Climate Finance Regime Complex: A Network Approach

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Abstract. Climate adaptation and mitigation require enormous investments in clean technologies and infrastructure. To meet this need, a regime complex of intergovernmental organizations (IGOs), financial regulators, associations of investors and financial institutions, and civil society organizations has emerged to mobilize finance. The literature on the global climate finance regime has so far narrowly focused on the international transfers of financial resources from developed to developing countries, and too often restricted the analysis to multilateral institutions that facilitate these transfers. Utilizing network data, we demonstrate the extent and structure of the "climate finance regime complex" (CFRC), showing that it consists of a much broader range of actors and functions than is often acknowledged. Evaluating its institutional structure through the theoretical lens of regime complexity, we highlight several findings. First, the CRFC is highly dense but fragmented, with heavy overlaps in international institutions' goals. Several IGOs, particularly those belonging to the UN system, act as focal institutions, while multilateral development banks play important bridging roles between clusters of otherwise sparsely connected institutions.

1. Introduction

Transforming the economy to respond to the threat of climate change requires a fundamental shift in the flow of money. To meet this challenge, the provision of climate finance is becoming a critical issue area. Beginning with the creation of the Global Environment Facility (GEF) in 1992, a dizzying array of international institutions related to climate finance have emerged. With 197 countries signing the 2016 Paris Agreement, which set out as one of its missions to "[m]aking finance flows consistent with pathways towards low greenhouse gas emissions and climate-resilient development" (UNFCCC 2015, Article 2), the number of regional and international bodies with a mission to finance climate change mitigation or adaptation has continued to climb. Governments have revamped their commitments to contribute to the Green Climate Fund (GCF); the Group of Twenty (G20) and the Financial Stability Board (FSB) sponsored the creation of the Task Force on Climate-related Financial Disclosures (TCFD) in 2015; two years later, central bankers and financial regulators around the world formed the new Network for Greening the Financial System (NGFS). Indeed, a report by the United Nations Environment Programme (UNEP) finds a near-exponential increase in the number of initiatives related to sustainable finance since the 1990s, both at the national and international levels, involving government and private-sector actors (UNEP Inquiry 2020, 14–15).

Yet a less rosy picture also prevails with respect to the role of finance in addressing climate change. Some observers claim that the proliferation of climate finance institutions at the international level, such as multilateral climate funds, has led to inefficiency in the channeling and delivery of finance (Amerasinghe et al. 2017, 4). Current levels of funding fall far short of existing targets, and developing countries that need multilateral sources of mitigation and adaptation

finance nevertheless face numerous hurdles to accessing funding from a tangle of institutions (Pickering, Betzold, and Skovgaard 2017). Universal definitions and standards regarding climate finance have long been lacking, leaving states and intergovernmental organizations (IGOs) to diverge in their interpretation of key concepts like adaptation finance (Hall 2017; Pauw 2017). The TCFD developed guidelines for how publicly-traded companies can disclose climate-related activities, but these recommendations have not yet been adopted widely in the industrialized economies, and financial markets have not yet internalized climate externalities (GSIA 2019).

This apparent dilemma of climate finance -- between institutional proliferation and continued inefficiencies -- has been the focus of study by scholars of international organizations (IOs) for some time. But this scholarship has thus far been limited in two ways: 1) *functionally*: by conceiving of climate finance solely as the channeling of financial resources from developed to developing countries, it has limited its scope to a single dimension of a multi-dimensional issue area; and 2) *institutionally*: by focusing on the IGOs and multilateral development banks (MDBs) that provide mitigation and adaptation finance to developing countries, it has limited its analysis to a relatively small subset of institutions involved in climate finance.

The global governance of climate finance is paramount in weaning states and the private sector away from carbon-intensive energy sources and coordinating them to embrace a more sustainable economic development. While climate finance is often subsumed under the broader umbrella of climate change, we insist in studying climate finance "as a system or subsystem in its own right" (Pickering, Betzold, and Skovgaard 2017, 2) because of its outsized role in any policy response to mitigating or adapting to climate change. But our understanding of how the institutional arrangement of climate finance affects its effectiveness will be incomplete without first comprehending the full scope of its constituent actors and institutions. We thus aim to take

this first step of identifying what we believe is an exhaustive set of institutions involved in the global governance of climate finance and describing it through the framework of regime complexity. We analyze this "climate finance regime complex" (CFRC) with original data consisting of 56 international institutions and over 8,000 organizations affiliated with them. Utilizing network analysis of three networks generated from this data, we find that the CFRC is a large-scale, highly dense, diverse, but fragmented regime complex.

The next section takes stock of the literature on climate finance by scholars of global governance. While these scholars have offered important insights about this regime, the literature has so far been limited in two respects: functionally, scholars conceive of climate finance rather narrowly as the international transfer of financial resources from developed to developing countries; empirically, they have generally focused on multilateral institutions that are designed to fulfil this function, namely climate funds and multilateral development banks. This section also offers the definition and dimensions of climate finance that we believe are wide enough to accommodate the emerging regime complex in climate finance. It then highlights the dilemma between climate finance's necessary role in the international response to climate change on the one hand, and the challenges endemic to directing capital flows to mitigation and adaptation and turning the financial system toward sustainable assets and projects, on the other. Section 3 surveys the expanding literature on international regime complexity, paying particular attention to what we know about the structural dimensions of regime complex that are theoretically important. It also places special emphasis on the climate change regime complex. Section 4 explains network analysis, our data source and data collection process. Section 5 presents our findings, illustrated through three network visualizations that depict the CFRC from different levels of analysis. Section 6 concludes.

2. Global Governance of Climate Finance

As the awareness and international efforts to address climate change has intensified, so too has the realization that financial resources need to be mobilized to fund climate mitigation and adaptation projects. In accordance with this realization, IGOs and governments have established a myriad of multilateral institutions designed to allocate financial resources to help facilitate these goals. The international climate finance regime has thus become a relatively crowded system of norms, rules, institutions, and practices by which these actors collectively manage the policy domain of climate finance, all in the absence of an authoritative government at the international level. This landscape can therefore be considered a system of *global governance of climate finance* (Ruggie 2014, 5).

In the last decade, scholars of International Relations (IR) and International Organizations (IOs) have increasingly turned their attention to this phenomenon. Owing to this scholarship we have a good sense of some important features of the climate finance governance system: like the broader climate change global governance regime, the climate finance regime is fragmented, consisting of a wide range of actors; this fragmented regime is nevertheless "orchestrated" by a handful of focal institutions such as the GCF and the United Nations Framework Convention on Climate Change's (UNFCCC) Standing Committee on Finance; that MDBs and multilateral climate funds play an important (though not perfectly optimal) role in channeling financial resources from developed to developing countries; and that power dynamics, especially those between wealthy countries that contribute funds to developing country recipients that face particularly severe risks from climate change, often make the system less efficient that we might expect. Despite these valuable insights, this literature has remained limited in two respects.

First, it has conceived of climate finance solely as the transfer of financial resources from wealthy to developing countries. Explicitly or implicitly adopting the definition of climate finance by Stadelman et al (2013) as "financial flows mobilized by industrialized country governments and private entities that support climate change mitigation and adaptation in developing countries," this research program has investigated political and institutional issues that this definition naturally evokes. These issues include the faultlines between developed and developing countries (Betzold and Weiler 2017; Gomez-Echeverri 2013; Grasso 2011), the sometimes diverging interpretations of climate finance (especially adaptation finance) by finance ministries in contributor and recipient states in the context of international negotiations (Hall 2017; Skovgaard 2017), and the domestic politics in developed countries shaping their varying commitments to pledging climate finance to multilateral or bilateral climate finance transfers (Pickering et al. 2015; Pickering and Mitchell 2017).

The second limitation of the IR scholarship on climate finance is that it has restricted its scope of empirical analysis to the set of institutions designed to facilitate these international transfers, namely IGOs, MDBs and multilateral climate funds. As Watson and Schalatek (2020) observe, there is a myriad of bilateral, multilateral, regional and national institutions and implementing agencies dedicated to climate finance. A handful of these multilateral institutions are part of the UNFCCC Financial Mechanism. Several studies have investigated the institutional dynamics within and relationships between these multilateral climate funds. Kalinowski (2020), for example, offers a case study of the Green Climate Fund (GCF), finding that its inclusive stakeholder involvement makes it relatively unique among IOs but that its institutional culture of donor-recipient parity, consensus orientation, and the need to balance multiple priorities has led to gridlock. Expanding the scope of analysis, Graham and Thompson (2014) explore a broader

climate finance landscape in an important contribution. They argue that the Global Environment Facility (GEF) acts as an "orchestrator" in the climate adaptation finance regime, supporting and steering various implementing agencies to effect change in developing country recipients. Yet they suggest that the GEF has recently faced competition from other multilateral climate finance agencies including the Adaptation Fund (AF) and the Green Climate Fund (GCF), as well as other development IGOs. Focusing on power dynamics, Graham and Sedaru (2020) investigate the role of powerful states in exerting control over these multilateral climate finance institutions' resource allocation. Analyzing the funding rules of 18 such institutions, they find that wealthy states either pursued permissive funding rules or weighted voting rules when designing these institutions so as to maintain influence over the allocation of their financial contributions.

Another strand of research explores the role of MDBs in the climate finance regime and their efficacy in delivering funds to developing countries. Because developing countries often lack the public finances necessary to build sustainable energy systems, MDBs -- including the European Investment Bank (EIB), World Bank, European Bank for Reconstruction and Development (EBRD), Asian Development Bank (ADB), Inter-American Development Bank (IADB) and the African Development Bank (AfDB) -- have become a significant channel of financing (Reinsberg et al. 2020). Of these, Delina (2017) investigates the ADB's shifting priorities from supporting fossil fuel interventions to funding sustainable energy projects between 2000 and 2014, showing that it has become an increasingly active participant in the climate finance system. Yet when the efficacy of MDBs as a group are analyzed, their track record is more mixed. Michaelowa et al (2020), for example, find that MDB trust funds do not live up to strategic allocation of funds between mitigation, adaptation, and capacity building. While funds with a focus on mitigation generally allocate funds in line with their mission, those with an adaptation focus do not seem to

prioritize countries most strongly in need, and capacity building activities do not seem to focus on countries with weak institutions.

The scholarship on the global governance of climate finance from the IR and IO perspectives is rapidly expanding and offers valuable insights into the structure and functioning of this governance area, with clear policy implications for how states and IGOs can navigate this terrain and reform the existing institutional arrangements. But as highlighted above, this research has remained partial in its scope by focusing specifically on a single dimension of climate finance -- the reallocation of funds from developed to developing countries -- and empirically examining IGOs and multilateral institutions geared to achieve this goal. As we demonstrate below, climate finance is a far broader policy area, whose goals involve the pivoting of financial systems toward a more sustainable economy and whose landscape includes a host of non-state actors

While an universally-accepted definition of climate finance remains elusive, many credible organizations have coalesced around a high-level definition. Climate finance can be thought of as *capital flows directed toward low-carbon and climate-resilient development interventions with direct or indirect greenhouse gas mitigation or adaptation benefits* (Climate Policy Initiative 2015, 1; also see Falconer and Stadelmann 2014 and UNFCCC 2014). Climate finance is thus specifically concerned with addressing climate change, and this definition encompasses all sources of capital, private and public, as well as a wide array of destinations for this capital, including capacity building measures and implementation of policies. Further, climate finance can be directed at the *mitigation* of greenhouse gas emissions or the *adaptation* of human or natural systems to the impact of climate change.

Departing from the predominant tendency in the literature, we argue that climate finance is manifested in five dimensions: (1) the channeling of funds from developed to developing

countries which are more vulnerable to the risks of climate change; (2) an investment and lending approach by investors and financial institutions that considers climate impacts in portfolio selection, portfolio management, and securitization; (3) publicly-traded companies' disclosure of their climate-related investments and activities so as to inform investors; (4) financial institutions' risk management practices that factors in climate-related risks; and (5) efforts by central banks and other financial regulators (i) to account for climate-related risks when considering monetary policy and financial regulation, and (ii) to actively use tools at their disposal to promote green investment or discourage brown investment.

A distinction should be made between climate finance on the one hand and sustainable or green finance, on the other. Sustainable or green finance, often used interchangeably, refers more broadly to an investment approach that considers environmental, social and governance (ESG) factors,which can include climate change mitigation and adaptation, but can also encompass the preservation of biodiversity and air quality, pollution prevention, more equitable corporate governance, and so on (European Commission n.d.; UNEP Inquiry 2020). In this article we are primarily interested in the supply and global governance of finance specifically directed at addressing climate change, and so we do not consider broader sustainable or green finance.

Directing financing to mitigation and adaptation projects and transforming the financial sector to take account of climate risks is fundamental for addressing climate change for several reasons. To achieve the goal of keeping global average warming below 2°C by 2030, the amount of global investments in energy-efficient infrastructure and low-carbon technologies could total US$13.5 trillion (The New Climate Economy 2014). Private-sector capital, simply by virtue of its size, must play a dominant role in providing this investment, while public funds must help in catalyzing private investments (Gomez-Echeverri 2013). This is particularly true for developing

countries whose public-sector funds are often scarce. Financing is needed for large developing countries to continue industrializing without becoming major carbon emitters by investing in clean technologies. For the most vulnerable developing countries already susceptible to damages from climate change, adaptation finance is paramount for survival (UNFCCC 1992, Article 4(3)).

In addition to channeling funds to climate-related projects and enterprises, the financial sector must itself adapt to climate change. This is because of three types of major risks that climate change poses to financial institutions: 1) physical risks -- the damage from climate and weather-related events on property and commerce; 2) liability risks -- the impacts that could arise if parties who have suffered loss and damage from the effects of climate change seek compensation from those they hold responsible; and 3) transition risks -- the financial risks from the structural economic adjustment to a low-carbon economy that could result in the re-pricing of a range of assets and commodities (Carney 2015).

But pivoting the financial system to serve climate needs and shielding itself from climate risks encounter a number of institutional and microeconomic challenges. First and most fundamentally, the financial and corporate sectors have traditionally not internalized environmental externalities. By failing to put a price on the environmental impacts of their investments, they under-invest in “green” activities and over-invest in “brown” activities.

Second, a maturity mismatch exists between the supply of long-term funding relative to the demand for funding by long-term projects, including sustainable infrastructure projects. This problem arises because the financing of long-term green infrastructure projects relies heavily on bank lending, while banks are constrained in providing sufficient long-term loans due to relatively short tenor of liabilities.

Third, a lack of clarity regarding what constitutes climate finance, and in turn the absence of standards for accounting and performance assessment for financial institutions, disincentivizes them from allocating resources for green projects and assets. With unclear definitions of climate or green finance, there is a danger of "green washing," in which, for example, issuers or "green assets" make misleading claims about the environmentally friendly nature of their assets (Berensmann and Lindenberg 2016).

Fourth, information asymmetries and ubiquitous, making climate investments uncertain and costly. This is particularly the case, for example, when companies do not disclose the environmental information of their assets and projects, making these projects unattractive for investors. Even when companies disclose such information, the lack of consistent and reliable labeling of green assets can deter investors. Investors often rely on ratings agencies as a heuristic for assessing assets, but green investments are generally not included in the relevant benchmarks of rating agencies because they do not have a sufficient track record to be given a rating (Berensmann and Lindenberg 2016). Information asymmetries also exist when financiers lack information on the commercial viability of green technologies as well as policy uncertainties on green investments.

Fifth, many financial institutions have yet to develop the capacity to identify and quantify the credit and market risks that may arise from their environmental exposure, and thus often underestimate the risks of brown investments and overestimate the risks of green ones (G20 Green Finance Study Group 2016).

Lastly, fossil-fuel companies make up a large share of pensions portfolios and benchmark stock market indices. For instance, 19% of FTSE 100 companies are in natural resource and extraction sectors, and a further 11% by value are in power utilities, chemicals, construction and

industrial goods sectors. Ironically, however, these sectors account for less than 5% of the UK's GDP, thereby being grossly overrepresented in the stock market index (Stern 2016, 12).

Despite these disincentives, the amount of funds flowing toward mitigation and adaptation projects has recently been on the rise. In terms of actual dollar amounts, the Climate Policy Initiative found that total global climate finance flows increased from US$342 billion in 2013 to US$546 billion in 2018 (Buchner et al. 2019). This rise in climate finance is due in part because of the increasing number of public policy changes around the world, as governments and the private sector profess their commitments to reduce greenhouse gas (GHG) emissions and limit the average temperature rise in line with international agreements. A 2015 report by the UN Environment Programme (UNEP) notes that there is a "quiet revolution" underway, marked by a rise in the number of policy measures in many countries, targeting main asset pools and actors as well as the underlying governance of the financial system to align finance toward a more sustainable economy (UNEP 2015).

At the global level, too, there is now a proliferation of efforts to shift finance toward a sustainable future. Another UNEP report finds that, as of April 2020, there were 115 different "partnerships" at the international, regional, and national levels (UNEP Inquiry 2020, 8).[1] These partnerships, however, vary tremendously in their form and levels of institutionalization, ranging from informal pledges, associations of private-sector financial institutions, coalitions of substrate regulators, to formal IGOs.

This landscape of climate finance institutions at the international level is larger than is assumed by most IR and IO scholars of the climate finance regime. To enhance our empirical

[1] Like our contribution here, this UNEP report uses network analysis to describe the institutional landscape of these partnerships. But its data includes partnerships whose missions focus on sustainable and green finance (UNEP Inquiry 2020, 36), which we explicitly exclude.

understanding, we demonstrate the scope of the climate finance regime through network analysis, and evaluate its institutional structure through the theoretical framework of "international regime complexity." The next section considers this theoretical framework.

3. International Regime Complexity in Climate Finance

International agreements have proliferated and deepened in recent decades to govern different areas of world politics. At the same time, the number and diversity of actors involved in promulgating, implementing, and monitoring these international agreements have also expanded (Alter and Meunier 2009; Eilstrup-Sangiovanni 2016). Scholars have termed these growing systems of overlapping institutions and actors -- including governments, intergovernmental organizations (IGOs), transnational actors, private firms and non-profit organizations -- "regime complexes." The central questions in the regime complexity research program concern the creation of new institutions to supplement existing institutions, the conditions under which institutions cooperate or compete, and whether complexes improve or degrade substantive outcomes compared to outcomes under a single global institution (Henning 2019, 25–26).

This research program has also advanced several definitions of regime complexes that differ at the margins. Of these, we most closely align ourselves with Orsini et al., (2013) and define a regime complex as *a network of three or more international institutions that relate to a common subject matter, exhibiting overlapping membership, and generate substantive, normative, or operative interactions between them*.

Several clarifications are in order. First, the institutions that constitute the basic units of a regime complex can be understood as the set of formal and informal rules that "prescribe

behavioral roles, constrain activity, and shape expectations" (Keohane 1989, 3).[2] International institutions, then, include legally constituted and highly structured IGOs; less formal fora such as the G20 or G7; organizations of substate regulators and ministries, civil society organizations (CSOs) and non-governmental organizations (NGOs); associations of private-sector firms and private transnational regulatory organizations (PTROs); and institutions constituted by combinations of governmental, private and NGO representatives (Abbott 2012; Henning 2017, 20; Henning and Pratt 2020, 4–5) Second, a regime complex must be composed of at least three institutions. Third, consisting of at least three institutions does not automatically constitute a regime complex. Constituent institutions need to interact. Fourth, within a regime complex, elementary institutions have partially but rarely entirely overlapping memberships (Orsini, Morin, and Young 2013; Raustiala and Victor 2004).[3] Fifth, breaking with earlier conceptualizations of regime complexes (Gehring and Faude 2013; Raustiala and Victor 2004), we do not presume that specific structural characteristics are intrinsic to regime complexes. Regime complexes, for example, are not fragmented or non-hierarchical by definition. Similarly, we are agnostic as to whether the interactions between constituent institutions are competitive or cooperative. Indeed, inter-institutional relationships in a regime complex may evolve from divergent to synergistic, or vice versa, over time.

While we do not assume inherent structural features, we take heed of recent conceptual advances that argue regime complexes vary along several structural dimensions. Most important

[2] Orsini et al (2013) consider *regimes*, rather than institutions to be the constitutive elements of regime complexes. We do not draw a meaningful boundary between regimes and institutions, but adopt the latter term simply to conform to most of the recent literature on regime complexity.

[3] Henning's (2017) definition of regime complexes explicitly excludes member states and organizations that make up the constitutive institutions for methodological reasons, so as "to examine the relationship between state preferences on the one hand and conflict and cooperation within the complex on the other" (p. 20). We include member states and organizations because one of our main tasks is to show the extent of their overlap within the regime complex.

of these is the presence or absence of *hierarchy*. Hierarchy exists in a regime complex if institutions are "nested" or embedded within legally superordinate institutions (Aggarwal 1998) or otherwise implicitly or explicitly recognize the right of other institutions to shape rules, coordinate projects, or set the terms of cooperation (Henning and Pratt 2020, 7). Hierarchy is absent when elementary institutions do not exercise authority over others. Networks of institutions, for example, in which institutions are linked via information-sharing, work-flow integration and cross-representation on governing boards are not hierarchical (Henning and Pratt 2020, 8). Hierarchy and centrality are closely associated structural characteristics. A regime complex with a high centrality is one in which many or most of the constituent institutions are connected to a single focal institution (Orsini, Morin, and Young 2013). We will describe the measure of centrality in the context of network analysis in Section 4.

Another key dimension is the degree of functional overlap, or *differentiation*, between constituent institutions. An undifferentiated regime complex is populated by institutions with similar mandates, functions, and governance activities. On the other hand, an undifferentiated regime complex will have constituent institutions whose functions are more specialized and unique from one another (Henning and Pratt 2020, 9-10).

Another important structural dimension is a regime complex's *density*. A completely dense network connects all institutions to one another, whereas a low density signifies that institutions are connected only to one or a handful of other institutions (Orsini, Morin, and Young 2013).

Scholars have often characterized regime complexes as fragmented. *Fragmentation* occurs when a regime complex is both non-hierarchical and low in density. "Fragmentation occurs when the mechanisms that coordinate different institutions break down" (Henning 2017, 20). Greenhill and Lupu (2017, 184-85) explain fragmentation in IGO networks, operationalized as modularity.

One important area of global policy domain that has been studied through the regime complexity framework is climate change governance (Abbott 2012, 2014; Cole 2015; Keohane and Victor 2011). In fact, the study of regime complexity is inextricably bound up with the way the climate change regime has evolved. An important study by Keohane and Victor (2011) examined the emerging cluster of mostly intergovernmental institutions around the UNFCCC through the regime complex framework. This complex was soon expanded to include transnational institutions composed of non-state actors, ranging from cities, private transnational regulatory organizations, businesses, foundations, and civil society organizations (Abbott 2012; Bulkeley et al. 2012; Green 2014; Hale and Roger 2014). This crowded landscape has been likened to an "organizational ecology" (Abbott, Green, and Keohane 2016) which a handful of IGOs "orchestrate" (Hale and Roger 2014). Abbott (2012) notes that, in contrast to the traditional regime complex concept, the complex in climate change lacks a central international institution with the authority to set the agenda for the whole complex ("weak nesting") and has a relatively high degree of duplication of policy goals ("overlap"). Scholars have pointed out potential advantages of the regime complex governance model in the climate change policy domain, arguing that societal actors can bypass recalcitrant governments by directly engaging with the regime complex, that institutions within the complex can put pressure on governments to take action on climate change (Abbott 2014). On the other hand, questions remain on the effectiveness of the climate change regime complex (Jordan et al. 2015). Because transnational governance models often rely on voluntary measures, they allow laggards to free ride on the efforts of climate leaders at no cost (Hale and Roger 2014).

Much scarcer are studies that approach the global climate finance regime from a regime complexity lens. Scholars of the broader climate change regime complex have recognized the

importance of several large regimes that address sustainable finance issues in their mission, including major IGOs such as the UN Environmental Program Finance Initiative (Hale and Roger 2014) and private sector-led regimes Institutional Investor Group on Climate Change, Investor Network on Climate Risk, and Carbon Disclosure Project (Abbott 2012). But these studies do not treat the climate finance regime as a system in its own right. The contributors in a special issue of *International Environmental Agreements* (Pickering, Betzold, and Skovgaard 2017) fruitfully draws on the concepts of fragmentation and complexity from the regime complexity literature, but again, they focus on a narrow functional and institutional scope as highlighted above. The CFRC is far larger than these scholars have documented, involving thousands of private-sector firms, hundreds of charitable foundations, academic institutions and non-profit organizations, and dozens of national governments and IGOs. We present the network data on the CFRC in the next section, paying particular attention to theoretically significant features, such as its centrality, fragmentation, density, and the role of actors that bridge separate clusters.

4. Network Data and Method

Network analysis is a method that focuses on analyzing patterns of relations among agents. The value of network analysis in international relations lies in the description of large international collaboration structures, investigation of network effects on key outcomes, testing of existing network theory in the context of international relations, and development of new sources of data (Hafner-Burton, Kahler, and Montgomery 2009). Network analysis illustrates relationships defined by two objects: nodes, which represent individual entities or organizations and the links between them, referred to as edges. These two elements form persistent patterns of association and create structures that can define, enable, or restrict the behavior of nodes in any particular network

(Hafner-Burton, Kahler, and Montgomery 2009). Network analysis enables us to discover and understand these structures, and even in some cases predict future trends through looking at patterns of current and past relations.

4.1 Data Collection

We cast a wide net in gathering the data to construct our networks. Our initial step was to gather the multilateral funds tracked on the *Climate Funds Update* website[4] and the institutions and organizations listed on the "Supporting Institutions" and "Connecting the Dots" pages on the *Climate Action in Financial Institutions* website.[5] From there, we visited the websites of the listed institutions and followed two parallel and iterative data collection processes. The first process consisted of gathering all institutions affiliated with these institutions whose missions explicitly included issues related to furthering the goals of climate finance. We define institutions as either recurring forums or international institutions that employ staff. This definition excludes one-off events and conventions held at the international level. The second process was gathering all organizations (governments and government institutions, state-owned enterprises, private-sector firms, non-profit organizations, and academic institutions) that are listed on the websites of these institutions either as founders, supporters, members, partners, affiliates, investors, collaborators, and funders.

There are some other limitations with our dataset. Attesting to the extensiveness of the CFRC, we kept discovering institutions during our data collection process. We stopped collecting data in February 2021 to begin the analysis, but we discovered several additional regimes after that date, which we plan to include in a future iteration of this project. As Hale and Roger (2014, 70) put it

[4] https://climatefundsupdate.org/. Accessed 4 February 2021.
[5] https://www.mainstreamingclimate.org/connecting-the-dots/. Accessed 17 October 2020.

nicely, because transnational governance often involves numerous decentralized institutions, "cases must be identified through 'searching and asking,' essentially a large-N version of 'soaking and poking'." Our current dataset contains 53 institutions (see Appendix A) and 8,178 organizational affiliates.

Another concern related to non-exhaustibility is more difficult to overcome: because we base our collection of affiliate organizations entirely on what is listed on institutions' websites, we do not include organizations with membership in, partner with, or sponsor these institutions that are not readily listed on those websites. There may also be a language and geographic bias in our dataset. Because all of our searches were done in English, and nearly all of the institutions in our data have websites in English, it is reasonable to assume that institutions based in or closely connected to the Western world are over-represented in our data. Even with these limitations, we believe our novel dataset can usefully advance our understanding of the structure of global governance in the domain of climate finance.

Once our organizational affiliate dataset was complete, we removed duplicate entries and duplicate edges between affiliate organizations and regimes, corrected for special characters, and consolidated. Specifically, all subsidiaries of private-sector organizations were consolidated under the parent organization's name (for example, BlackRock Investment Management and BlackRock Trident Holding Co. were both renamed as BlackRock).

4.2 Network Creation

We used the R packages *igraph* and *tidyverse* to structure and clean the data, as well as to generate network metrics. We then imported the data into Gephi, an open-source network analysis software for the final visualizations presented below (Bastian et al. 2009). The data were separated into two datasets: one containing both institutions and their affiliate organization, and the other institutions

and their institutional collaborators. The first dataset produced three opportunities for network analysis: a bipartite network of institutions and organizations, an "organizations with institutions in common" network, and an "institutions with organizations in common" network. The second of these produced a network graph with over 7,000 nodes and nearly 6 million edges. This was simply too large for R to compute, so we chose to exclude it from the analysis. We used the third dataset to create Figure 1. Thus, we present three networks: collaboration between institutions (Figure 1), a bipartite network of institutions and their affiliate organizations (Figure 2), and institutions with shared affiliate organizations (Figure 3). All three networks are undirected, which means the edges are reciprocal.

A bipartite network (also called a two-mode network) consists of two types of nodes and edges connecting different types of nodes, rather than the same type (Murphy and Knapp 2017). Our bipartite network consists of two sets of nodes: one representing institutions and the other their affiliate organizations. The edges between the two sets of nodes signifies membership of an organization within an institution.

In the network depicting institutions with shared affiliate organizations (Figure 3), the nodes are represented by climate finance institutions and the edges between them represent organizations that have common affiliations with both. These edges are weighted - the more organizations a pair of climate finance institutions have in common, the thicker the edge. In the network depicting collaborations between institutions (Figure 1), the nodes are also institutions but the edges represent collaboration, partnership or sponsorship between them, rather than common organizational affiliates.

4.3 Network Properties

The distribution of edges in a network suggests three important structural characteristics that are of interest to scholars of regime complexity: (1) the importance (centrality) of nodes in the network, (2) the tightness with which the nodes are connected (density), and (3) the division of the network into subgroups (also called clusters or communities). These characteristics can yield theoretically relevant insights and generate hypotheses for future research. We now explain the measures associated with each characteristic in turn.

Network researchers commonly focus on three measures of centrality: degree, closeness, and betweenness. Degree centrality of a node is the sum of the value of the ties between that node and every other node in the network. This measure tells us how much access a particular node has to the other nodes. Closeness centrality is calculated using the length of the path between a node and every other node, which could estimate the time required for information or resources to propagate to a given node in a network. Betweenness centrality corresponds to the number of shortest paths in the network that pass through a particular node, and therefore it measures the dependence of a network on a particular node for maintaining connectedness (Hafner-Burton, Kahler, and Montgomery 2009).

We describe the tightness with which nodes in the network are connected by focusing on two measures: node degree and network density. The node degree shows how many edges each node in the network is connected to. This measure suggests individual nodes that are more highly connected, and which nodes, by extension, have more influence or are positioned to initiate the diffusion or new ideas, information or norms (Burt 2000; Rogers 1983). Network density shows a ratio between the number of edges a given node has and all possible edges that node could have in a network. Network density ranges from 0 to 1, with 1 indicating a maximum density whereby all

nodes are connected to all other nodes, and 0 indicating a network in which no node is connected to any other node.

Lastly, the division of the networks into subgroups is assessed through the clustering coefficient. Clustering coefficient illustrates how connected the clusters are in a network. A high clustering coefficient, as with node degree, ranges from 0 to 1, with 1 indicating dense connections between clusters, while 0 suggests no connections between them. While we do not discuss all of these measures in the next section, Appendix B contains a list of all measures for the networks we present.

5. Networks of Climate Finance Regime Complex

We present three networks with nodes representing two levels of analysis -- institutions and the individual organizations affiliated with them -- to offer a complete view of the CFRC's centrality, density and clustering. In all, the insight that emerges from these networks is that the CFRC is a large scale network with low centralization and highly fragmented at the institutional level, yet relatively centralized and densely connected at the organizational level.

5.1 Collaborations between Climate Finance Institutions

Figure 1 depicts institutions as nodes and the collaboration between them as edges. It consists of 125 regimes, 57 of which are explicitly focused on climate finance, and the rest are international organizations, multilateral institutions or forums with a wider mission with which climate finance institutions collaborate. Links between international and transnational institutions is the level of analysis that IR scholars on global governance most commonly study. Collaboration in this network is conceived of broadly, including partnerships between, and sponsorships and founding

of institutions. The colors of the nodes correspond to the status of the institutions: blue nodes indicate that the institution is an IGO, red nodes are private-sector institutions, and green-nodes are non-profit institutions.

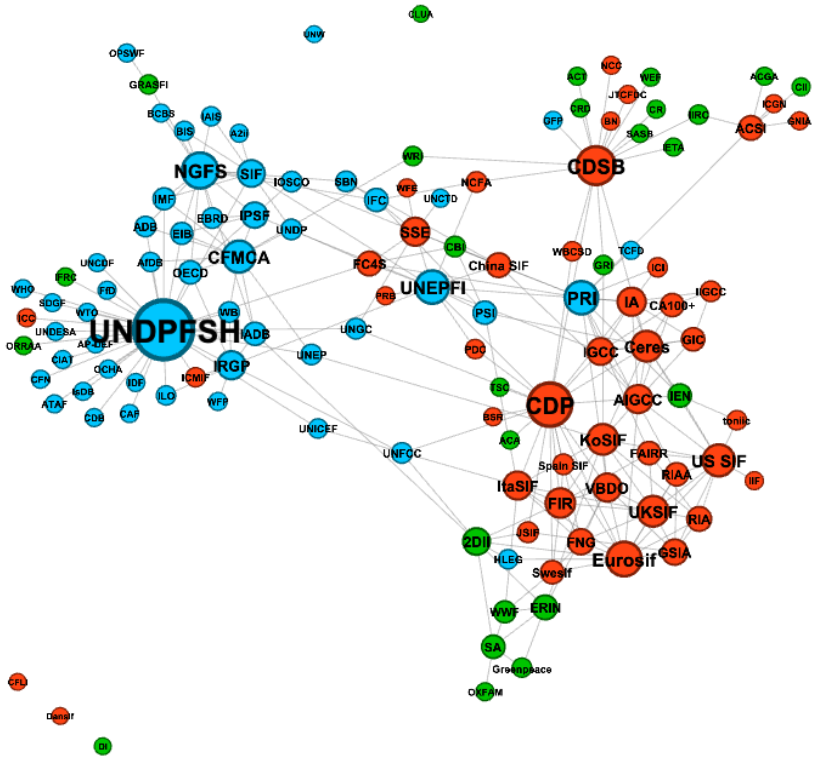

Figure 1. Collaboration between climate finance institutions.
Notes: nodes are colored by their status: blue=IGOs, red=private-sector, green=non-profit. Edges are unweighted and undirected.

In terms of degree and closeness centrality measures, this network is characterized by low centrality (4.45 and 0.0025, respectively). Low network density (0.037) also suggests that on average, each node is not connected to very many other nodes. At the same time, its betweenness measure is relatively high (143.62), suggesting that a handful of nodes act as important bridge actors that connect most other nodes. Indeed, several regimes are positioned as central actors. The UN Development Programme's Finance Sector Hub (UNDPFSH) is the most central in terms of degree centrality (35) and betweenness centrality (2508.5). True to its name, the UN Finance Sector Hub acts as a hub connecting various other UN entities (UNICEF, UN Environmental

Program (UNEP) and its Finance Initiative (UNEPFI), UN Framework for Climate Change (UNFCC), UN Development Program (UNDP), etc.) and many national-level government agencies and IGOs. CDP (formerly Carbon Disclosure Project), an organization that solicits information on greenhouse gas emissions and climate change data from companies and cities, is another central node. It stands as a bridge between the densely connected cluster of private-sector "sustainable investment forums" with regional roots (US SIF, UKSIF, Eurosif, Korea SIF (KoSIF), etc.) and UN-affiliated entities.

Other central nodes include: Climate Disclosure Standards Board (CDSB) which provides material information for investors and financial markets by integration climate-related data and financial reporting; the UN's Principles for Responsible Investment (PRI), a network of institutional investors that works to implement environment, social and governance (ESG) standards in their investment decisions and reporting; the UN Environment Programme's Finance Initiative (UNEPFI), a partnership between the UN, banks, investors and insurance companies that seeks to encourage the global financial sector to better implement ESG principles; the Network for Greening the Financial System (NGFS), a forum in which central bankers and financial supervisors exchange information and help support the financial system to transition to a sustainable economy.

Along with a low level of centrality, the CFRC is characterized by relatively clear clusters. When the nodes are colored by modularity (a community-detection algorithm in Gephi (Blondel et al. 2008)), 8 clusters appear. A clustering coefficient of 0.32, however, suggests that these clusters are only sparsely connected, illustrating a relatively fragmented regime complex.

Lastly, there are outlier regimes, illustrated by five unconnected nodes on the periphery of the network. These nodes are Danish Sustainable Investment Forum (Dansif), Climate Finance Leadership Initiative (CFLI), DivestInvest (DI), UN Women (UNW), and Climate and Land Use

Alliance (CLUA). While these institutions boast moderate to large numbers of affiliate organizations (shown in the next subsection), we did not find information on their direct collaboration with other institutions in this network.

5.2 Climate Finance Institutions with their Affiliate Organizations

Figure 2 is a bipartite network that shows what organizations are affiliated with which climate finance institutions. The organizations that compose the vast majority of the nodes are of a wide array of types: national governments, government agencies and departments, private-sector firms, state-owned enterprises, cities, charitable and non-profit organizations, and academic institutions. The climate finance institutions with which these organizations are affiliated are in the center of each cluster (too small to see at this scale), and we labeled 21 of the largest climate finance institution clusters. In total, this network consists of 57 institutional nodes and 8,178 organizational nodes. This network thus shows the size of each climate finance institution in terms of their affiliated organizations, and to a limited extent, the overlap in affiliated organizations between institutions.

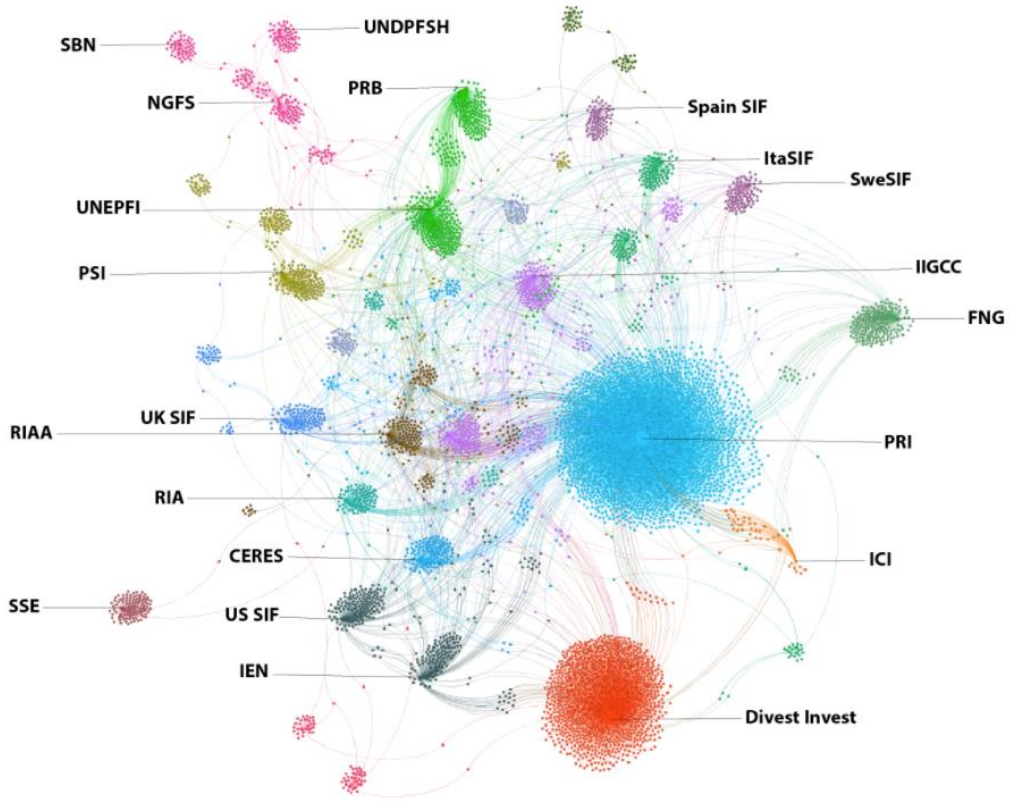

Figure 2. Climate finance institutions and their affiliated organizations.
Note: nodes are colored by modularity; edges are undirected and unweighted. Labels added in Adobe Illustrator.

Several climate finance institutions stand out as the most central nodes. PRI, UNEPFI and DI, a non-profit organization aiming to influence investors to divest from fossil fuels, are by far the largest regimes in terms of the degree, betweenness, and closeness centrality measures. As is visually clear, this means that these three institutions have the largest number of affiliate organizations, and many of these organizations heavily overlap with organizations affiliated with other regimes like the Institutional Investors Group on Climate Change (IGCC), Principles for Sustainable Insurance Initiative (PRI), UNEPFI's subsidiary organizations Principles for Responsible Banking (PRB), and the regional sustainable investment forums.

Some interesting patterns emerge when analyzing node-level measures of centrality. Large global financial institutions, especially asset managers (BlackRock, Amundi, Mirova), universal banks and conglomerates (BNP Paribas, Allianz and AXA), and index providers (MSCI and FTSE

Russell), are affiliated with the largest number of climate finance institutions by degree. In terms of betweenness and closeness centrality measures, however, a somewhat different and unexpected set of actors are positioned as bridges between clusters. These are publicly-owned or cooperative financial institutions (Nordic Investment Bank, UK-based public pension scheme Environmental Agency Pension Fund, and US-based union-owned Amalgamated Bank), non-profit investment management companies and superannuation funds (the Quaker organization Friends Fiduciary, Church of Sweden, AustraliaSuper, Future Super and New Zealand Superannuation Fund), and charitable organizations and asset managers that cater to them (Joseph Rowntree Charitable Trust, Rockefeller Brothers Fund and Boston Common Asset Management).

Because the node types are heterogenous, taking the average of the centrality data for the whole bipartite network does not yield meaningful network-level measures; we instead chose to transform this network and generate centrality measures in the next subsection.

5.3 Climate Finance Institutions with Organizations in Common

Figure 3 uses the same data as Figure 2 but converts it into a one-mode network -- that is, only shows institutional nodes while the edges represent the number of affiliate organizations in common between pairs of institutional nodes.[6] The circular representation of this network is for aesthetic purposes, and does not reflect peculiarities in the data or affect the analysis.

[6] To create this network, we used the Cross-Product Method, whereby we multiplied the bipartite matrix by its transpose to produce a one-mode network using the R package igraph (Murphy and Knapp 2017), and visualized it using the circular layout in Gephi.

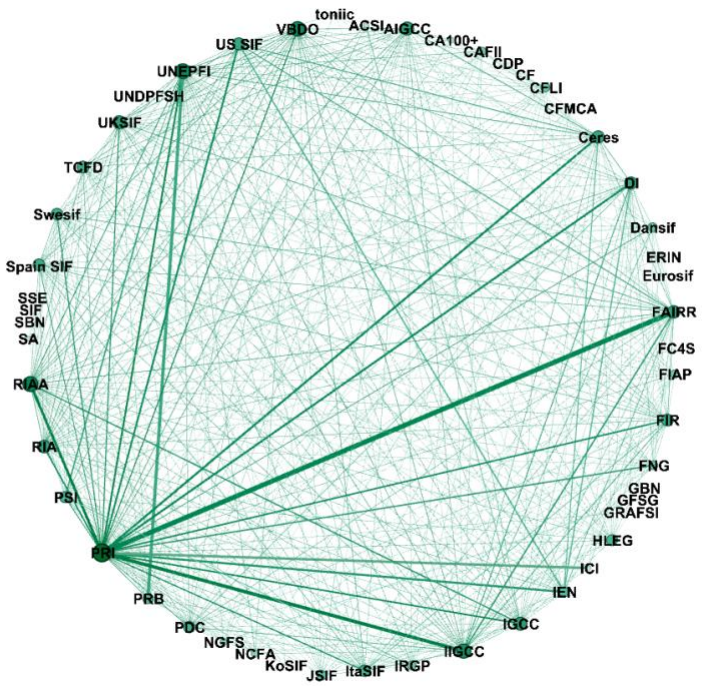

Figure 3. Climate finance institutions with shared affiliate organizations
Note: Node size by degree; edges undirected but weighted by number of affiliate organizations in common.

When considering affiliate organizations in common, the network's centralization is higher than in Figure 1. Both in terms of degree (16.6) and closeness (0.0055), this network performs better than when analyzing collaboration between climate finance institutions. Its betweenness centrality, on the other hand, is much lower than in the institutional collaboration network (30.5), suggesting that Figure 3 is not as dependent on a handful of climate finance institutions when it comes to sharing affiliate organizations. This suggestion is also supported by a relatively high clustering coefficient (0.73), indicating that the clusters within this network are somewhat densely connected.

Familiar institutions act as central nodes in this network. PRI is by far the most connected node to other institutions, and as indicated by the thickness of the edges connected to it, it shares the largest number of organizations with Farm Animal Investment Risk & Return (FAIRR), IIGCC, Responsible Investment Association Australasia (RIAA), the Boston-based investor network

Ceres (formerly Coalition for Environmentally Responsible Economies), and many others. UNEPFI is another central institution with many organizations in common with PRB, PSI and others.

Three descriptive findings emerge from the network data presented in this section. First and most broadly, there is significant diversity in types of actors that make up the CFRC, including IGOs, private-sector and non-profit forums and organizations. The significant presence of non-state actors both at the institution- and organization-levels complicate the common view among regime complexity scholars that states and IGOs are the primary actors engaged in governing through formal rules (Abbott 2012; Gehring and Faude 2013). Second, at the level of institutions, the CFRC is non-hierarchical: while several institutions are well-connected to others, the regime complex overall is characterized by low centralization and high fragmentation, with sparse connections between clusters of institutions. On the other hand, the third finding is that there is closer integration at the level of financial firms, non-profit and other organizations affiliated with these institutions. This suggests that many organizations proactively affiliate, support, and seek membership in multiple climate finance institutions.

6. Conclusion

There is now a sizable scholarship on international and transnational regime complexes -- systems of overlapping institutions and actors that govern a particular global policy issue. In this article, we presented and analyzed network data on the climate finance regime complex (CFRC), a global policy issue that remains underappreciated in the literature of global governance despite its fundamental importance for climate change adaptation and mitigation. An analysis of networks showing (1) collaboration between institutions at the international and transnational level, (2)

climate finance institutions and the organizations affiliated with them, including governments, private-sector firms, non-profit organizations, and academic institutions, and (3) shared affiliate organizations between climate finance institutions, we found that the CFRC is characterized by low centralization and relative fragmentation at the regime-level, yet highly dense and relatively centralized at the organization-level.

Appendices

Appendix A
List of regimes (with founding year, institution type (IGO, private-sector, non-profit), geographic scope)

	Abbreviation	Institution Name	Year Founded	Geographic Scope	Institution Type
1	Ceres	Ceres	1989	US	Private-sector
2	SBN	Sustainable Banking Network	2012	Global	IGO
3	GSIA	Global Sustainable Investment Alliance	2012	Global	Private-sector
4	GRASFI	Global Research Alliance for Sustainable Finance and Investment	2017	Global	Non-profit
5	AIGCC	Asia Investor Group on Climate Change	2011	Asia	Private-sector
6	Eurosif	European Sustainable Investment Forum	2001	Europe	Private-sector
7	RIAA	Responsible Investment Association Australasia	2000	Australia	Private-sector
8	RIA	Responsible Investment Association Canada	1990	Canada	Private-sector
9	UKSIF	UK Sustainable Investment & Finance Association	1991	UK	Private-sector
10	US SIF	US Sustainable Investment Forum	2010	US	Private-sector

11	VBDO	Dutch Association of Investors for Sustainable Development	1995	Netherlands	Private-sector
12	JSIF	Japan Sustainable Investment Forum	2003	Japan	Private-sector
13	GIC	Global Investor Coalition on Climate Change	2012	Global	Private-sector
14	IGCC	Investor Group on Climate Change	2013	Australia & New Zealand	Private-sector
15	IIGCC	Institutional Investors Group on Climate Change	2001	Europe	Private-sector
16	NGFS	Network for Greening the Financial System	2017	Global	IGO
17	TCFD	Taskforce for Climate-Related Financial Disclosure	2015	Global	IGO
18	IA	The Investor Agenda	2017	Global	Private-sector
19	ACSI	Australia Council of Superannuation Investors	2001	Australia	Private-sector
20	CA100+	Climate Action 100+	2017	Global	Private-sector
21	PRI	Principles for Responsible Investment	2006	Global	IGO
22	CDP	CDP	2000	Global	Private-sector
23	UNFCC	United Nations Framework Convention on Climate Change	2016	Global	IGO
24	NCFA	Natural Capital Finance Alliance	2012	Global	Private-sector
25	CDSB	Climate Disclosure Standards Board	2007	Global	Private-sector
26	PSI	Principles for Sustainable Insurance Initiative	2012	Global	IGO
27	PDC	Portfolio Decarbonization Coalition	2014	Global	Private-sector
28	SSE	Sustainable Stock Exchanges	2009	Global	Private-sector
29	FC4S	International Network of Financial Centers for Sustainability	2017	Global	Private-sector

30	CFMCA	Coalition of Finance Ministers for Climate Action	2018	Global	IGO
31	PRB	Principles for Responsible Banking	2019	Global	Private-sector
32	SIF	Sustainable Insurance Forum	2016	Global	IGO
33	UNDPFSH	UNDP Finance Sector Hub	2019	Global	IGO
34	IPSF	International Platform on Sustainable Finance	2019	Global	IGO
35	DI	DivestInvest	2014	Global	Non-profit
36	IEN	Intentional Endowments Network	2014	US	Non-profit
37	ICI	Initiative Climat International	2015	France	Private-sector
38	SA	ShareAction	2005	Global	Non-profit
39	toniic	toniic	2010	Global	Private-sector
40	Spain SIF	Spain Sustainable Investment Forum	2009	Spain	Private-sector
41	ItaSIF	Italy Sustainable Investment Forum	2001	Italy	Private-sector
42	KoSIF	Korea Sustainable Investment Forum	2007	Korea	Private-sector
43	Dansif	Denmark Sustainable Investment Forum	2008	Denmark	Private-sector
44	Swesif	Sweden Sustainable Investment Forum	2003	Sweden	Private-sector
45	FIR	Forum for Responsible Investment	2001	France	Private-sector
46	FNG	Forum Nachhaltige Geldanlagen	2001	Germany/Austria/Switzerland	Private-sector
47	China SIF	China Social Investment Forum	2012	China	Private-sector
48	OPSWF	One Planet Sovereign Wealth Funds	2017	Global	IGO
49	FAIRR	Farm Animal Investment Risk & Return	2015	Global	Private-sector
50	ERIN	European Responsible Inevestment Network	2016	Europe	Non-profit
51	IRGP	InsuResilience Global Partnership	2017	Global	IGO

52	2DII	2° Investing Initiative	2012	Global	Non-profit
53	CFLI	Climate Finance Leadership Initiative	2018	Global	Private-sector

Appendix B
Network Metrics

Measures of Network Centrality, Density, and Clustering		
	Networks	
	Collaboration between institutions (Figure 1)	**Institutions with organizations in common (Figure 3)**
Average Degree centrality	4.45	16.6
Closeness centrality	0.0025	0.0055
Average Betweenness centrality	143.62	30.5
Network density	0.37	0.33
Avg. clustering coefficient	0.33	0.73
Diameter	7	5
Note: Because Figure 2 is a bipartite network, average metrics for that network does not yield meaningful results. For this reason, metrics for that network are not shown.		

References

Abbott, Kenneth W. 2012. "The Transnational Regime Complex for Climate Change." *Environment and Planning C: Government and Policy* 30(4): 571–90.

Abbott, Kenneth W. 2014. "Strengthening the Transnational Regime Complex for Climate Change." *Transnational Environmental Law* 3(1): 57–88.

Abbott, Kenneth W., Jessica F. Green, and Robert O. Keohane. 2016. "Organizational Ecology and Institutional Change in Global Governance." *International Organization* 70(2): 247–77.

Aggarwal, Vinod K., ed. 1998. *Institutional Designs for a Complex World*. Cornell University Press. http://www.jstor.org.libproxy.temple.edu/stable/10.7591/j.ctvv414p7 (January 18, 2021).

Alter, Karen J., and Sophie Meunier. 2009. "The Politics of International Regime Complexity." *Perspectives on Politics* 7(1): 13–24.

Amerasinghe, Niranjali, Joe Thwaites, Gaia Larsen, and Athena Ballesteros. 2017. *THE FUTURE OF*

THE FUNDS. World Resources Institute.
Bastian, Mathieu, Sebastien Heymann, Mathieu Jacomy, and others. 2009. "Gephi: An Open Source Software for Exploring and Manipulating Networks." *Icwsm* 8(2009): 361–62.
Berensmann, Kathrin, and Nannette Lindenberg. 2016. *Green Finance: Actors, Challenges and Policy Recommendations*. Bonn, Germany: Deutsches Institut für Entwicklungspolitik.
Betzold, Carola, and Florian Weiler. 2017. "Allocation of Aid for Adaptation to Climate Change: Do Vulnerable Countries Receive More Support?" *International Environmental Agreements: Politics, Law and Economics* 17(1): 17–36.
Blondel, Vincent D, Jean-Loup Guillaume, Renaud Lambiotte, and Etienne Lefebvre. 2008. "Fast Unfolding of Communities in Large Networks." *Journal of Statistical Mechanics: Theory and Experiment* 2008(10): P10008.
Buchner, Barbara et al. 2019. *Global Landscape of Climate Finance 2019*. Climate Policy Initiative.
Bulkeley, Harriet et al. 2012. "Governing Climate Change Transnationally: Assessing the Evidence from a Database of Sixty Initiatives." *Environment and Planning C: Government and Policy* 30(4): 591–612.
Burt, Ronald S. 2000. "The Network Structure of Social Capital." In *Research in Organizational Behavior (Vol*, Press.
Carney, Mark. 2015. "Breaking the Tragedy of the Horizon: Climate Change and Financial Stability." https://www.bankofengland.co.uk/-/media/boe/files/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability.pdf?la=en&hash=7C67E785651862457D99511147C7424FF5EA0C1A.
Cole, Daniel H. 2015. "Advantages of a Polycentric Approach to Climate Change Policy." *Nature Climate Change* 5(2): 114–18.
CPI. 2015. *A Closer Look at the Landscape: 2015 Methodology*. Climate Policy Institute. https://www.climatepolicyinitiative.org/wp-content/uploads/2015/11/A-Closer-Look-at-the-Landscape-2015-Methodology.pdf.
Delina, Laurence. 2017. "Multilateral Development Banking in a Fragmented Climate System: Shifting Priorities in Energy Finance at the Asian Development Bank." *International Environmental Agreements: Politics, Law and Economics* 17(1): 73–88.
Eilstrup-Sangiovanni, Mette. 2016. 1 *Global Governance Networks*. eds. Jennifer Nicoll Victor, Alexander H. Montgomery, and Mark Lubell. Oxford University Press. http://oxfordhandbooks.com/view/10.1093/oxfordhb/9780190228217.001.0001/oxfordhb-9780190228217-e-30 (October 11, 2020).
European Commission. "Overview of Sustainable Finance." *European Commission*. https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainable-finance_en (January 11, 2021).
Falconer, Angela, and Martin Stadelmann. 2014. *What Is Climate Finance? Definitions to Improve Tracking and Scale up Climate Finance*. Climate Policy Initiative.
G20 Green Finance Study Group. 2016. *G20 Green Finance Synthesis Report*.
Gehring, Thomas, and Benjamin Faude. 2013. "The Dynamics of Regime Complexes: Microfoundations and Systemic Effects." *Global Governance* 19(1): 119–30.
Gomez-Echeverri, Luis. 2013. "The Changing Geopolitics of Climate Change Finance." *Climate Policy* 13(5): 632–48.
Graham, Erin R., and Alexandria Serdaru. 2020. "Power, Control, and the Logic of Substitution in Institutional Design: The Case of International Climate Finance." *International Organization* 74(4): 671–706.
Graham, Erin R., and Alexander Thompson. 2014. "Efficient Orchestration?" In *International Organizations as Orchestrators*, eds. Kenneth W. Abbott, Philipp Genschel, Duncan Snidal, and Bernhard Zangl. Cambridge: Cambridge University Press, 114–38. https://www.cambridge.org/core/product/identifier/CBO9781139979696A015/type/book_part (January 6, 2021).

Grasso, Marco. 2011. "The Role of Justice in the North–South Conflict in Climate Change: The Case of Negotiations on the Adaptation Fund." *International Environmental Agreements: Politics, Law and Economics* 11(4): 361–77.
Green, Jessica F. 2014. *Rethinking Private Authority: Agents and Entrepreneurs in Global Environmental Governance*. Princeton, NJ: Princeton University Press.
GSIA. 2019. *Sustainable Investor Poll on TCFD Implementation*. http://www.gsi-alliance.org/wp-content/uploads/2019/12/Global-Sustainable-Investment-Alliance-TCFD-Poll.pdf.
Hafner-Burton, Emilie M., Miles Kahler, and Alexander H. Montgomery. 2009. "Network Analysis for International Relations." *International Organization* 63(3): 559–92.
Hale, Thomas, and Charles Roger. 2014. "Orchestration and Transnational Climate Governance." *The Review of International Organizations* 9(1): 59–82.
Hall, Nina. 2017. "What Is Adaptation to Climate Change? Epistemic Ambiguity in the Climate Finance System." *International Environmental Agreements: Politics, Law and Economics* 17(1): 37–53.
Henning, C. Randall. 2017. *Tangled Governance: International Regime Complexity, the Troika, and the Euro Crisis*. First Edition. Oxford, United Kingdom: Oxford University Press.
———. 2019. "Regime Complexity and the Institutions of Crisis and Development Finance." *Development and Change* 50(1): 24–45.
Henning, C Randall, and Tyler Pratt. 2020. "Hierarchy and Differentiation in International Regime Complexes: A Theoretical Framework for Comparative Research."
Jordan, Andrew J. et al. 2015. "Emergence of Polycentric Climate Governance and Its Future Prospects." *Nature Climate Change* 5(11): 977–82.
Kalinowski, Thomas. 2020. "Institutional Innovations and Their Challenges in the Green Climate Fund: Country Ownership, Civil Society Participation and Private Sector Engagement." *Sustainability* 12(21): 8827.
Keohane, Robert O., ed. 1989. *International Institutions and State Power: Essays in International Relations Theory*. Boulder, CO: Westview Press.
Keohane, Robert O., and David G. Victor. 2011. "The Regime Complex for Climate Change." *Perspectives on Politics* 9(1): 7–23.
Michaelowa, Katharina, Axel Michaelowa, Bernhard Reinsberg, and Igor Shishlov. 2020. "Do Multilateral Development Bank Trust Funds Allocate Climate Finance Efficiently?" *Sustainability* 12(14): 5529.
Murphy, Phil, and Brendan Knapp. 2017. "RPubs - Bipartite/Two-Mode Networks in Igraph." https://rpubs.com/pjmurphy/317838 (October 28, 2020).
Orsini, Amandine, Jean-Frédéric Morin, and Oran Young. 2013. "Regime Complexes: A Buzz, a Boom, or a Boost for Global Governance?" *Global Governance: A Review of Multilateralism and International Organizations* 19(1): 27–39.
Pauw, W. Pieter. 2017. "Mobilising Private Adaptation Finance: Developed Country Perspectives." *International Environmental Agreements: Politics, Law and Economics* 17(1): 55–71.
Pickering, Jonathan et al. 2015. "Acting on Climate Finance Pledges: Inter-Agency Dynamics and Relationships with Aid in Contributor States." *World Development* 68: 149–62.
Pickering, Jonathan, Carola Betzold, and Jakob Skovgaard. 2017. "Special Issue: Managing Fragmentation and Complexity in the Emerging System of International Climate Finance." *International Environmental Agreements : Politics, Law and Economics; Dordrecht* 17(1): 1–16.
Pickering, Jonathan, and Paul Mitchell. 2017. "What Drives National Support for Multilateral Climate Finance? International and Domestic Influences on Australia's Shifting Stance." *International Environmental Agreements: Politics, Law and Economics* 17(1): 107–25.
Raustiala, Kal, and David G. Victor. 2004. "The Regime Complex for Plant Genetic Resources." *International Organization* 58(2): 277–309.
Reinsberg, Bernhard, Katharina Michaelowa, Igor Shishlov, and Axel Michaelowa. 2020. *Climate Change-Related Trust Funds at the Multilateral Development Banks*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Rogers, Everett M. 1983. *Diffusion of Innovations*. 3rd ed. New York : London: Free Press ; Collier Macmillan.
Skovgaard, Jakob. 2017. "Limiting Costs or Correcting Market Failures? Finance Ministries and Frame Alignment in UN Climate Finance Negotiations." *International Environmental Agreements: Politics, Law and Economics* 17(1): 89–106.
Stadelmann, Martin, Axel Michaelowa, and J. Timmons Roberts. 2013. "Difficulties in Accounting for Private Finance in International Climate Policy." *Climate Policy* 13(6): 718–37.
Stern, Nicholas. 2016. "Climate Change and Central Banks." Presented at the BIS Meeting.
The New Climate Economy. 2014. "Better Growth, Better Climate: The New Climate Economy Report." : 40.
UNEP. 2015. *The Financial System We Need: Aligning the Financial System with Sustainable Development*. United Nations. http://www.un-ilibrary.org/environment-and-climate-change/the-financial-system-we-need_599999aa-en (January 10, 2021).
UNEP Inquiry. 2020. *Nudging the Financial System: A Network Analysis Approach*.
UNFCCC. 1992. "United Nations Framework Convention on Climate Change." : 33.
———. 2014. *Summary and Recommendations by the Standing Committee on Finance on the 2014 Biennial Assessment and Overview of Climate Finance Flows*. United Nations Framework Convention on Climate Change.
Watson, Charlene, and Liane Schalatek. 2020. *The Global Climate Finance Architecture*. Heinrich Boll Stiftung.