in the sample from a substantive perspective.[37] We do not disregard, however, the substantive dimension, but rather study it indirectly. Our hypothesis is that if the substantive norms of the CSR schemes in our sample had not imposed significant requirements on participating firms, multiple certification would not have led to a separating equilibrium, as both "brown" firms and "green" firms could have subscribed to multiple schemes at negligible cost.

3) Governance

For this criterion, we have generally adopted the methodology developed by Abbott and Snidal, which distinguishes between organizations based on the entities governing them, and can be of three types: civic society, industry, and states, producing seven possible categories: schemes governed by only one type of the governing body (states, firms, or NGOs), by two (states-firms, NGOs-firms, or states-NGOs), or by all three (Abbott & Snidal, 2010).

4) Industry sector

We distinguished between the following sectors, relying on the Industry Classification Benchmark (ICB) scheme:[38] agriculture, chemicals, financial services, textile, mining & metals, forestry, marine, tourism & leisure, utilities, toys, and electronics.

Analysis of the schemes based on the above classification produced the following results.[39] We found, first, that there were more specific schemes (40) than general ones (21) (out of total of 61

[37] Thus, for example, Judge-Lord, McDermott, and Cashore's recent analysis focuses on the differences between two forestry CSR programs: The Forest Stewardship Council and the Sustainable Forestry Initiative (Judge-Lord et al., 2018).
[38] Our classification of sectors is generally based on the ICB scheme, but does not follow it exactly; see **Appendix C** for the exact allocation, and http://www.icbenchmark.com/Site/ICB_Structure for the ICB scheme.
[39] See **Appendix B** for the complete analysis.

schemes).[40] We expected specific schemes to adopt a more stringent compliance framework than general ones, but a chi square test[41] did not reject the null hypothesis that the stringency of the compliance system is independent of the scheme type. This result may be explained by the fact that our sample size was not large enough or by evolutionary changes in the institutional structure of general schemes. A second intriguing finding concerns the distribution of the stringency levels: we found that there were more strict schemes (36) than soft (15) or intermediate (9) (with 1 inapplicable, UNEP).[42] Third, we analyzed the governance structures of the schemes. We found that the governance bodies of the CSR organizations were dominated by civil society and industry sectors, which were represented in the governance of 41 and 51 schemes, respectively, with the state assuming a secondary role (participating in the governance of 16 schemes).[43]

4. Results

Structure of the CSR Network

To expose the topological structure of the CSR regimes network, we analyzed it first as an affiliation or bipartite network (Borgatti & Everett, 1997; Huang, Vodenska, Wang, Havlin, & Stanley, 2011; Jason Beckfield, 2010). The affiliation CSR network contains 49 regimes as one set of nodes (**Appendix A**), and 31,987 firms as another. All the data refer to membership or certification as of **December 31, 2014**. Our analysis focused on the induced graph, depicting the relations between the CSR schemes (*the IACN mapping*). Each node in the IACN represents a CSR scheme. Two nodes are connected by an edge if a firm exists that is a member of both schemes or holds a certificate from both. We first analyzed the unweighted graph of the induced CSR schemes network (IACN), in which we disregarded the number of firms that two schemes have in common.

[40] The exact distribution of the sectors by category was: 10 food & agriculture, 6 chemicals, 6 financial services, 5 textile, 3 mining & metals, 2 forestry, 2 marine, 2 tourism & leisure, 1 utilities, 1 toys, and 1 electronics.

[41] We considered 9 (31) soft (non-soft) specific codes and 6 (14) soft (non-soft) general codes. The expected values were 10 (30) soft (non-soft) specific codes and 5 (15) soft (non-soft) general codes. The test produced $p = 0.527$.

[42] The inner distribution of the stringency sub-categories was as follows: strict (36): 12 general, 24 specific; soft (15): 6 general, 9 specific; intermediate (9): 2 general, 7 specific; UNEP (inapplicable): general.

[43] This was the exact distribution: civil society & industry (23), civil society, industry & states (10), industry & states (4), industry (14), civil society (8), states (2).

Next, we relaxed this assumption and considered weights as well. Detailed description of the data collection process and other methodological issues are found in the methodological appendix.[44]

Figure 1 shows the unweighted graph of the IACN together with its centrality properties. The network consists of $|V| = 49$ vertices and $|E| = 362$ edges. **Table 1** describes the distribution of firms with multiple certifications.

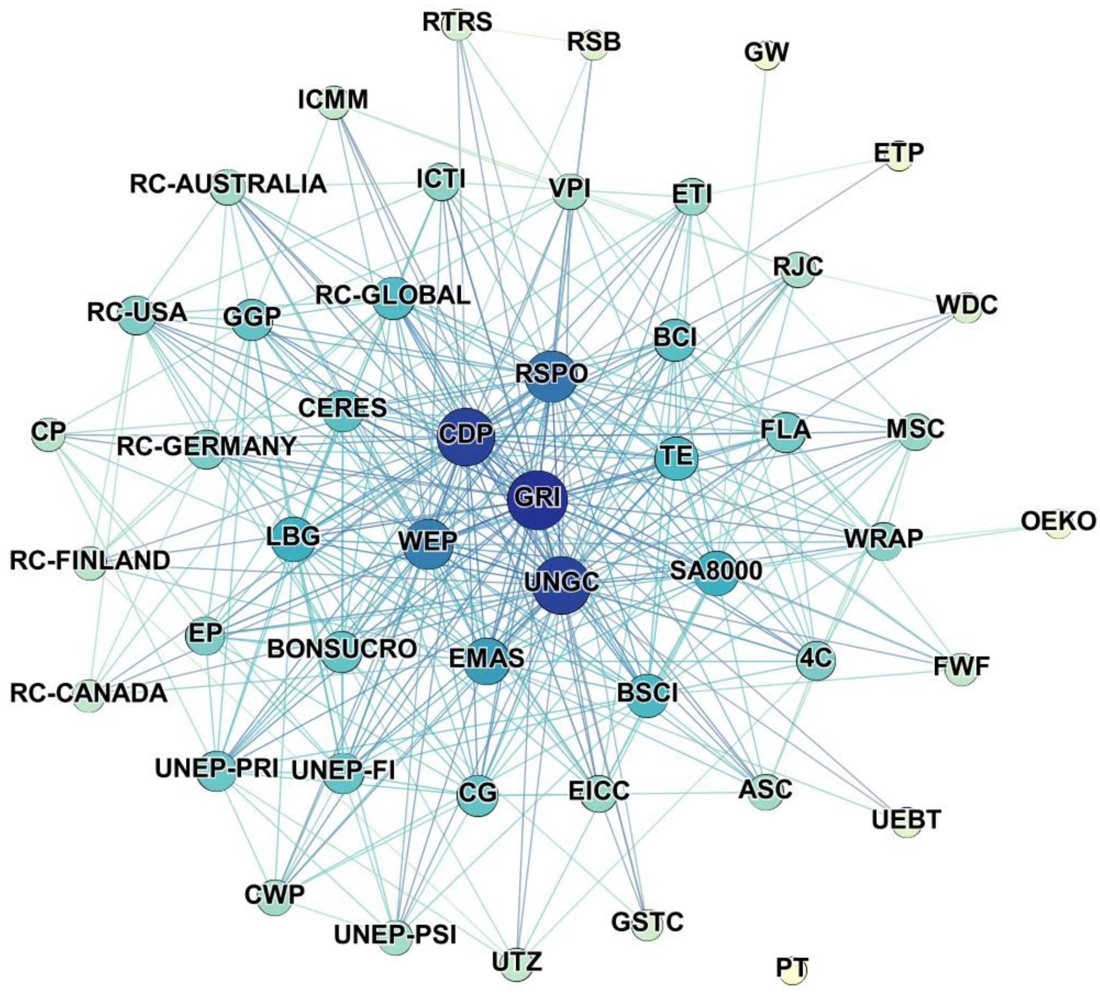

Figure 1. The Induced (Affiliation) CSR-Scheme Network (IACN)

Central nodes with large degrees are denoted by dark filled circles. Peripheral nodes with a small degree are light colored. Note the single unconnected node of PT at the bottom. All figures were made using the Gephi software package and Fruchterman Reingold algorithm (Bastian, Heymann, & Jacomy, 2009).

[44] See the supplementary materials, available in the SSRN version of the paper.

Table 1. Distribution of firms with multiple certifications

Number of connections	Number of firms
2	2153
3	477
4	122
5	59
6	26
7	12
8	3
9	2

The network was found to be rather cohesive, as suggested by the following measures: *average distance* (1.723), *diameter* (3), *density* (0.308), and *average clustering coefficient* (0.715). Excluding the Pro Terra code (PT), all the schemes are connected. This result is surprising because the network has evolved outside the domains of either state law or international treaty law, without formal hierarchical control. To place our findings in perspective, we compared them with the findings of two recent studies that analyzed the network of multilateral environmental treaties (MET) (Kim, 2013-14) and public international organizations (PIO) (Jason Beckfield, 2010). While the MET and PIO are different from the CSR network in the sense that they focus on States, Treaties and Treaties-related organizations, they share a common structure when considered at a higher level of abstraction. Like the CSR network, the MET and PIO networks have a multiplexed structure, which consists of several layers of interactions that include legal texts, governing institutions and affiliated entities. Each of these studies analyzed a different layer of the multiplexed network. For the MET network, which consists of 747 multilateral environmental agreements connected by cross-references, Kim reported an average path length of 4.70 and a diameter of 12 (for 2002) (Kim, 2013-14). For the bi-partite PIO network, consisting of IOs and states, Beckfield reported an average path length of 2.678 and a density of 0.528 (for 2000) (Jason Beckfield, 2010). Despite the fact that the MET and PIO networks have a longer history (their origins go back to early 20th century) they display a level of cohesiveness that is quite similar to that of the induced CSR-schemes network.

We used several measures of centrality to analyze the relative importance of the different schemes (degree, betweenness centrality, Dangalchev closeness centrality, and eigencentrality). Integrating the results across measures reveals the following schemes to be most central: GRI, UNGC, CDP, RSPO, WEP, and SA8000. **Table 2** includes a summary of our analytical results for the IACN. A more detailed description of our analysis and of the mathematical measures and methods we used is provided in **Appendix C**.

Figure 2 depicts graphically the IACN, where each edge is weighted as follows: for any two CSR schemes, $i, j,$ with l_i, l_j members respectively, and w_{ij} common firms, the weight is $w_{ij}/\sqrt{l_i l_j}$. We found that the strength of the weight reflects two phenomena. First, it reflects the tendency of firms in a specific sector to join several schemes that operate in that sector. For example, UNEP-FI and UNEP-PSI (financial sector) have the largest weighted edge (0.316), although the nominal number of firms they share is relatively small (30). Similar links exist in the fishery (ASC-MSC), extractive and mining (ICMM-VPI), and diamond and jewelry (RJC-WDC) sectors. Second, the links between the largest general schemes, CDP-GRI, GRI-UNGC, and CDP-UNGC, were also comparatively strong. This may reflect a social expectation for a firm committed to CSR values to be linked to these central schemes. A detailed list of the largest weighted links is given in **Appendix B2**. **Appendix B1** provides another graphic visualization of IACN, focusing on the nominal weights of the edges.

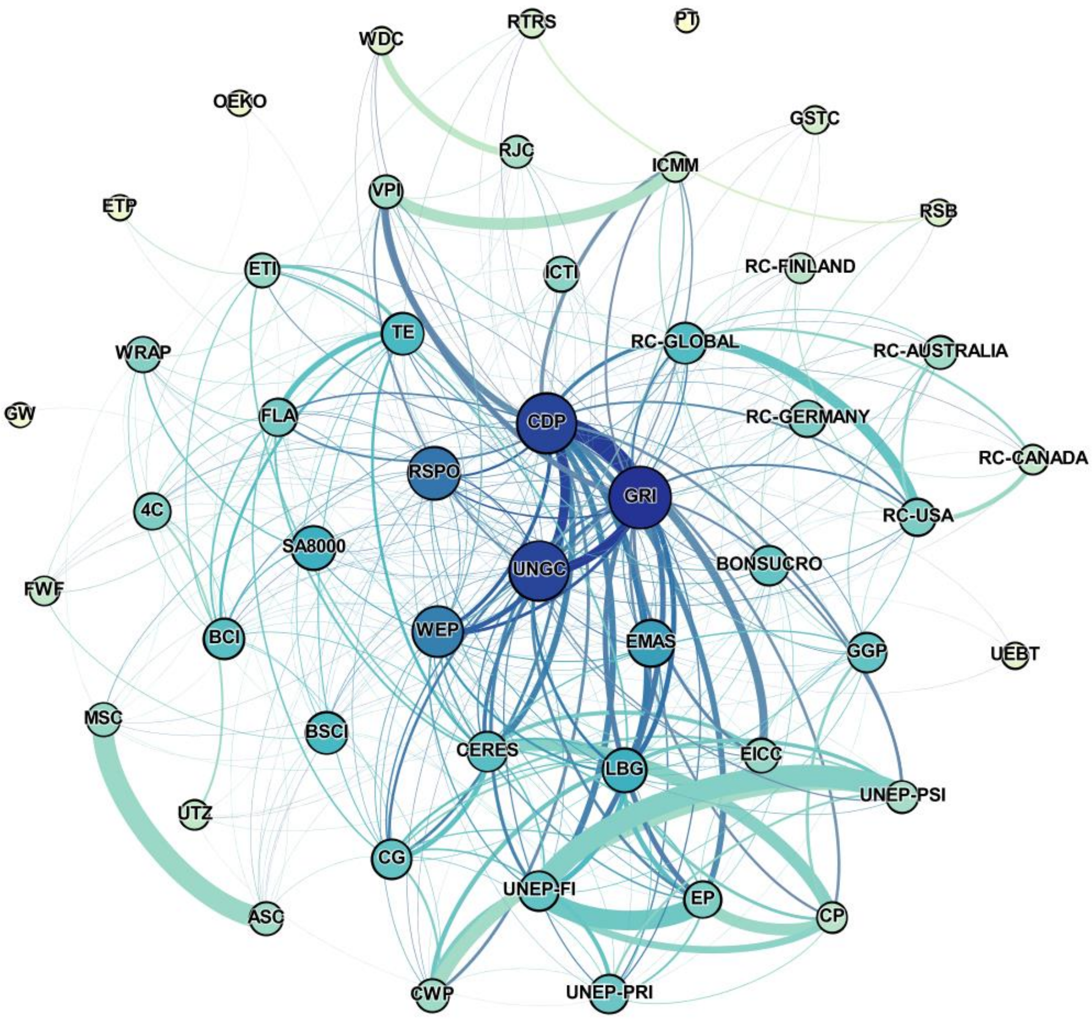

Figure 2. The IACN with Normalized Weights

Dark-colored circles together with their edges are associated with a larger degree. Thick edges represent larger weights.

We wanted to check whether the topological structure produced by the bi-partite analysis is consistent with the mapping of the direct institutional links between the CSR schemes produced by *the institutionally derived or IDCN mapping*. As noted above, we distinguished between five types of institutional connections: governance, partnership, compliance cooperation, membership, and support. The institutional links are directed, except partnership, which is symmetrical. This generated a directed and unconnected graph with 61 nodes ($|V| = 61$) and 116 edges ($|E| = 116$). In our analysis, however, we considered all edges as bi-directional, because the direction of the edges has little relevance for our analysis of network dynamics (e.g., diffusion of ideas and norms). We focused on the largest weakly connected component (WCC), which consists of 46 organizations. The IDCN had similar structural attributes to the IACN, revealing a significant level of cohesiveness (**Table 2)**. We also found an overlap in the identity of the dominant schemes, which included GRI*, ISEAL, UNGC*, ISO, SA8000*, and UNEP as the most central, with CDP*, CERES, and RC-GLOBAL somewhat lagging behind (overlapping schemes are marked by *). Consistent with the central position of several organizations, we also found relatively high centralization scores, especially for the IACN (0.635, IDCN=0.310). Again, this result was unexpected, given the lack of formal hierarchical control.

Figure 3 provides a visual representation of the IDCN. See **Appendix D** for the complete analysis. In **Appendix E** we also provide a visual representation of IDCN, which includes a functional analysis of the nodes.

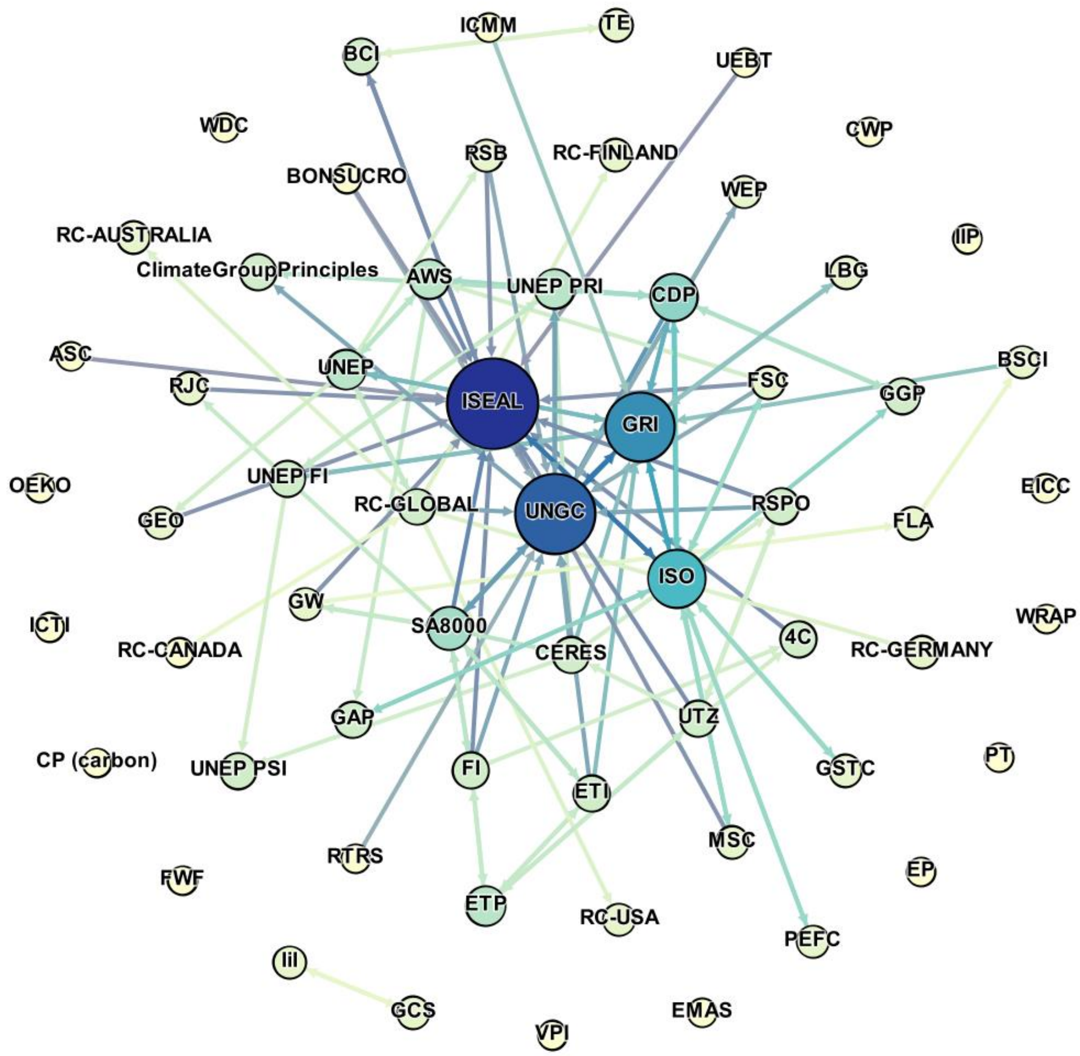

Figure 3: **The IDCN**

Large and dark circles correspond to nodes with large incoming degree. The brightness of the edges is proportional to incoming and outgoing degree of the node.

Table 2 summarizes our results regarding the topological structure of the induced CSR network, comparing between the IACN and IDCN mappings. The leading schemes in **Table 2** are analyzed with respect to the three measures of centrality.

Table 2. Summary of network statistics (IDCN and IACN)

Measure	IACN			IDCN (WCC)		
Nodes	49			46		
Edges	362			84		
Diameter	3			6		
Average distance	1.723 (0.538)			2.749 (0.983)		
Density	0.308			0.081		
Centralization	0.635			0.310		
	Average	Leading schemes		Average	Leading schemes	
Degree	14.776 (10.241)	GRI CDP UNGC RSPO WEP	44 41 41 33 31	3.652 (3.591)	ISEAL UNGC GRI ISO UNEP + UNEP Financial Codes	17 15 11 9 8
Dangalchev closeness centrality	14.949 (3.538)	GRI CDP UNGC RSPO WEP	22.75 22 22 20 19.5	8.274 (2.378)	UNGC ISEAL GRI SA8000 ISO	13.688 13.313 12.688 12 11.688
Betweenness centrality (normalized)	0.015 (0.032)	GRI CDP UNGC SA8000 RSPO	0.149 0.127 0.104 0.079 0.053	0.040 (0.081)	UNGC ISEAL GRI RC-GLOBAL ISO	0.339 0.321 0.223 0.214 0.163
Eigenvector centrality	0.020 (0.011)	GRI UNGC CDP RSPO WEP	0.047 0.045(4) 0.045(2) 0.040 0.039	0.022 (0.018)	UNGC ISEAL SA8000 GRI CERES	0.076 0.070 0.057 0.056(8) 0.046
Clustering coefficient (normalized)	0.715 (0.235)			0.187 (0.303)		

Numbers in parentheses are standard deviations of the averages. All measures in IDCN refer to WCC. Largest values associated with the measures (excluding the clustering coefficient), together with the five corresponding schemes, are given in the Leading schemes columns.

5. Greenwashing or Honest Signaling: Analysis of the Networked Signaling Hypothesis

The networked signaling (NS) model presented above conceptualizes multiple certifications as a form of costly signaling (socio-legal handicaps), which exploits the networked structure of the domain of CSR schemes. It also explains how this mode of networked signaling can produce a separating equilibrium, which distinguishes between high/low sustainability performers. We hypothesized that firms with multiple certifications display a stronger CSR performance than do their peers with fewer certifications. According to the NS model, the number of certifications should correlate positively with CSR performance. To test this hypothesis, we compared our data on multiple certifications with data on global CSR rankings, obtained from Dow Jones Sustainability Indices and FTSE4Good, which are widely considered to be credible proxies for good CSR performance (Lourenço et al., 2014; Montiel & Delgado-Ceballos, 2014; Wu & Shen, 2013: 3531). Most of the empirical literature on corporate sustainability has similarly used external organizations such as DJSI, FTSE4Good, KLD indices, and others to measure the level of sustainability performance achieved by different companies (Antolín-López, Delgado-Ceballos, & Montiel, 2016: 9; Montiel & Delgado-Ceballos, 2014: 127). A recent survey of CSR experts has found DJSI and FTSE4Good to be among the four most credible global sustainability ratings, out of a total of 18 (GlobeScan/SustainAbility, 2013).

We obtained two datasets from both DJSI and FTSE4Good: one that includes the universe of firms from which the sustainability indices were constructed, and the other that includes ultimate constituents of the indices, which are a subset of the total universe. DJSI and FTSE4Good Indices are designed to measure the performance of companies demonstrating strong environmental, social, and governance (ESG) practices. They have a dual goal: to provide a tool for the creation of index-tracking investments, financial instruments, and fund products focused on responsible investment, and more important for our study, to help identify leading environmentally and socially responsible companies.[45]

[45] See, for FTSE4GOOD, http://www.ftse.com/products/indices/FTSE4Good?_ga=1.174472427.877647568.1464114119 and for DJSI, see Dow Jones Sustainability Indices Methodology (March 2016) available at: http://eu.spindices.com/indices/equity/dow-jones-sustainability-world-index.

The DJSI and FTSE indices focus on positive criteria for selecting companies,[46] but have developed different selection approaches. DJSI selects the companies in its various indices based on a *best-in-class* approach, which picks out the best performers in each industrial sub-sector. Each DJSI benchmark index has a different target number. For example, the Dow Jones Sustainability World Index (DJSI World) includes the top 10% of the leading sustainability companies out of the largest 2,500 companies in the S&P Global BMI, whereas DJSI Europe includes the top 20% of companies among the 600 largest developed European companies listed in the S&P Global BMI. Since the launch of DJSI World, in 1999, other indices have been added to the series.[47] Unlike the DJSI series, the FTSE4Good series is based on a principle of eligibility (an absolute threshold approach), so that "[a]ll companies in each constituent Universe index that pass the eligibility criteria detailed in the FTSE4Good Index Inclusion Rules at the review date are included in the relevant FTSE4Good Benchmark Index."[48]

Both indices employ a complex array of criteria to decide which firm to include in their sustainability indices (FTSE4GOOD, 2016b; RobecoSAM, 2016a; Slager & Chapple, 2015: 406). FTSE4Good rating is based on 300 individual indicators distributed across three pillars (environmental, social, governance) and 14 themes (FTSE-Russell, 2018). DJSI ranking is similarly based on 3 pillars (economic, environmental, social), which are comprised of multiple questions (S&P-Dow-Jones-Indices & ROBECO-SAM, 2016).[49] The selection of firms to the DJSI and FTSE sustainability indices is based on multiple criteria and it is therefore not determined by a single proxy, such as their certification by certain CSR programs or membership in them.

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[46] FTSE uses some built-in exclusion criteria, whereas DJSI, which does not rely on negative screening in its general indices, offers some exclusion indices. *E.g., Dow Jones Sustainability World Enlarged Index ex Alcohol, Tobacco, Gambling, Armaments & Firearms and Adult Entertainment*. For a detailed description of the selection methodologies of both index families, see *FTSE, Index Inclusion Rules for the FTSE4Good Index Series* (version 1.6, June 2015) [hereinafter FTSE4Good Index Inclusion Rules], [https://web.archive.org/web/20151029122349/http://www.ftse.com/products/downloads/F4G-Index-Inclusion-Rules.pdf]; Dow Jones Sustainability Indices Methodology (Oct. 2017) [hereinafter DJSI Methodology], [https://eu.spindices.com/indices/equity/dow-jones-sustainability-world-index].

[47] For the full list, see *DJSI Family Overview*, ROBECOSAM, http://www.sustainability-indices.com/index-family-overview/djsi-family-overview/index.jsp (last visited March 29, 2018).

[48] FTSE RUSSELL, GROUND RULES: FTSE4GOOD INDEX SERIES §§ 5.3.2 (version 2.3, Oct. 2015). https://web.archive.org/web/20160108211822/http://www.ftse.com/products/downloads/FTSE4Good_Index_Series.pdf.

[49] Further details on FTSE4GOOD assessment criteria can be found in (FTSE4Good, 2016a; Slager & Chapple, 2015).

DJSI and FTSE4Good rely on a variety of sources in their ranking process. DJSI uses detailed questionnaires developed by RobecoSam, which are tailored to each industrial sector.[50] In addition to the data collected through questionnaires, RobecoSam also relies on "ongoing monitoring of media and stakeholder commentaries and other publicly available information from consumer organizations, NGOs, governments or international organizations to identify companies' involvement and response to environmental, economic and social crisis situations that may have a damaging effect on their reputation and core business" (S&P-Dow-Jones-Indices & ROBECO-SAM, 2016: 16). For many questions, companies receive the maximum score for a question only if they have provided adequate supporting material (RobecoSAM, 2016b: 8). FTSE4Good uses only publicly available data in assessing ESG practice and does not accept information provided privately by companies (FTSE4GOOD, 2017: 4). DJSI relies on the expertise of a leading global environmental research agency, the SAM Group; FTSE has recently ended its long-term relationship with the UK-based agency, Eiris, and started to perform the ESG assessment in-house.

In the case of DJSI, our sample includes data about the constituents of the following six indices: DJSI World, DJSI North America, DJSI Europe, DJSI Korea, DJSI Australia, and DJSI Asia-Pacific;[51] in the case of FTSE4Good, we received data on the constituents of FTSE4Good Global (FTSE All World Developed Indices Constituent Data, 31-12-2014). For both, the data were for 31 December, 2014.

We used the data to test three complementary hypotheses, which jointly examine the NS model and the existence of a separating equilibrium. Our first hypothesis states:

(H1) Firms selected (denoted by s) as constituents of either the DJSI or the FTSE4Good sustainability indices are more likely to be part of the CSR-scheme network (denoted by NW), that is, to be certified by at least one code, than are firms that were not selected from the universe of candidate firms (denoted by $\sim s$).

[50] See, for example, the questionnaires used to evaluate firms in the Metals and Mining and in the Diversified Consumer Services sectors (http://www.robecosam.com/en/sustainability-insights/about-sustainability/corporate-sustainability-assessment/sample-questionnaire.jsp).

[51] To make our analysis consistent, we removed from our universe the firms that were considered for participation only in DJSI World Enlarged or DJSI Emerging Market because we did not have data on the constituents of these indices.

Mathematically, (H1) can be formulated as follows:

$$(1) \quad \frac{|s \cap NW|}{|s|} > \frac{|{\sim}s \cap NW|}{|{\sim}s|}.$$

Eq. (1) implies that:

$$(2) \quad \Pr(NW|s) > \Pr(NW|{\sim}s).$$

We found that Eq. (2) holds for both DJSI and FTSE4GOOD (Table 3, rightmost column), which supports our first hypothesis.

Table 3: Likelihood that firms are part of the affiliation network

	$\lvert s\rvert$	$\lvert{\sim}s\rvert$	$\lvert s \cap NW\rvert$	$\lvert{\sim}s \cap NW\rvert$	$\Pr(NW\lvert s)$	$\Pr(NW\lvert{\sim}s)$	$\frac{\Pr(NW\lvert s)}{\Pr(NW\lvert{\sim}s)}$
DJSI	505	2393	486	1004	0.96	0.43	2.29
FTSE	760	1327	585	652	0.77	0.49	1.57

To verify that inclusion in the indices is uniquely related to the network and not driven by a correlation with another variable, we conducted an additional analysis to check whether our hypothesis also holds across several categories of attributes of the firms. We focused on three categories: industrial sector (measured according to the categories used by the FTSE and the DJSI), country, and market capitalization. To this end, we considered the reduced probabilities $\Pr(NW|{\sim}s \cap *_\alpha)$, $\Pr(NW|s \cap *_\alpha)$, $\alpha = 1,2, .. n_{*,}$ where * stands for any of the foregoing categories, and n_* is the number of constituents in category $*$. We argue that if

$$(3) \quad \Pr(NW|s \cap *_\alpha) > \Pr(NW|{\sim}s \cap *_\alpha)$$

is satisfied for every $*$ and α, the correlation between certification and inclusion is unique. In general, we found that (3) is satisfied for each of the categories we tested, rejecting the alternative hypothesis that our results were driven by these three attributes. The complete analysis of each category is provided in Appendices F1, F2, and F3.

To complement our first hypothesis, we considered the relation between the number of certifications a firm has and the likelihood of its inclusion in the indices. We hypothesized that:

(H2) A firm that is certified by multiple schemes is more likely to be included in the indices than one with fewer certifications, that is, as the number of certifications grows, so does the probability of a firm being included.

To avoid the fluctuations caused by a relatively low number of firms with more than four certifications, we pooled together these firms. As shown in **Table 4**, after pooling, the probabilities increase *monotonically* with the number of certifications (n_s).

Table 4. Probability of being included in the indices as a function of the number of certifications (n_s). Firms with $n_s \geq 5$ are pooled.

	DJSI			**FTSE**		
$\boldsymbol{n_s}$	$\lvert \boldsymbol{s \cap n_s} \rvert$	$\lvert \boldsymbol{\sim s \cap n_s} \rvert$	$\boldsymbol{Pr(s \lvert n_s)}$	$\lvert \boldsymbol{s \cap n_s} \rvert$	$\lvert \boldsymbol{\sim s \cap n_s} \rvert$	$\boldsymbol{Pr(s \lvert n_s)}$
1	112	563	0.17	199	334	0.37
2	153	266	0.37	152	184	0.45
3	121	122	0.50	125	97	0.56
4	41	34	0.55	47	22	0.68
5-9	59	19	0.76	62	15	0.81

We also tested (H2) without pooling the firms with $n_s \geq 5$ and received similar results; see Appendix F4 for the complete analysis.

To rule out the possibility that the effect of increased probability for inclusion in the indices is due to correlation with another variable (in particular, the firm's market capitalization and its industrial sector), we also performed a logistic regression where the predictors were the number of certifications, n_s, and the response was a binary vector assigned a value of 1 if a firm is included and 0 if not. We then considered industry and market capitalization as additional dummy variables. The complete analysis is given in appendix F5. As can be seen from the results, inclusion in the indices is positively correlated with n_s. Furthermore, adding the dummy variables did not affect the significance and monotonicity of the coefficients. This suggests that the monotone increase in the probability of a firm being included is positively correlated with its number of certifications, even when controlling for the effect of its industrial sector or its market capitalization.

It could be argued that firms' inclusion in FTSE4Good and DJSI is related to the stringency of the CSR schemes and not to the number of certifications as postulated by H2. According to this argument, firms certified by stringent schemes are more likely to be included in the indices than firms that are affiliated with a less stringent ones. We distinguished between three types of CSR stringency levels: strict, intermediate, soft (26, 8, 15 codes, respectively). **Table 5** (top) summarizes that distribution of firms with respect to the stringency level of the schemes they are associated with. For the purpose of the analysis, we distinguished first between firms that are certified only by soft schemes (which include intermediate and soft)[52] and firms with no certification. We performed a χ^2 test to check the null hypothesis of independence between firm's inclusion in the indices and its certification by soft schemes. As evident from Table 5 (bottom), the null hypothesis for this analysis is strongly rejected for both indices. Firms certified exclusively by soft schemes have a significantly higher probability to be included, compared to firms which are not affiliated with any standard. We complemented this analysis by comparing between firms that are certified by at least one strict CSR scheme and firms that are certified exclusively by soft schemes. We considered (via χ^2 test) the null hypothesis of independence between firm's inclusion in the indices and its affiliation with at least one strict scheme. According to this analysis, in FTSE there is no indication that certification by at least one strict scheme has any effect on the probability of inclusion compared to certification by soft schemes only. For DJSI the null hypothesis is rejected. Firms affiliated with at least one strict scheme are more likely to be included than firms certified by soft ones only.

Table 5. Inclusion versus stringency and certification in general

	DJSI		FTSE	
	included	not included	included	not included
Strict	81	124	90	94
Soft	405	880	495	558
χ^2	0.023		0.633	
soft	405	880	585	652
not certified	19	1389	175	675
χ^2	3E-102		4E-33	

We further examined the identity of the firms at the tail of the distribution, namely, firms with 7-9 certifications (**Table 6**). According to the NS hypothesis, these firms should exhibit strong

[52] Because intermediate schemes leave the final decision as to which compliance option to choose to the regulated firm, we combined the soft and intermediate categories for the purpose of this analysis.

CSR performance. Indeed, most of them were included in either the DJSI or the FTSE4GOOD (14 out of 17, 82%), and a somewhat smaller group in both indices (11 out of 17, 65%). Note that out of these 17 firms, 8 belong to the financial sector and are members of one of the financial CSR schemes sponsored by UNEP, UNEP-FI, or UNEP-PSI. We suggest two complementary explanations for this finding. First, the large financial firms, at the top of the certification list, have wide public exposure and therefore may value their reputation more than comparable firms in other sectors (Wu & Shen, 2013). Second, the cost of certification may be lower for these conglomerates than for comparable firms in other sectors.

Table 6. Firms with 7-9 certifications

Firm	**Degree**	**DJSI**	**FTSE**	**UNEP-FI or UNEP-PSI membership**
1. 3M	7	1	0	0
2. Anglo American	7	1	1	0
3. Arkema†	7	0	0	0
4. BASF	7	1	1	0
5. BNP Paribas	7	1	1	1
6. British Petroleum (BP)	7	0	0	0
7. Credit Suisse	7	1	1	1
8. Evonik Industries	7	0	1	0
9. Kao	7	1	1	0
10. Nestle	7	1	1	0
11. Royal Bank of Scotland†	7	1	1	1
12. RSA Insurance	7	0	1	1
13. Aviva	8	1	1	1
14. HSBC Holdings	8	0	1	1
15. Nike	8	1	1	0
16. Bank of America	9	1	1	1
17. Swiss Re	9	1	1	1

Finally, we examined the linkage between the eigenvector centrality of a firm and the probability of it being included. We hypothesized that:

(H3) There is a positive correlation between the eigenvector centrality of a firm and its probability of being included.

Eigenvector centrality (or eigencentrality) provides a more refined notion of centrality than degree because it takes into account the importance of the nodes with which a node is linked. Unlike degree centrality, which simply measures the local connectivity of node i, eigencentrality x_i provides a measure of the global importance of a node in view of the total connectivity of the network. Thus, eigencentrality serves as a better indication of the role played by a node in the diffusion of information across the entire network. Firms with high eigencentrality act as information hubs, relaying information created in other nodes to the rest of the network. Our hypothesis was driven by the idea that high eigencentrality extends the public exposure of firms (because it implies that they are connected to other nodes with high eigencentrality). It therefore also increases the costs of infringement and provides firms with a higher eigencentrality (compared to firms with the same number and type of certifications) a stronger incentive to comply with the requirements of CSR standards or potentially to go beyond them.[53]

Eigencentrality can be calculated by making x_i proportional to the average of the eigencentralities of the nodes neighboring node i. It can be formulated as:

$$(4) \quad x_i = \frac{1}{\lambda} \sum_{j=1}^{n} A_{ij} x_j,$$

where A_{ij} is the adjacency matrix (i.e., $A_{ij} = 1$ if nodes i and j are connected, and $A_{ij} = 0$ otherwise), and λ is a constant. For most values of λ, the only solution of the system of equations (4) is that all x_i values are zero. But for specific values of λ, these equations also admit non-zero solutions. Such values of λ are eigenvalues of the network, and the corresponding lists of solutions, $x = (x_1, x_2, x_3, \ldots, x_n)$, are called eigenvectors.

The eigenvector centrality of a node i is determined by the value of x_i in the eigenvector corresponding to the largest eigenvalue (largest value of λ for which there are non-zero solutions). It is mathematically guaranteed by the Perron-Frobenius theorem that there exists a maximal value of λ for which there is a unique eigenvector (if the graph is connected), and that all the corresponding values of x_i are positive and non-zero. Because there is a strong correlation between the degree of a node and its importance based on the eigenvector centrality measure, which becomes more pronounced as the number of certifications increases, we controlled for the degree

[53] It can be argued also that linking with codes with higher eigencentrality conveys a stronger signal.

to be able to measure the additional effect of eigenvector centrality on the probability of each node being included.

To test this, we measured EC values for all firms and schemes in the bipartite network. Next, we performed a logistic regression, where the predictors are the eigencentralities (normalized by maximal value) of firms that are also included in an index, and where the number of certifications, $n_s = 1,2,3,4$ and larger than 4, is fixed. The response is a binary vector that assumes the values 0 or 1 for firms excluded from or included in the index, respectively. Results for both indices are summarized in **Table 7** top (original). We found that it is more likely that a firm with a large EC is included than excluded, and the likelihood increases as n_s increase ($n_s \geq 2$). The effect is significant for both indices.[54]

To reject the possibility that the effect is due to correlation with the market capitalization of the firm, we performed another regression where the latter served as an additional predictor (see **Appendix F5**). Again, as in the case of hypothesis (H2), our analysis confirms that the influence of eigencentrality on the probability of a firm being included does not change when the market capitalization of the firm is also considered.

Table 7: Eigenvector centrality and signaling

	DJSI			**FTSE**		
$\boldsymbol{n_s}$	**Coefficient**	**SE**	**p value**	**Coefficient**	**SE**	**p value**
1	-1.22337	0.579031	0.034618	-0.31202	0.441213	0.479453
2	0.964174	0.233935	3.76E-05	0.474461	0.245178	0.052969
3	1.13039	0.192463	4.27E-09	0.88933	0.197982	7.06E-06
4	1.495633	0.300365	6.38E-07	1.354748	0.332581	4.63E-05
5-9	2.437975	0.316972	1.45E-14	2.148093	0.359651	2.33E-09

Limitations

The study has several limitations. The first one has to do with the fundamental features of network analysis. The network-based approach provides a way to uncover the underlying architecture of

[54] As eigencentralities are network variables which may bias a logit model, we performed a similar logistic regression using a new network constructed by firms redistributed at random at each code, keeping the code size (total number of firms) fixed. A detailed analysis is given in Appendix G.

the CSR system by reducing it to an abstract structure of connection patterns (Kim, 2013-14: 980). But although this analysis allows us to expose large-scale linking patterns, it cannot capture processes that take place at the micro-level within firms or CSR organizations. Our network-driven analysis should therefore be supplemented by studies that examine institutional micro-processes in light of the network perspective we propose.

A second limitation concerns the need for analysis that considers longer time ranges. Our research is based on data focusing on a single-year membership or certification. To achieve a better understanding of the structural evolution of the CSR network and of the signaling behavior of firms, it would be necessary to perform a dynamic analysis that uses longitudinal data. Such analysis can utilize, for example, longitudinal data of firm membership or certification, together with historical data on sustainability performance (for example, obtained from DJSI and FTSE). This would make it possible to examine whether an increase in the number of memberships or certifications is associated with improved performance. Data on membership and certification are held by private bodies, some of which are not willing to share data with researchers. As a result, we were unable to develop a sufficiently large historical dataset, which would have allowed us to conduct a more extensive dynamic analysis. By contrast, in the field of international relations there has been a concerted effort, going back to the 1980s, to develop datasets focusing on inter-state militarized conflicts, international crisis behavior, treaty membership, and more (for a detailed description, see (Maoz, 2010: 16-17)). Our work is pioneering in its attempt to develop a similar dataset in the field of CSR regulation.

6. Discussion and Policy Implications

We argued at the introduction that the authority of CSR schemes should be viewed as an *emergent, network-based property*, that is dependent on the evolvement of a multiplexed (ensemble) structure of closely connected CSR schemes. The topological analysis provides preliminary support for that argument, by showing that both the IDCN and the IACN exhibit a high level of correlated cohesiveness. In a companion paper Perez and Stegmann study the layer of cross-citations between the standards associated with the IDCN (Perez & Stegmann, 2018). They find that this layer forms a well-connected network.[55] The multiplexed cross-supportive and cross-validating interactions

[55] Perez and Stegmann find that 53 of 57 codes (92.98%) were part of one network; that is they either cited at least one other code , or were cited by another code. The average path length was 2.86.

between the CSR schemes have, we argue, a synergistic effect that enhances the network's regulatory power (both in general and at the level of individual schemes). More studies are needed however in order to elucidate how the different layers are linked and how this inter-layer connectivity is theoretically and empirically related to the evolution of global governance structures. There is an emerging literature in physics and ecology that has studied multiplexed networks and has developed various quantitative tools which can be utilized in future studies (Hu et al., 2011; Pilosof et al., 2017). We believe that the networked governance paradigm can be usefully extended to other areas of transnational law. For example, the Ebola crisis of 2014-2015 exposed the crucial role of non-governmental organizations (NGOs) in fighting the spread of the disease, together with the World Health Organization (WHO). NGOs such as Médecins Sans Frontières, Partners in Health, and Samaritan's Purse were central in providing medical assistance on the ground and in sounding a global alert (Gostin & Friedman, 2015: 1905). Network analysis can expose the structure and dynamics of the field of global health governance (Gostin & Katz, 2016).

Our findings also suggest that in evaluating the contribution of certain CSR standards to global governance processes one should examine not just their intrinsic properties but also their network-related attributes. Integrating the results of the four measures of centrality we used (degree, closeness, betweenness, and eigenvector centralities) in the context of the IACN and IDCN mappings highlighted the central position of several organizations: GRI, UNGC, CDP, RSPO, WEP, SA8000, ISEAL, ISO, UNEP, CERES, and RC-GLOBAL. This finding suggests that these bodies play a coordinating role in the network, consistent with the arguments of Abbott and Snidal, and of Ruggie (Abbott & Snidal, 2010; J. G. Ruggie, 2001). The central position of these schemes can be attributed to the service they provide to the network as a whole: some of them produce general norms (GRI, UNGC, CERES), others produce norms in a certain field (gender equality, labor rights, carbon accounting) albeit with a cross-sectorial influence (WEP, SA8000, CDP), or provide umbrella institutional services (ISEAL, ISO, and UNEP). These findings suggest that the criticism leveled against some CSR organizations, such as the Global Compact and WEP (Berliner & Prakash, 2015; Bexell, 2012), may have missed their synergistic contribution to the network dynamics.

We argued that firms use *multiple certifications* to signal their commitment to CSR values. Multiple certifications function as handicaps with differential cost structure (Zahavi & Zahavi, 1999). Our findings provide support for the existence of a separating equilibrium by showing that firms with multiple certifications display a stronger CSR performance (as reflected in DJSI and FTSE4GOOD rankings) than do their peers with fewer certifications. This finding fills a significant lacuna in the literature on signaling and CSR (Zerbini, 2015: 11). The idea that firms may use certification as a credible signaling device has been noted before (Connelly et al., 2011: 45; Kayser et al., 2014; Zerbini, 2015: 6), but these studies focused on single certifications and ignored the network aspect (which allows firms to produce enhanced signal by combining certifications). We have also shown that stronger CSR performance correlates positively with higher eigencentrality values, even when the degree of the firms is kept fixed. This suggests that the position of a firm within the network may play a role, in addition to its number of certifications, in predicting CSR performance. More work is needed in order to fully corroborate our thesis, both by drawing on other, more refined sustainability measures[56] and by considering longer time horizons.

The present article weighs in on the ongoing debate between those who claim that CSR instruments constitute greenwash with no behavioral effects (Berliner & Prakash, 2015: 116; Zerbini, 2015: 14-15) and those who see them as a new form of global regulatory authority (Heilmayr & Lambin, 2016; Pattberg & Widerberg, 2015: 689). By demonstrating a positive correlation between certification by multiple CSR schemes and sustainability performance, our analysis shows that certification or membership in CSR schemes is not just cheap talk. The finding that multiple certifications constitute a robust proxy for strong sustainability performance suggests that regulators should integrate CSR schemes in their regulatory strategy, for example, by encouraging firms to seek certification by several CSR schemes. Our study has not considered, however, the overall effect of the CSR network as a whole on sustainability. More research needs to be conducted to clarify what is the optimal mixture of public and private instruments and to what extent public bodies should seek to intervene in the design and implementation of CSR norms.

[56] E.g., Vigeo/Eiris rankings (http://www.vigeo-eiris.com/solutions-for-investors/sustainability-ratings/) or MSCI rankings (https://www.msci.com/msci-acwi-sustainable-impact-index).

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Supplementary Materials

Governance through Global Networks and Corporate Signaling

3 October 2018

Appendix A – The List of Schemes in our Database

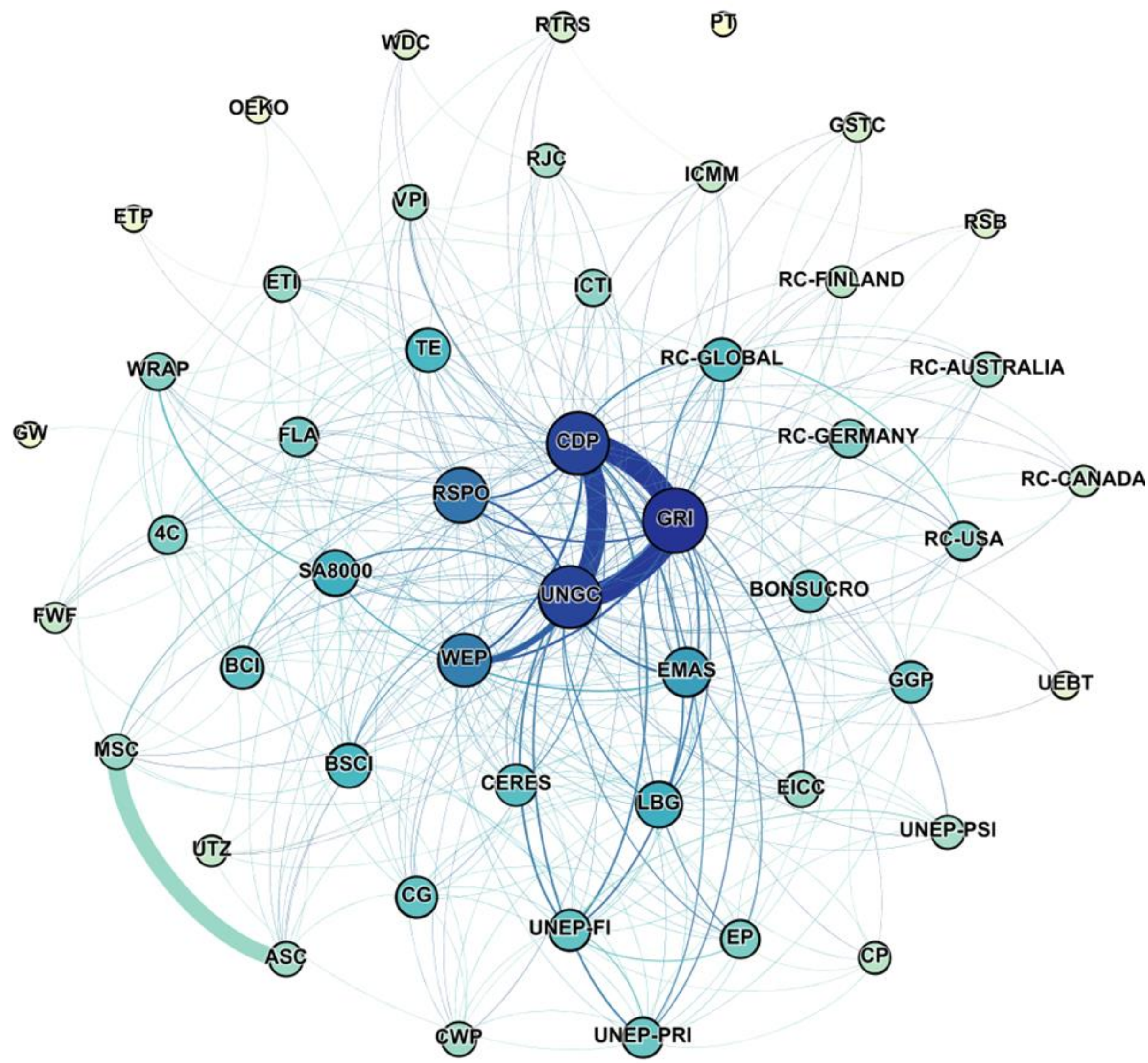
Code/Institution	Initials	Distribution of Degrees in the Affiliation Mapping (IACN)	Distribution of Degrees in the Institutional Connections Mapping - Undirected (IDCN)
1. Aquaculture Stewardship Council	ASC	11	1
2. Better Cotton Initiative	BCI	19	2
3. Better Sugar Cane Initiative	BONSUCRO	18	2
4. Business Social Compliance Initiative	BSCI	21	2
5. Carbon Disclosure Project	CDP	41	7
6. Carbon Principles	CP (carbon)	8	
7. Climate Wise Principles	CWP	11	
8. Code of Conduct for the Tea, Coffee and Cocoa Sectors	UTZ	7	5
9. Common Code for the Coffee Community	4C	15	3
10. Council for Responsible Jewelry Practices Code of Conduct	RJC	10	2
11. Eco-Management and Audit Scheme	EMAS	26	
12. Electronic Industry Code of Conduct	EICC	12	
13. Equator Principles	EP	15	
14. Ethical Tea Partnership	ETP	2	3
15. Ethical Trading Initiative Base Code	ETI	12	4
16. Fair Labor association workplace code of conduct	FLA	16	2
17. Fair Wear Foundation	FWF	7	
18. Fairtrade International	FI*		5
19. Forest Stewardship Council Principles and Criteria	FSC*		4
20. Global Gap	GAP*		2
21. Global Reporting Initiative	GRI	44	11
22. GoodCorporation standard - with the Institute of Business Ethics	GCS*		
23. GoodWeave	GW	1	3
24. Greenhouse Gas Product Certification Standard	GGP	18	2
25. International Council of Chemical Associations - Responsible Care	RC-GLOBAL	20	7
26. International Council of Toy Industries - ICTI CARE (Caring, Awareness, Responsible, Ethical) Process	ICTI	13	
27. International Council on Mining and Metals (ICMM) Sustainable Development Principles	ICMM	7	1
28. International Organization for Standardization (ISO 14001)	ISO*		9

29. Investing in Integrity	IiI*		
30. Investors in People Standard	IIP*		
31. London Benchmarking Group	LBG	23	1
32. OEKO-TEX® Standard 100	OEKO	2	
33. ProTerra	PT	0	
34. Responsible Care Australia	RC-AUSTRALIA	11	1
35. Responsible Care Canada	RC-CANADA	7	1
36. Responsible Care Finland	RC-FINLAND	8	1
37. Responsible Care Germany	RC-GERMANY	15	1
38. Responsible Care USA	RC-USA	15	1
39. Round Table Responsible Soy	RTRS	5	1
40. Roundtable on Sustainable Palm Oil	RSPO	33	4
41. Social Accountability 8000	SA8000	23	8
42. Textile Exchange	TE	21	1
43. The Alliance for Water Stewardship	AWS*		5
44. The Climate Group Principles https://www.theclimategroup.org/sites/default/files/archive/files/The-Climate-Principles-English.pdf)	CG	18	2
45. The Coalition for Environmentally Responsible Economies - CERES Principles - Ceres Company Network	CERES	19	7
46. The Global Sustainable Tourism Council	GSTC	5	1
47. The Golf Environment	GEO*		2
48. The international Social and Environmental Accreditation and Labelling Alliance	ISEAL*		17
49. The Marine Stewardship Council Principles and Criteria	MSC	12	2
50. The Mission of the Roundtable on Sustainable Biomaterials	RSB	4	3
51. The Program for the Endorsement of Forest Certification	PEFC*		1
52. The Union for Ethical BioTrade	UEBT	3	1
53. The Women's Empowerment Principles	WEP	31	1
54. UN Global Compact	UNGC	41	15
55. United Nations Environment Programme	UNEP*		5
56. UN Principles for Responsible Investment	UNEP PRI	17	4
57. UNEP FI Principles for Sustainable Insurance Initiative	UNEP PSI	10	2
58. UNEP Statement by Financial Institutions on the Environment & Sustainable Development + Statement of Environmental Commitment by the Insurance Industry	UNEP FI	18	3
59. Voluntary Principles on Security and Human Rights	VPI	11	
60. World Diamond Council Resolution on Conflict Diamonds	WDC	4	
61. Worldwide Responsible Apparel Production Principles	WRAP	14	

Appendix B1:

The Affiliation Network of CSR-Schemes and Firms: The Induced CSR-Schemes Network with Nominal Weights[57]

The following graph was constructed using the *adjacency matrix* A_W, which was assigned with nonnegative numbers (weights) s.t $w_{ij} > 0$ if schemes i, j have mutual firms, and $w_{ij} = 0$ otherwise. In the following figure the edges are colored according to the strength of their nominal weights.



[57] Edges corresponding to weights in the intervals [1,9], [10,99] were colored blue and light green, respectively. Weighs greater or equal to 100 were black colored (thick line).

Appendix B2

Largest normalized weights

The following table show the schemes corresponding to the endpoints nodes of the 16 largest normalized weighted edges, together with the code's lengths. The nominal (number of connecting firms) and normalized weights are given in the next two columns, respectively. Joint firms (if exist) are listed in the rightmost column.

Code	Length	Code	Length	Nominal weight	Normalized weight	Socio-legal common denominator
UNEP-FI	209	UNEP-PSI	43	30	0.316456	Financial Services
ASC	955	MSC	2858	505	0.305674	Fishery
EP	79	UNEP-FI	209	36	0.280166	Financial Services
CDP	2231	GRI	2816	682	0.272094	General Schemes, disclosure standards
CWP	30	UNEP-PSI	43	7	0.194896	Financial Services
CERES	63	CP	4	3	0.188982	-
ICMM	20	VPI	28	4	0.169031	Extractive and Mining
CP	4	EP	79	3	0.168763	Financial Services
RC-GLOBAL	521	RC-USA	156	45	0.157845	Responsible Care (branches)
GRI	2816	UNGC	8384	676	0.139125	General Schemes
CDP	2231	UNGC	8384	593	0.137113	General Schemes
CDP	2231	EICC	108	58	0.118159	-
RJC	374	WDC	38	13	0.109048	Diamond and Jewelry
CDP	2231	LBG	117	55	0.107652	General Schemes
CP	4	UNEP-FI	209	3	0.103757	Financial Services
CWP	30	UNEP-FI	209	8	0.101031	Financial Services

Appendix C:

Centrality measures in the IACN network

The distance between nodes i and j, $d(i,j)$, is defined as the minimum number of edges that need to be traversed in order to reach from one node to the other. The diameter (the distance between the two furthest nodes) is $D_{ACN} = 3$. The average distance, which is the average of all shortest paths between the network's nodes, is $\langle d_{ACN} \rangle = 1.723$.[58] The *density* of the graph, defined as the ratio between the number of edges, to the number of possible edges (number of pairs of nodes) (Prell, 2012: 166); is $\rho = \frac{2|E|}{|V|(|V|-1)}$ $\rho_{ACN} = 0.308$.

The degree of a node is the number of connection it has, or the number of edges emanating from it. We find that the average degree of the IAC is $\langle C_D \rangle = 14.776$.[59] The highest degree, $C_D^{\max} = 44$ was associated with the GRI Code. Other highly connected schemes were UNGC and CDP (41), RSPO (33), and WEP (31). The complete distribution is provided in **Appendix A**. The analysis also exposed schemes that are only loosely connected to the network; prominent among these were GW, OEKO, and ETP, with only one or two edges. The node degrees provide a good measure of the local connectdeness of a node, but do not take into account the position of the node within the network as a whole. The closeness centrality, providing a more holistic assessment of the ease of reaching other nodes in the network from any given node is defined as the (normalized) reciprocal of farness (Prell, 2012: 108). The more *central* a node is, the *lower* its total distance is from all other nodes and the larger the measure of its closeness centrality is. We used a variant of closeness centrality, introduced by Dangalchev (Dangalchev, 2006): $C_{Da}(i) = \sum_{j \neq i} 2^{-d(i,j)}$. The largest Dangalchev closeness centrality measures for ACN were associated with GRI (22.75), CDP, UNGC (22), and RSPO (20). The average Dangalchev centrality for the ACN was $\langle C_{Da} \rangle = 14.949$

A third measure of centrality we considered is betweenness centrality, which looks at how often an actor lies in the shortest paths *between* two other actors, and reflects the capacity of a certain actor to broker (bridge) between groups, and the likelihood that information originating anywhere in the network will pass through that node (Long, Cunningham, & Braithwaite, 2013). Specifically, the betweenness centrality calculates how many times an actor (e.g., CSR code or firm) is located along the shortest paths (*geodesics*)[60] linking all pairs of other nodes in the network (Prell, 2012: 104). The betweenness centrality of a node v is defined by $C_B(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$ where σ_{st} is the number of shortest paths linking nodes *s* and *t*, of which $\sigma_{st}(v)$ paths pass through node *v*[61]. The betweenness centrality quantifies the influence of node *v* on the flow of information between nodes *s* and *t*. The largest betweenness centrality values, corresponding to the unweighted adjacency matrix, was associated with GRI: $\max_v C_B(v) = 0.149$, followed by CDP (0.127), UNGC (0.104), SA8000 (0.079) and RSPO (0.053).[62] The average was $\langle C_B \rangle = 0.015$.

The local clustering coefficient of a node v, C_v, is defined as the probability that two randomly selected neighbors of v are connected to each other (Easley & Kleinberg, 2010: 44). I.e., if a node v has k_v neighbors, and every neighbor of v was connected to every other neighbor then, $\frac{k_v(k_v-1)}{2}$ edges would

[58] The averages were taken over finite nonzero distances only (finite length links connecting different nodes).
[59] Average weighted degree $\langle C_D^W \rangle = 31.197$. Here each edge connecting a node (code) is equally weighted with the number of firms multiply subscribed to that code, normalized by the appropriate summation over all nodes. $\langle D_G^W \rangle = \sum_v k_v w_v / \sum_v w_v$ where k_v is the degree of node v and w_v is its weight.
[60] In a graph, there can be more than one shortest path between two nodes. For instance, there can be two paths of three hops between the nodes.
[61] The unconnected nodes are not part of the shortest paths and thus, in effect, are not included in this calculation.
[62] These values are normalized by the number of pairs of nodes excluding v, ($\frac{(n-1)(n-2)}{2}$).

exist between them, and C_v denotes the fraction of existing edges out of this maximum. The average clustering coefficient $\langle C \rangle$ is the average of C_v over all v. For the ACN, $\langle C \rangle = 0.715$.

The centralization of a network measures how centralized a network is in comparison to a perfectly centralized network: a star graph in which one central node has ties to every other node (Kali & Reyes, 2007: 600). Centralization is given by $C_G = \frac{\sum_i [C_D^* - C_D(i)]}{(n-1)(n-2)}$, where C_D^* is the maximum value of degree centrality in the network (measured by the number of edges, both in an out) and $(n - 1)(n - 2)$ in the denominator is the sum of the value in the numerator computed for a star graph with *n* nodes. Centralization ranges from 0 (perfectly decentralized) to 1 (perfectly centralized, a star graph). The ACN graph centralization was found to be $C_G = 0.635$, which is quite high.

Appendix D: Schemes' classification						
Code	**General/ Specific**	**Stringency of the Compliance Regime** strict/soft	**Governance**			**Sector**
			civil society	industry	states	
4C	Specific	strict	V	V		agriculture
ASC	Specific	strict	V	V		marine
AWS	Specific	intermediate	V	V	V	utilities
BCI	Specific	strict	V	V		agriculture
BONSUCRO	Specific	strict	V	V		agriculture
BSCI	General	strict	V	V	V	
CDP	general	soft	V			
CERES	general	strict	V	V	V	
CG - ClimateGroupPrinciples	general	soft	V			
CP (carbon)	specific	soft		V		financial services
CWP	specific	strict	V	V		financial services
EICC	specific	soft	V	V		electronics
EMAS	general	strict			V	
EP	specific	soft		V		financial services
ETI	general	strict	V	V		
ETP	specific	strict	V			agriculture
FI	general	strict	V	V		
FLA	general	strict	V	V		
FSC	specific	strict	V	V		forestry
FWF	specific	strict	V	V		textile
GAP	specific	strict		V		agriculture
GCS	general	strict	V			
GEO	specific	strict	V			tourism & leisure
GGP	general	intermediate	V	V		
GRI	general	intermediate	V	V		
GSTC	specific	soft	V	V		tourism & leisure
GW	specific	strict	V	V	V	textile
ICMM	specific	strict		V		mining & metals
ICTI	specific	strict	V	V		toys
IiI	general	strict	V			
IIP	general	strict		V	V	
ISEAL	general	strict	V			
ISO[63]	general	strict		V	V	

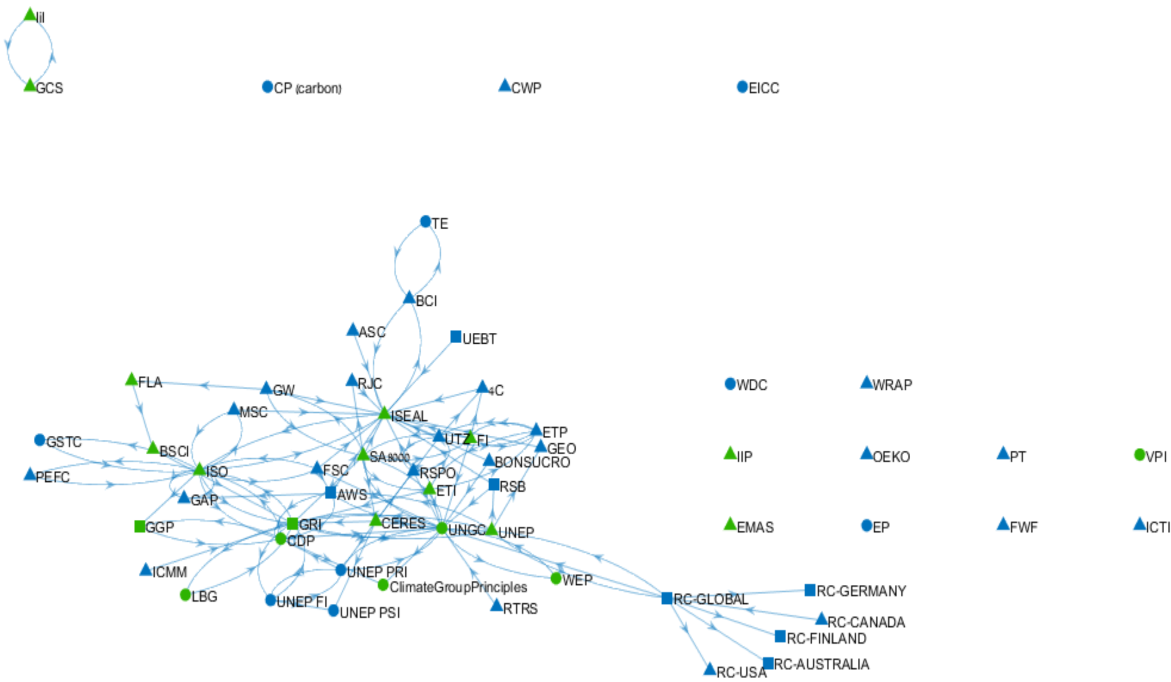
[63] The classification refers to ISO 14001.

LBG	general	soft		V		
MSC	specific	strict	V	V		marine
OEKO	specific	strict		V		textile
PEFC	specific	strict	V	V		forestry
PT	specific	strict	V			agriculture
RC-AUSTRALIA	specific	intermediate		V		chemicals
RC-CANADA	specific	strict		V		chemicals
RC-FINLAND	specific	intermediate		V		chemicals
RC-GERMANY	specific	intermediate		V		chemicals
RC-GLOBAL	specific	intermediate		V		chemicals
RC-USA	specific	strict		V		chemicals
RJC	specific	strict		V		mining & metals
RSB	specific	intermediate	V	V	V	agriculture
RSPO	specific	strict	V	V		agriculture
RTRS	specific	strict	V	V		agriculture
SA8000	general	strict	V	V		
TE	specific	soft	V	V		textile
UEBT	specific	intermediate	V	V		
UNEP	general	not applicable			V	
UNEP FI	specific	soft		V	V	financial services
UNEP PRI	specific	soft	V	V	V	financial services
UNEP PSI	specific	soft		V	V	financial services
UNGC	general	soft	V	V	V	
UTZ	specific	Strict	V	V		agriculture
VPI	general	soft	V	V	V	
WDC	specific	soft		V		mining & metals
WEP	general	soft	V	V	V	
WRAP	specific	Strict	V	V	V	textile

The network's heterogeneous structure had several manifestations. We found that there were more specific schemes (40) than general ones (21) and that there were more strict-compliance schemes (36) than soft (15) or intermediate (9) ones. Strict compliance designates schemes with third party assurance; soft schemes are those that rely solely on corporate self-assessment, while intermediate compliances leaves the firm the option to choose between the latter two tracks. We also found that private schemes were slightly more likely to have a strict compliance framework than the general ones were. The probability of a specific code having a non-soft compliance framework (0.775) was 10% larger than the probability of a general code having a non-soft compliance framework (0.7). Analysis of the governance structures of the schemes attested to the dominance of civil society and industry in leading the CSR network: these two sectors were represented in the governance of 41 and 51 schemes, respectively, the state assuming a secondary role (participating in the governance of 16 schemes).

Appendix E: the Institutionally Derived Schemes Network with Functional Attributes

The heterogeneous structure of the CSR schemes network reflects an emergent division of labor between the different schemes. To measure this attribute of the network, we analyzed the schemes according to a taxonomy that distinguishes between them based on four criteria: generality (distinguishing schemes with broad applicability from specific ones), stringency of the compliance regime (distinguishing between soft, intermediate, and strict compliance frameworks), governance structure (role played by civic society, industry, and states in the governance of the code), and industrial sector (see methodological appendix for complete description). The following figure provides a visual representation of the IDCN, highlighting some of the functional differences between the schemes.



The Institutionally Derived Schemes Network with Functional Attributes

General nodes are light green colored; specific nodes are blue colored. Soft nodes are round shaped; intermediate nodes are square shaped; strict nodes are triangle shaped.[64]

[64] Because UNEP is an umbrella organization the stringency property was not applicable to it.

Appendix F1: Analysis of the Industry Sub-Category

The two indices use the Industry Classification Benchmark (ICB),[65] but while in FTSE, firms are classified by their *industry code*, in DJSI they are classified by their *sector*, which is a subcategory of an Industry. In order to find the DJSI ancestors industries, we accumulated firms that reside both in DJSI and FTSE. These firms were then equipped with a *sector* and an *industry*. We first assigned a FTSE industry code to every DJSI sector and then used this correspondence mechanism to find the industry membership of almost all the other firms in DJSI. The results for the Industry category are summarized below:

DJSI	$\lvert NW \cap s \cap I \rvert$	$\lvert s \cap I \rvert$	$\lvert NW \cap \sim s \cap I \rvert$	$\lvert \sim s \cap I \rvert$	$\frac{Pr(NW \mid s \cap I)}{Pr(NW \mid \sim s \cap I)}$
Basic Materials	39	52	108	191	1.33
Consumer Goods	50	62	116	258	1.79
Consumer Services	39	53	119	339	2.1
Financials	96	113	166	521	2.67
Health Care	26	32	46	171	3.02
Industrials	92	119	145	363	1.94
Oil & Gas	31	38	52	134	2.1
Technology	25	30	78	184	1.97
Telecommunications	11	14	34	72	1.66
Utilities	18	28	37	96	1.67
FTSE					
Basic Materials	44	56	72	104	1.13
Consumer Goods	73	101	97	190	1.42
Consumer Services	71	104	71	196	1.88
Financials	147	205	77	238	2.22
Health Care	39	60	27	71	1.71
Industrials	82	102	169	287	1.37
Oil & Gas	16	18	48	108	2
Technology	54	72	31	63	1.52
Telecommunications	25	35	8	17	1.52
Utilities	23	29	35	60	1.36

As the table demonstrates (3) indeed holds for all industries, in both indices. Moreover, the deviations from $\Pr(NW|s)\,/\Pr(NW|\sim s)$ are in general smaller than the deviations from 1.

[65] See, http://www.icbenchmark.com/.

Appendix F2: Analysis of the Country Sub-Category

In the country category, we focused on several countries that represent both big economies and different geographical regions. These consist of: Australia (AU), Canada (CAN), Germany (GER), Japan (JA), United Kingdom (UK) and United States (USA). The results are given in the following table.

DJSI	$\lvert \boldsymbol{NW} \cap \boldsymbol{s} \cap \boldsymbol{C}\rvert$	$\lvert \boldsymbol{s} \cap \boldsymbol{C}\rvert$	$\lvert \boldsymbol{NW} \cap \sim\boldsymbol{s} \cap \boldsymbol{C}\rvert$	$\lvert \sim\boldsymbol{s} \cap \boldsymbol{C}\rvert$	$\frac{\boldsymbol{Pr}(\boldsymbol{NW}\mid\boldsymbol{s}\cap\boldsymbol{C})}{\boldsymbol{Pr}(\boldsymbol{NW}\mid\sim\boldsymbol{s}\cap\boldsymbol{C})}$
AU	37	45	38	138	2.99
CAN	23	25	44	82	1.71
GER	16	22	25	40	1.16
JA	51	63	130	276	1.72
UK	36	45	98	138	1.13
USA	97	120	269	871	2.62
FTSE					
AU	29	46	31	53	1.08
CAN	21	23	32	52	1.48
GER	22	31	22	33	1.06
JA	112	174	117	301	1.66
UK	85	97	27	34	1.10
USA	131	175	225	481	1.60

The results are also in agreement with equation (3).

Appendix F3: Analysis of the Market Capitalization Sub-Category

The last category we examined was companies' market capitalization (Ca) in FTSE (the relevant data for DJSI was missing). We divided the companies into four groups according to their market capitalization, divided into four intervals in million USA dollars (left most column in Table F3-1 below). Consistent with our hypothesis (H1) Eq. (3) also holds for the *market capitalization* category.

Table F3-1

FTSE - Mkt Cap, USDm (Ca)	$\|NW \cap s \cap Ca\|$	$\|s \cap Ca\|$	$\|NW \cap \sim s \cap Ca\|$	$\|\sim s \cap Ca\|$	$\frac{Pr(NW\|s \cap Ca)}{Pr(NW\|\sim s \cap Ca)}$
1E2-1E3	3	11	5	25	1.36
1E3-1E4	241	361	341	818	1.60
1E4-1E5	301	378	269	475	1.41
1E5-1E6	28	32	21	26	1.08

To be complete, we also tested the hypothesis that firms with a larger market capitalization would be more likely to be included in the indices than firms with lower market capitalization. The logic for this hypothesis is that larger firms will be better able to cope with the costs of CSR certification. As shown in Table F3-2 the probability to be included, increases with capital interval. When confined to the network (right column), the corresponding probabilities are larger.

Table F3-2

FTSE - Mkt Cap, USDm (Ca)	$\mathrm{Pr}(s\|Ca)$	$\mathrm{Pr}(s\|Ca \cap NW)$
1E2-1E3	0.31	0.38
1E3-1E4	0.31	0.41
1E4-1E5	0.44	0.53
1E5-1E6	0.55	0.57

Appendix F4: Likelihood of being included to the indices as a function of the number of certifications

We calculated the probability that a firm in the bipartite network is included in the indices, when the number of subscriptions n_s (ranging from one to nine) is varied. We expected to find a *monotonically increasing* behavior of the probabilities with n_s.

Table F4-1

	DJSI			**FTSE**		
$\boldsymbol{n_s}$	$\|\boldsymbol{s \cap n_s}\|$	$\|\boldsymbol{\sim s \cap n_s}\|$	$\boldsymbol{Pr(s\|n_s)}$	$\|\boldsymbol{s \cap n_s}\|$	$\|\boldsymbol{\sim s \cap n_s}\|$	$\boldsymbol{Pr(s\|n_s)}$
1	112	563	0.17	199	334	0.37
2	153	266	0.37	152	184	0.45
3	121	122	0.50	125	97	0.56
4	41	34	0.55	47	22	0.68
5	32	11	0.74	32	8	0.8
6	15	3	0.83	16	4	0.8
7	8	4	0.67	9	3	0.75
8	2	1	0.67	3	0	1
9	2	0	1	2	0	1

Consistent with hypothesis H2, we found a *monotonically increasing* behavior for $n_s \leq 6$. This pattern was violated for $n_s = 7$, but this violation was expected because the number of firms with more than 6 links is relatively small. Despite this violation, the support for our hypothesis is quite strong. Note also that the two firms with a maximum number of links (Bank of America and Swiss Re) are included both in DJSI and FTSE4.

Appendix F5

We argue in hypothesis (H2) that the probability of a firm to be included in the sustainability indices increases with the number of certifications (Table 4 in the paper). To further support this claim, we performed a logistic regression where the predictors were the number of certifications, and the response was a binary vector of the included (1) and not included (0) firms. The results are presented in part A of table F4-1 below.[66]

It can be seen from the table that the coefficients of the logit model monotonically increase with the number of certifications, n_s. In part B, we also included the industry sectors in the predictors matrix, to verify that the coefficients were not significantly perturbed by these variables. A similar analysis was carried out in part C, for FTSE4good firm's (**log**) Market Capitalization (**MC**) in million USD (We used the log market capitalization since the range spans several orders of magnitude, similar results are obtained for the market capitalization itself). This time the additional single dummy variable was continuous. In each case, the monotonicity of the coefficients and significance for the desired variables, were preserved. Our analysis of the influence of market capitalization was restricted to the FTSE4Good Global index because the data we received from DJSI did not include that information. In contrast to FTSE, DJSI has refused to share with their data on the free float market capitalization of their listed companies.

Table F5-1

	DJSI			**FTSE**		
A # certifications	**coefficient**	**SE**	**p value**	**coefficient**	**SE**	**p value**
$n_s = 2$	1.080766	0.154568	2.71E-12	0.34448	0.143117	0.016085
$n_s = 3$	1.577253	0.175841	2.97E-19	0.784122	0.163466	1.61E-06
$n_s = 4$	1.860401	0.270013	5.58E-12	1.282297	0.279545	4.49E-06
$5 \leq n_s \leq 9$	2.657486	0.290532	5.86E-20	1.922981	0.302265	1.99E-10
B # certifications and industry						
$n_s = 2$	1.100648	0.15718	2.51E-12	0.413587	0.150244	0.005909
$n_s = 3$	1.680881	0.180847	1.48E-20	0.843647	0.173042	1.09E-06
$n_s = 4$	2.030279	0.279234	3.57E-13	1.53826	0.297829	2.41E-07
$5 \leq n_s \leq 9$	2.862023	0.300576	1.7E-21	1.969065	0.319208	6.89E-10
Oil&Gas	0.738652	0.345572	0.032559	-1.74782	0.379122	4.02E-06
Basic Materials	-0.18234	0.319221	0.567872	-1.38165	0.312477	9.8E-06
Industrials	0.947539	0.285146	0.000891	-1.17007	0.269434	1.41E-05
Consumer Goods	0.18284	0.306114	0.550312	-0.92804	0.2831	0.001045
Health Care	0.723948	0.35958	0.044081	-0.09001	0.345754	0.794615
Consumer Service	0.221807	0.316117	0.48289	-0.42526	0.289956	0.142476
Telecommunications	0.09528	0.443937	0.83006	0.596916	0.474863	0.208744
Utilities	0.468601	0.390736	0.23042	-0.92871	0.359458	0.009776
Financials	0.495551	0.283808	0.080797	0.050973	0.273708	0.852265
C # certifications and market capitalization						

[66] To avoid numerical discrepancies caused using Matlab's *mnrfit* function, probably due to singularity of the predictors matrix, we have omitted the variables $n_s = 1$ and *Technology* from our computations.

$n_s = 2$		0.345747	0.143197	0.015758
$n_s = 3$		0.780431	0.163571	1.83E-06
$n_s = 4$		1.295543	0.279967	3.7E-06
$5 \leq n_s \leq 9$		1.917245	0.302385	2.29E-10
Log (MC)	**Not available**	0.054164	0.049825	0.277005

Eigenvector centrality (EC)

In our third hypothesis (H3) we hypothesized that the probability to be included in the indices is positively correlated with eigenvector centrality. In Table 6 we show that it is more likely that a firm with large EC is included than excluded, and the likelihood increases as n_s increase (for $n_s \geq 2$). The effect is significant in both indices. To eliminate the event of a positive correlation with the (log) *market capitalization* variable, we performed another regression, where the market capitalization variable is an additional predictor (see part B of Table F4-2 below). The coefficients and p values in part B (market capitalization is added as an extra independent variable) are close to those in part A[67] (market capitalization is absent). Finally, we performed another regression in the presence of the two variables of market capitalization and industry sector as additional independent predictors. The results are given in part C (market capitalization and industries are added as extra independent variables).

The coefficients in part C slightly differ from those in parts A and B. Nevertheless, the monotonicity and significance is preserved. This analysis supports the claim that our main results are not an artifact of a correlation with the firm's market capitalization or industry sector.

Table F5-2

	FTSE		
A # certifications	**coefficient**	**SE**	**p value**
$n_S = 1$	-0.39832	0.450334	0.376428
$n_s = 2$	0.52961	0.248608	0.033146
$n_s = 3$	0.904824	0.199409	5.69E-06
$n_s = 4$	1.38595	0.340578	4.71E-05
$5 \leq n_s \leq 9$	2.146599	0.360008	2.48E-09
B # certifications and market capitalization			
$n_S = 1$	-0.39162	0.450737	0.384933
$n_s = 2$	0.525607	0.248753	0.034604
$n_s = 3$	0.905106	0.199497	5.71E-06
$n_s = 4$	1.400369	0.341	4.01E-05
$5 \leq n_s \leq 9$	2.142453	0.360028	2.67E-09
Log (MC)	0.056723	0.049918	0.255823
C # certifications and market capitalization and industry			

[67] Since market capitalization values where measured for a somewhat smaller population, the numbers in part A and Table 6 (FTSE) in the paper slightly differ.

$n_S = 1$	-0.19695	0.474538	0.678123
$n_s = 2$	0.760257	0.262734	0.003808
$n_s = 3$	1.039786	0.212329	9.73E-07
$n_s = 4$	1.739183	0.360964	1.45E-06
$5 \leq n_s \leq 9$	2.226635	0.37648	3.33E-09
Log (MC)	0.033014	0.05183	0.524147
Oil&Gas	-1.7967	0.384667	3E-06
Basic Materials	-1.37105	0.31518	1.36E-05
Industrials	-1.23989	0.271743	5.05E-06
Consumer Goods	-0.91575	0.284374	0.001281
Health Care	-0.1629	0.348126	0.639835
Consumer Service	-0.4277	0.290828	0.141391
Telecommunications	0.505635	0.477978	0.290118
Utilities	-0.94419	0.362133	0.009126
Financials	0.095356	0.274472	0.728278

Appendix G

Since the eigencentralities of different nodes are strongly correlated values, applying the logit model with the eigencentralities as independent variables may induce a bias. To rule out this possibility when using a logistic regression to test the correlation between these variables and inclusion in the sustainability indices, we performed the following procedures. First, we constructed a new shuffled network in which firms at each code were redistributed at random such that the number of code members was kept fixed. This resulted in new populations of 1018 (856) firms that were also residing in DJSI (FTSE). Next, we performed a logistic regression as described in the main text, where the variables describe the new populations.

The table presents the results of this regression. For the original network (top), a positive significant correlation is evident in both indices for $n_s \leq 3$. Since the number of firms with a large degree is, as expected, small, the results are not significant then. However, no significant positive correlation is observed in the shuffled network (bottom) in both indices, even for low degrees. Therefore, we can rule out the possibility that the bias caused by the dependence between the explaining variables is the source of the observed correlation with between the eigencentrality and inclusion in the indices.

Table G-1: Eigenvector centrality and signaling

		DJSI		**FTSE**	
	n_s	**Coefficient**	**p value**	**Coefficient**	**p value**
original	1	1.344813	2.09E-10	0.793006	0.000244
	2	1.475091	4.51E-10	1.209206	1.63E-06
	3	1.861352	6.19E-07	1.06617	0.004625
	4	0.729006	0.446867	0.593858	0.509811
	≥ 5	0.40121	0.754554	1.669886	0.191633
shuffled	1	-0.03966	0.893438	-0.1908	0.52813
	2	0.238719	0.400318	0.266842	0.350663
	3	-0.10564	0.744555	-0.09408	0.775847
	4	-0.53877	0.555231	0.154613	0.855232
	≥ 5	-0.69462	0.526961	0.022294	0.98194