Interdependence of global health partnerships: A study of interlocks

Center for Philanthropy Studies, University of Basel

Marybel Perez

Georg von Schnurbein

Theresa Gehringer

Abstract

When a firm sits at the board of two different organizations it is said that the organizations are connected through interlocks. Interlocks may reduce uncertainty by enabling the organization to directly obtain information and resources from its environment which facilitates its adaptation. Here we concentrate on the potential information implications of the interlock structure between 10 global health partnerships on the development of the sector. Through a network analysis of board interlocks we analyze the information flow and quality of two types of global foundations: global coordination and financing foundations such as the Global Alliance for Vaccines and Immunization (GAVI), and product development foundations such as the International AIDS Vaccine Initiative (IAVI). The results show that all the partnerships are connected through interlocks which give have some capacity to disseminate novel information and control its quality. As a result, interlocks could allow for the coordination of the sector.

Keywords

Interlock, network, global health partnership, resource dependence

Introduction

Because of their adaptability and market approach, public-private partnerships have been seen as an effective method to tackle global health challenges and, as a result, have significantly proliferated in the last two decades. Bull, for instance, mentions 300 "Type II multiple stakeholder partnerships that have registered under the UN Commission of Sustainable Development" (2010, p. 224; see also Buse and Harmen, 2004; Martin and Halachmi 2012). Meanwhile, the collaborative character of global partnerships has raised concerns because the partnerships extend control over agenda-setting from governments and international organizations to businesses, the nonprofit sector, and individuals, which are considered non-representative policy actors (Bull, 2010; Eikenberry, 2006; Martin and Halachmi, 2012; Skelcher, 2010). The partnership approach has also been criticized because it fragments the sector, which makes it difficult to contribute to global common goals (Buse and Hawke, 2015; Nishtar, 2004).

The aim of this paper is to examine these two criticisms from the point of view of information networks and focusing on partnership boards. Boards are seen as mechanisms for organizations to mitigate uncertainty and handle external interdependencies (Pfeffer, 1972; Pfeffer and Salanzik, 1978). A board's means for mitigating uncertainty and handling external interdependencies are interlocks (Pfeffer, 1972). Interlocks take place when one individual from firm 1 sits at the board of firm 2 (direct interlocking), or two individuals from firm 1 sit at the boards of firms 2 and 3 (indirect interlocking).

As Pfeffer and Salanzik explained, two of the benefits of managing interorganizational dependencies, through interlocks, for example, are access to "information about the activities that organization which impinge on or affect the focal organization" and to "a channel for communicating information to another organization on which the focal organization depends" (1978, p. 145). Moreover, the relations established between organizations and individuals "serve as channels for persuasion and negotiation, and in these ways also stabilize interdependent relationships" (Pfeffer and Salanzik, 1978, p. 147). Drees and Heugens (2013) showed that interlocks frequently operate as a source of "advice and counsel," and are essential in "providing access to channels of information between organizations" (p. 23).

Consequently, we argue that the information network between partnerships built from interlocks may mitigate uncertainty and strengthen the sector if the network structure allows for innovation and sustainability. For innovation, the network needs to be open to circulate new information, and for sustainability, the network needs to maintain close relations.

Though the structure of the partnership boards has been analyzed in some evaluations (i.e. Brown, 2009; Buse and Takana, 2011), the interconnections between boards as a means for managing information interdependencies has not been considered. This perspective contributes to the study of GH governance by providing a broader picture of boards' structures. From this point of view, members are relevant not only because of the positions they occupy in the board individually, but also because of the network baggage they bring to the board, which makes them helpful to manage information uncertainty and strengthen the development of the GH sector.

The first section explains the role of interlocks in the management of external interdependencies. In contrast to most research on interlocks, we expand their origin from cooptation to constraint absorption and stakeholder representation. This is necessary because we are studying nonprofit partnerships constituted as foundations, and each type of interlock has a different effect on the information network, as is proposed in the second part of the first section. The second section describes the specific partnerships and interlocks studied. GH partnerships have adopted different organizational structures (Bull, 2010; Hodge and Greve, 2007). Here, we look at the interlocks between a group of partnerships in the Global Health (GH) sector (Tables 1 and 2) that have adopted a foundation structure where the board is the main governing body. The third section describes the data and the measures applied for the network analysis. Because we concentrate on information networks, we examine the whole board structure, which includes the board and advisory committees. Section 4 presents the results of the network analysis, which focus on the structure and actor centrality of the networks produced by the interlocks. Sections 5 and 6 present our discussion and conclusions.

1. Explaining partnership interlocks

1.1. Board composition: between cooptation and constraint absorption

Interlocks are usually explained in terms of cooptation, where a resourceful organization or individual—in terms of reputation, skills, information, authority, or financial resources—obtains a seat on the board of an organization, thereby holding decision-making power and insider information, in exchange for part of those resources and support (Pfeffer, 1972). Although members' and organizations' intentions to interlock may vary, as Mizruchi (1996) and Petersen (2016) have summarized, interlocks enable collusion, which means deceptively creating an agreement between

parties to obtain benefit at the expense of other parties. The consequence is that interlocks are studied as a vector of power imbalance (i.e. Carroll and Sapinski, 2011).

Nevertheless, board composition can be the result of constraint absorption, where organizations with mutual dependence create an entity in which they invest some of their resources to pursue a common objective (Casciaro and Piskorski, 2005). Joint ventures are an example of an entity resulting from constraint absorption (Casciaro and Piskorski, 2005; Pfeffer and Nowak, 1976). Representation of joint-venture parents in the board is usually part of the agreement and seen as a "precondition for success" (Petrovic, Kakabadse, and Kakabadse, 2006, p. 346). Collusion practices, such as self-dealing and opportunity conflicts, may also appear in joint ventures, although mutual dependence and interest in joint success tends to mitigate collusion risks (Shishido, 1987; for the partnerships in question see Martin and Halachmi, 2012).

Here, we study partnerships that have been the result of organizations pulling together resources as is usually done with joint ventures. However, there are important differences between joint ventures and public-private partnerships (Skelcher, 2010). First, the partnerships in question are bounded by a non-distribution constraint, meaning parents are not financially affected by the costs and benefits of their decisions. Second, the partnerships, like many nonprofit organizations, have been compelled to a certain extent to include stakeholders on their boards (Brown, 2009; Buse, 2004; Buse and Takana, 2011). Although stakeholders are usually defined as any party having an interest in an organization, these demands emphasize the importance of including individuals and organizations that can represent the beneficiaries. Therefore, board membership responds to more than just constraint absorption. Third, the partnerships may not only depend on the resources of the founders, but also on other kinds of organizations and individuals that become relevant over time. Therefore, the partnerships may extend their boards to include other organizations and individuals with which they build interdependencies.

These differences between parents, co-opts, and beneficiary representatives are important in terms of informational strategy. Parents have a direct interest in the success of a partnership and are a key source for the partnership. As a result, the position they hold in the informational network reveals their capacity to transmit and receive information. Beneficiary representatives also have a direct interest in the success of the partnership and may constitute an important source of information, although in some cases they are less crucial than parents are. Compared with parents, co-opts' interest in partnerships may be varied and unrelated to their success, and for the partnership, co-opts are an additional or alternative source of information, but are usually less central than parents. These different interdependencies are expected to affect the structure of the networks interconnecting the partnerships, as will be explained in the following section.

A word of caution is necessary. We deal with networks that will tend to cluster around partnership boards and committees, and the forces toward clustering may be stronger than the forces toward aggregation. This fact determines the kind of analysis we pursue, since the purpose is to study whether interlocks reduce information uncertainty by specifying how partnership boards may communicate through interlocks and examining the quality of such communications.

1.2. Board composition and the flow of information

The differences in the interdependencies explained above are expected to influence the overall structure of information networks as follows:

First, parents, co-opts, and beneficiary representatives may hold a position at any point of the network, but parents and beneficiary representatives tend to concentrate on the board significantly (which grants authority and duties), while co-opts will tend to concentrate on the committees (which rarely have authority). As a result, it is expected that parents are more central in the networks, and, therefore, are more capable to disseminate or control the flow of information at a higher degree than beneficiary representatives and co-opts.

Second, because of the foundational role of parents and the historical and institutional links between the partnerships (see section 2), it is expected that parent interlocks are denser than co-opts and beneficiary representatives, who embody the specific interdependencies of each partnership. Therefore, if parents tend to concentrate on boards and parent interlocks are denser, it is expected that networks with a core-periphery will form, where board members are central. For decades, research has tested the effect of network shape on stability and information flow, and found that the core-periphery structure tends to be superior for knowledge-transfer and innovation (see Lipparini, Lorenzoni, and Ferriani, 2014). First, a densely connected core guarantees swift information transmission because there are different paths through which information can be transmitted. Second, the connection of the core to a loosely connected or unconnected periphery guarantees that novel information is brought into the network; therefore weaker connections lead to more innovation.

Third, transfer of information is about not only channels, speed, and novelty, but it is also about effectiveness. If we expect that the information is transmitted effectively, then we should expect significant network cohesion. The risk of passing imperfect and even deceitful information through a network is reduced when the networks are cohesive, because there is a higher probability that it may be caught and deceiving members punished (i.e. Reagans and McEvily, 2003).

We will analyze both the direct interlocking networks of members and the indirect interlocking networks of organizations.

2. Partnerships

Two kinds of partnerships have been selected for this study (Tables 1 and 2) (Nishtar, 2004). These have been selected because they follow typical foundation governance, where the board is the main decision-making body.

Table 1. Partnerships for global coordination and financing (CF)

	Global Alliance for Improved Nutrition (GAIN)	**Global Alliance for Vaccines and Immunization (GAVI)**	**The Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM)**	**Nutrition International (NI) (former Micronutrient Initiative)**	**Roll Back Malaria (RBM)**
Year created	2002	2000	2002	1992	1998

Headquarters	Geneva, Switzerland	Geneva, Switzerland	Geneva, Switzerland	Ottawa, Canada	WHO, Geneva, Switzerland

Table 2. Partnerships for product development (PD)

	Drugs for Neglected Diseases Initiative (DNDi)	**International AIDS Vaccine Initiative (IAVI)**	**International Partnership for Microbicides (IPM)**	**Medicines for Malaria Venture (MMV)**	**The Global Alliance for TB Drug Development (TBA)**
Year created	2003	1996	2002	1999	2000
Headquarters	Geneva, Switzerland	New York, USA	Silver Springs, USA	Meyrin, Switzerland	New York, USA

2.1. Partnership parents, co-opts, and beneficiary representatives

Founders are defined in our analysis as parents. Websites and official documents provide information on founders and key partners. For example, the MMV was founded by the Government of Switzerland, UK Department for International Development, the Government of the Netherlands, The World Bank, and the Rockefeller Foundation,[1] the DNDi was founded by the Indian Council of Medical Research of India, Institute Pasteur of France, the Oswaldo Cruz Foundation of Brazil, and the WHO Special Programme for Research and Training in Tropical Diseases, among others. Founders sometimes hold permanent representations on boards, as is the case with the DNDi.[2]

Sometimes the statutes and bylaws of the partnerships establish permanent membership for specific founders and key partners. For instance, article 9 of GAVI statutes grant membership to the WHO, UNICEF, the World Bank, and the Bill and Melinda Gates Foundation, along with five seats for developing country governments;, five seats for donor country governments, and etc. Article 7 of GFATM statutes gives a permanent seat but non-voting rights to the WHO and UNAIDS, among other.

Beneficiary representatives are defined as civil society organizations. For instance, RBM, GAVI, and GFATM establish in their statutes and bylaws that civil society organizations must have permanent representation on their boards.

[1] See: https://www.mmv.org/about-us/our-history

[2] See: https://www.dndi.org/about-dndi/founding-partners/

Finally, all consultants, foundations, firms, research institutions, donor countries, implementing countries, international institutions, partnerships, and any organization that has not been identified as a parent or beneficiary representative are coded as co-opts.

3. Data and the analysis

The following information on members and organizations was collected for the analysis: name of board member, board structure to which the member is affiliated, organization to which the member is affiliated (interlock), and country of organization headquarters. The data was collected from the respective partnership websites in April 2017. Data gaps, such as the organizations to which members are affiliated, were researched on the internet. When no information was found, the item was coded as unknown.

The data was collected as 2-mode data: board member and board organization. The data was separated in two sets: board and board with committees. The 2-mode datasets were then converted into 1-mode datasets (Borgatti, Everett, and Johnson, 2013; Borgatti and Everett, 1997). As a result, we have 1-mode data for individuals and organizations for both boards and boards with committees. The data is undirected and the network measures explained below were calculated in UCINET.[3] The data was valued to give larger value to the nodes connected to boards and smaller value to the nodes connected with committees. This was done because board members meet more frequently (strength of tie) and hold more authority and duty compared to committees. Netdraw images of 2-mode data and 1-mode data are used as an illustration in the results section.

For the network analysis, the components (number of networks) and cohesion (density of connections) are analyzed to identify general trends among the partnerships to create comprehensive or clustered networks. In addition, a Girvan-Newman algorithm is applied to identify whether the clustered characters of the networks exclusively correspond with boards and committees or more complex groups, where different boards and committees are intertwined. Subsequently, a core-periphery analysis is conducted to elucidate the extent and strength of the network core on which the most central members and organizations rely. Finally, the centrality of the members and organizations are determined to identify the most salient nodes.

To examine cohesion, three measures were calculated in UCINET: density, average distance, and fragmentation. Density indicates the number of connections present in the network relative to the total possible number of connections (Wasserman and Faust, 1994); the higher the number, the more cohesive the network. To explain the characteristics of the networks' cohesion, we looked at the average distance, which measures the average shortest path between two nodes, and fragmentation, which measures the proportion of nodes unreachable from each other (Borgatti, Everett, and Johnson, 2013); the larger the average distance, the less centralization, and the smaller the fragmentation, the more inclusive the network. Due to a clustered network, the Girvan-Newman algorithm was applied to understand the overall form of the clusters. As Borgatti, Everett, and Johnson (2013) explain, the algorithm identifies "the structurally important edges whose removal fragments the network" (p. 195). It therefore identifies the point at which the cohesive groups start to disconnect.

[3] For more information on definitions and calculations see Borgatti, Everett & Freeman 2002.

The UCINET continuous core-periphery correlation was applied for the analysis (MINRES algorithm because the diagonals are not relevant) after the matrices were symmetrized. The continuous approach "simultaneously fits a core-periphery model to the data network and estimates the degree of coreness to the core of each actor' (Borgatti, Everett, and Freeman, 2002).

Betweenness and closeness are the centrality measures analyzed. These measures were chosen because they analyze nodes in the context of the network. Betweenness indicates, "what proportion of all the shortest paths from one [node] to the other pass through the focal node" (Borgatti, Everett, and Johnson, 2013). In other words, it identifies the node through which it is necessary to transit to pass information the quickest. As a result, these nodes have an important role in maintaining fluid communication in the network (Wasserman and Faust, 1994). Closeness identifies the nodes with the highest number of close connections (Borgatti, Everett, and Johnson, 2013). Therefore, closeness represents the degree of a node's independence (Prell, 2012; Wasserman and Faust, 1994). As Prell (2012) explains, betweenness calculates "a node's potential control over information flow," while closeness calculates a node's "independence" (p. 107). Normalized closeness scores are reported.

4. Results

4.1. General board characteristics

The board structure of partnerships varies considerably (Table 3). While IAVI and NI do not have advisory committees, the remaining boards have between one (DNDi, GAIN, and RBM) and six (GAVI) committees. Partnerships established in North America tend to have fewer committees (IAVI, NI, and IPM). However, the overall number of committees remains similar in both types of partnerships (10 in PD and 11 in CF).

An overview of the number of nodes (members) of the boards shows that the boards of CF partnerships tend to be larger than those of PD (Table 4). Nevertheless, when advisory committees are included the average number of nodes is larger for PD partnerships than for CF partnerships. This has implications on the network analysis. Have the differences in number of nodes been larger, it would have been necessary to normalize the matrices because large number of nodes concentrated on one type of partnership will significantly increase its likelihood of occupying a central position in the network (Borgatti, Everett and Johnson 2013).

Table 3. Board committees

Product development (PD)					Coordination and financing (CF)				
DNDi	**IAVI**	**IPM**	**MMV**	**TBA**	**GAIN**	**GAVI**	**GFATM**	**NI**	**RBM**
Scientific Advisory Committee		Finance, Audit and Compensation Committee	Access & Product Management Advisory Committee	Scientific Advisory Committee	Partnership Council	Executive Committee	Strategy Committee		Strategic Communications Partner Committee
		Scientific Advisory Board	Expert Scientific Advisory Committee	Stakeholders Association		Programme and Policy Committee	Audit and Finance Committee		Purpose of Advocacy and Resource Mobilization Partner Committee
			Global Safety Board	Access Advisory Committee		Governance Committee	Ethics and Governance Committee		
				Pediatric Advisory Group		Investment Committee			
						Audit and Finance Committee			
						Evaluation Advisory Committee			

Table 4. Number of nodes per partnership

Product development	Number of nodes (Board)	Number of nodes (with committees)	Coordination and financing	Number of nodes (Board)	Number of nodes (with committees)
DNDi	13	32	GAIN	10	15
IAVI	8	8	GAVI	28	52
IPM	11	21	GFATM	26	60
MMV	14	65	NI	12	12
TBA	8	82	RBM	15	31
Total	54	208	**Total**	91	170
Average	10.8	41.6	**Average**	18.2	34
Median	11	32	**Median**	15	31

Table 5 shows the total number of parents and beneficiary representatives in boards and committees. The table shows that about 12% of board and committee members are parents and less than 10% are beneficiary representatives. As a result, the total number of co-opts reaches approximately 78%. A complete list of parents and representatives is presented in the annex.

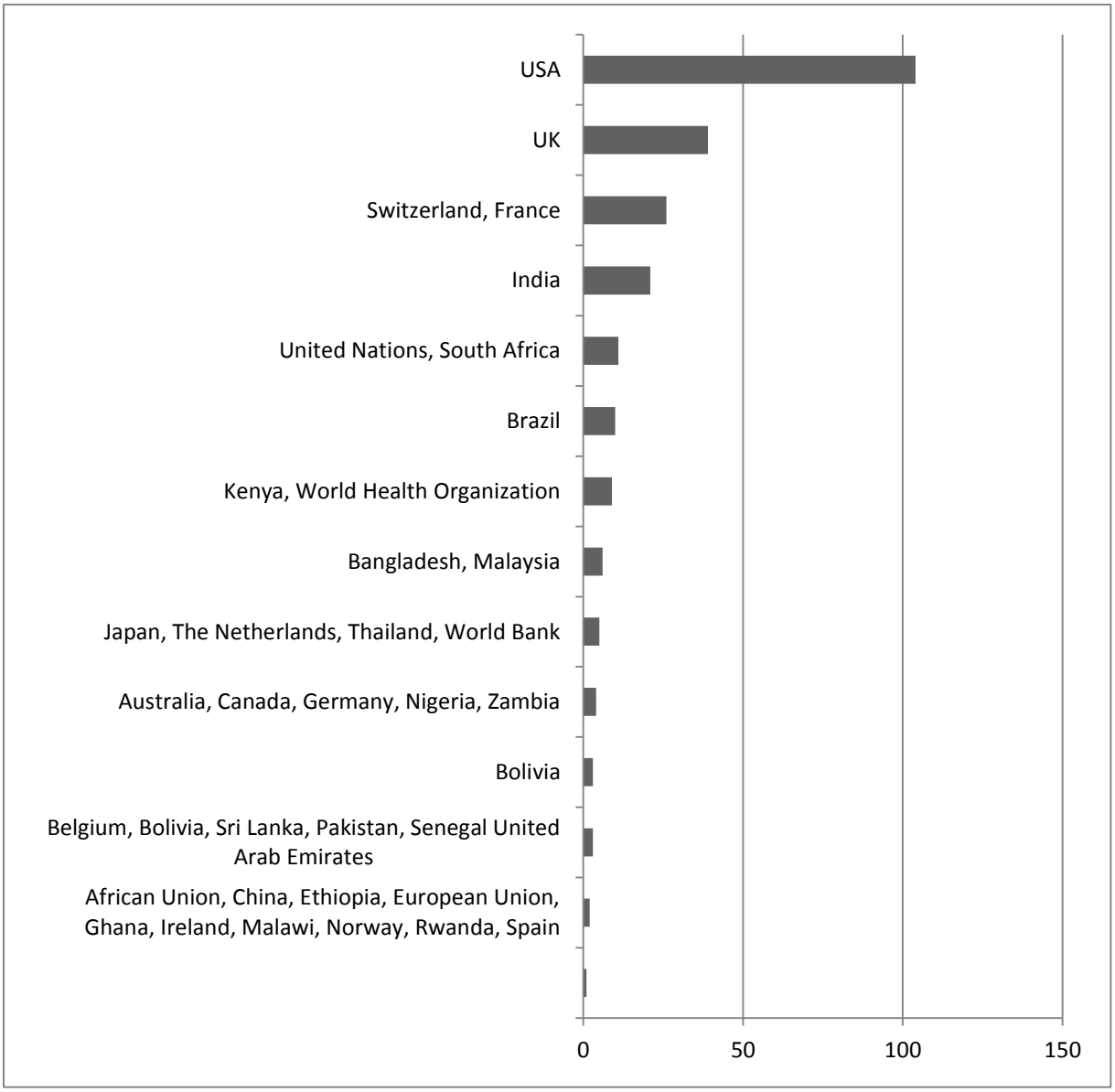
Table 5. Total number of parents and beneficiary representatives in boards and committees

	Parents	Beneficiary Representatives
Members	44	35
Organizations	17	30

The examination of the country of organization headquarters shows that in 52 countries, international organizations and international partnerships are represented through the members (Figure 1).[4] The USA has a significant presence (104 times), followed from afar by the UK (39 times), Switzerland, and France (26 times each). In this regard, except for the TBA, in which 49% of the members represent an organization established in the USA, European partnerships tend to have an average representation of USA organizations of 17%, while North American partnerships tend to have an average representation of USA organizations of 57%. In terms of diversity, this difference is important because North American partnerships tend to have smaller boards and fewer members than European partnerships.

Figure 1. Number of times each country, international organization, or international partnership is represented through a board member

[4] From our data, it is not possible to identify the country of origin of the members; therefore, we focus on the country of the organization with which board members are affiliated to examine how the distribution of countries represented may affect the network.



4.2. Characteristics of the networks

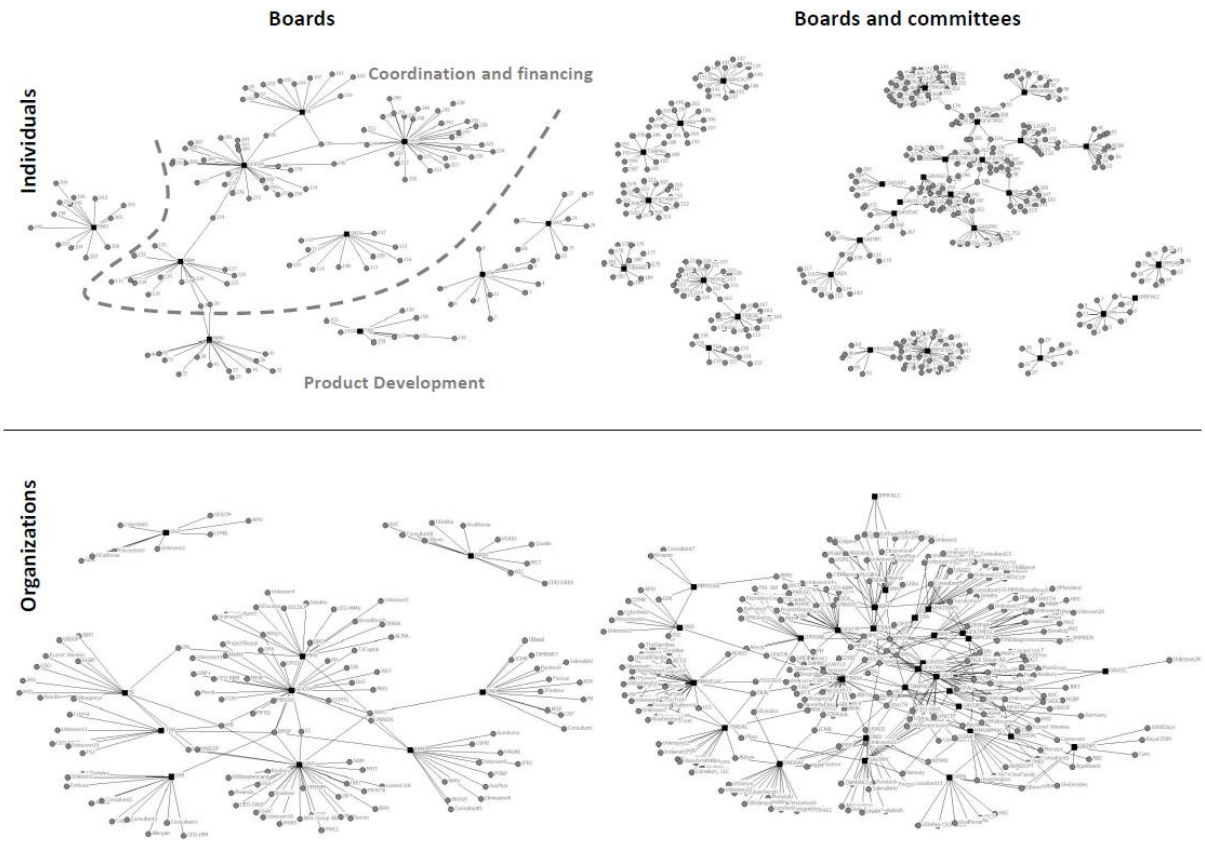
Figure 2 (top left) shows an important tendency of CF partnerships to interlock (top) compared with PD partnerships (bottom). It is significant that the interlocks between five boards create one main component. In fact, the following figures show that the interlocks have an increasing tendency to create one main component rather than two components separated by partnership type.

When committees are added, the main component remains and is extended with GAIN board and several committees (Figure 2, top right). Through the committees, all five CF partnerships are interlocked. Although DNDi shows increasing interlock with TBA through its committees, that is, the Pediatric Advisory Group and the Scientific Advisory Committee, the boards of DNDi, IAVI, IPM, and TBA remain disconnected from the main component.

From the perspective of indirect interlocking (interlocks of organizations), the tendency is also to create a main component. First, when concentrating on board interlocks, it is observed that only IAVI

and GAIN remain outside the main component (Figure 2, bottom left). Second, the network becomes one main component when the committees are added (Figure 2, bottom right). Even though IAVI and GAIN remain in the periphery of the network together with some committees, the boards of both types of partnerships tend to be pushed towards the center of the network, becoming more intertwined.

Figure 2. 2-mode networks of individuals and organizations per board and boards with committees



4.3. Centrality

Betweenness means that when, for instance, Médecins Sans Frontières, a member of DNDi, wants to pass information through the network, the BMGF is the quickest option and the WHO the second quickest option if the BMGF does not want to cooperate. The results show that the number of members whose betweenness is relevant for the network increases when the committees are added (Table 6). Except for the BMGF and the WHO, the results show that the distribution of betweenness among the five highest interlock scores are weakened and the interlocks in the second tier (last five) change significantly when the committees are added.

In the board networks, the five interlocks with the highest betweenness include three parents for the network of members (BMGF, WB, and WHO) and five parents for the network of organizations

(BMGF, WHO, WB, UNICEF, and DFA Canada). In the network of board and committee interlocks, the five interlocks with the highest betweenness only include two parents in the network of members (BMGF and WB) and three in the network of organizations (BMGF, WHO, and WB).

Table 6. Betweenness

	Board	**Board and Committees***
Members	1586.000 (BMGF) 1160.000 (WB) 650.000 (DFID, UK) 444.000 (WHO and CEO-MMV) 250 (DFA, Canada)	9318.400 (Stop TB) 6225.920 (BMGF) 5648.213 (WB) 4626.773 (DFID, UK) 4403.200 (ALMA) 3225.600 (CVD, the Republic of Mali) 3008.853 (GNP+ and MFA, France) 2329.600 (UBS) 1805.653 (Consultant) 1570.133 (EC)
Organizations	2018.878 (BMGF) 1875.878 (WHO) 689.600 (WB) 166.556 (UN)	30511.016 (BMGF) 12492.067 (WHO) 7308.465 (Eli Lilly) 6398.954 (WB)

	133.489 (UNICEF and DFAC)	5696.562 (EC)
	132.000 (EC)	5318.676 (UNICEF)
	94.111 (UNAIDS)	3225.528 (FIOCRUZ)
		3171.209 (JHU)
		2635.604 (MFATN)
		2051.169 (MSF)

*Attribute weighted centrality was applied because regular betweenness measures do not accept valued data.

Closeness means that if UNAIDS (member of RBM and GFATM), for example, seeks to launch an initiative through the studied network, it has enough channels to succeed. In other words, the interlock has a significant number of strong connections. The results show that interlocks with significant closeness results in the boards (the top four) remain significant when the committees are added (Table 7). In contrast with the results of betweenness, the majority or total number of significant closeness interlocks are parents. In addition, some of the interlocks with the highest closeness are also the interlocks with the highest betweenness: BMGF, WHO, and WB.

Table 7. Normalized closeness

	Boards	**Boards and committees**
Members	0.363 (WB) 0.354 (BMGF and DFID, UK) 0.340 (DFA, Canada) 0.332 (22 members of the GFATM board)	0.241 (WB) 0.239 (BMGF and DFID, UK) 0.237 (DFA, Canada) 0.235 (23 members of the GFATM board)
Organizations	0.623 (BMGF) 0.611 (WHO) 0.557 (WB)	0.341 (BMGF) 0.339 (WHO) 0.331 (WB)

0.496 (DFAC, UNAIDS, UNICEF)	0.321 (DFAC, UNAIDS, UNICEF)
0.479 (BHH, CEO-GAVI, CHCR, CVD, I Pasteur, MHCI, MHCS, MHT, MANGroup, NGSGroup, NAM, Roxbury, Rwanda, UBS, UK, UMHSM, USA, University Witwatersrand)	0.318 (BHH, CEO-GAVI, CHRC, CVD, Lazard Ltd., MFATN, MHCI, MHPS, MHT, ManGroup, NAM, NGS Group, Roxbury, Rwanda, Serum, UBS, UK, UMHSM, USA, University Witwatersrand)

4.4. Cohesion and coreness

Low cohesion results reflect the clustered form of the overall networks (see clustering coefficient and density in Table 8). The density of the networks significantly decreases when committees are added. This is because the overall number of node connections remains practically unchanged, while the network expands from 145 connections in boards to 408 connections when committees are added (see Table 5).[5] This is illustrated in the results of fragmentation, which show that the number of unreachable nodes significantly increases when the committees are added, particularly so for indirect interlocks. As a result, the limited possible connections to arrive to a fully connected network drops from 12.5% for members of boards to 3.6% when the committees are added, and from 14.4% for organizations in the board to 2.9% when the committees are added.

Table 8. Cohesion results and clustering coefficients

	Density	Fragmentation	Average distance	Clustering coefficient
			Board	
Members	0.125	0.576	2.116	0.984

[5] Although these signs rightly warn against comparing directly network densities (i.e. Wasserman and Faust, 1994), the overall low cohesion of all four networks remains significant.

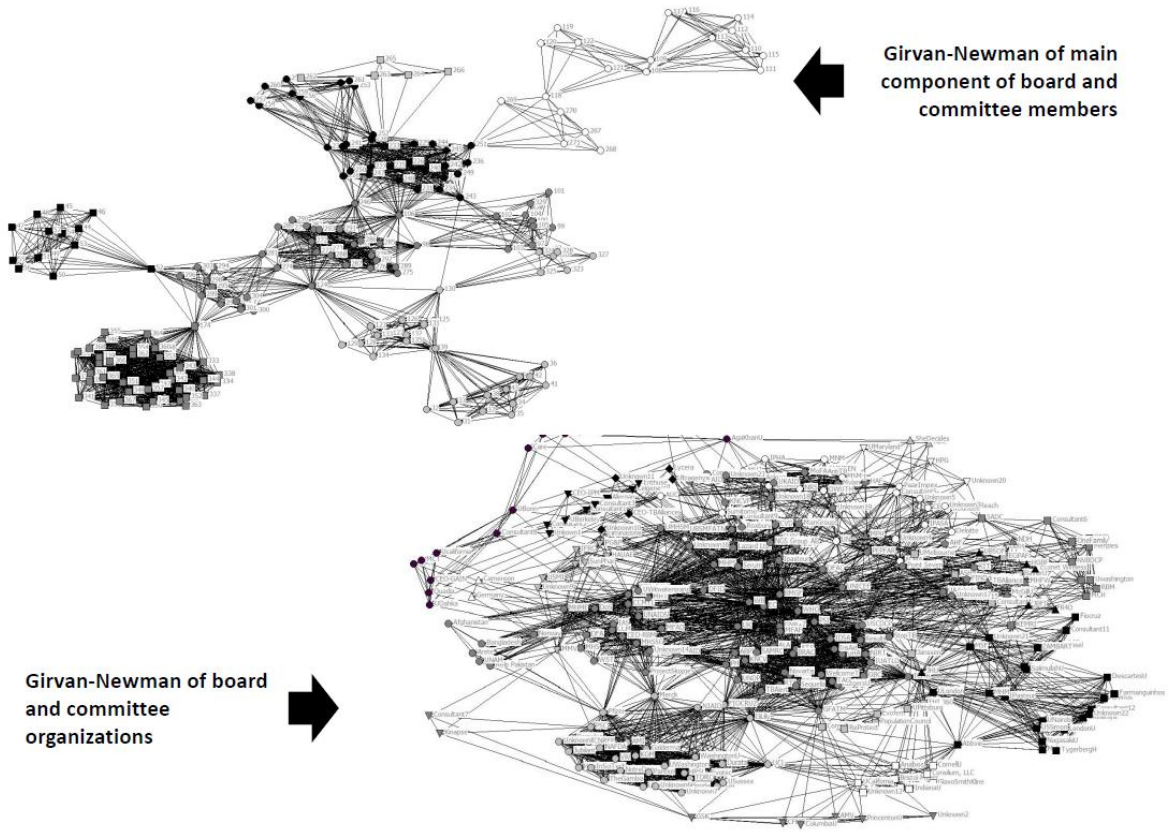
Organizations	0.144	0.267	1.880	1.013
	Board and Committees			
Members	0.036	0.936	1.561	0.987
Organizations	0.029	0.854	1.880	0.952

Being that the network is clustered, it is worth exploring whether the clustering of the network revolves exclusively around boards and committees rather than a mix of them. To this end, we applied the Girvan-Newman algorithm to the main components of the networks of boards and committees. In accordance with a clustered network, the overall results of clustering were high; nevertheless, the results suggest that the optimal groups do not necessarily correspond with boards or committees alone, but instead with mixtures boards and committees (Figure 3). A partition with 7 clusters (Q 0.700) is the most significant clustering for the network of board and committee members; there are 16 boards and committees in this main component (see Figure 3 and Table 9). A partition of 17 clusters (Q 0.600) is the most significant clustering for the network board and committee organizations, with 31 boards and committees. These partitions show large clusters toward the center of the network with a high number of connections, and smaller clusters with a limited number of connections toward the periphery (Table 9).

Table 9. Results of Girvan-Newman of main component of networks of board and committees

Members		**Organizations**	
Partition	**Q**	**Partition**	**Q**
2	0.071	9	0.380
3	0.500	10	0.380
4	0.590	11	0.390
5	0.620	12	0.580
6	0.630	13	0.580
7	**0.700**	14	0.580
8	0.700	15	0.590
9	0.700	16	0.590
10	0.700	**17**	**0.600**
11	0.700	18	0.600
12	0.690	19	0.600
13	0.680	20	0.600
14	0.680	21	0.590
15	0.670	22	0.570
16	0.650	23	0.570

Figure 3. Girvan-Newman networks of boards and committees



Despite the clustering tendency of the network, the results point toward a distinction between a core and a periphery. The distance between the results obtained and the continuous core-periphery model[6] indicate the limited but relevant significance of the core-periphery character of the network (See Ident, Table 10). Additionally, the nDiff results (a centralization measure) show that there is a solid core (Table 10) that consists of 52 nodes for the network of board and committee members and 50 for the network of board and committee organizations. In the member network, only one-fifth of parents and beneficiary representatives are in the core.

Table 10. Core-periphery results for board and committee networks

	nDiff	Ident	Core density	Periphery density	Number of nodes in core
Members	2.809	0.783	0.783	0.265	52
Organizations	1.810	0.651	0.116	0.003	50

[6] "The ideal scores of a one for every core member and a zero for actors in the periphery" (Borgatti, Everett, and Freeman, 2002).

Discussion

The results show there is a small number of parents represented in the boards who are not necessarily positioned at the center even though most of the partnerships are connected through the boards. We expected that parents would be more central in the networks, and, therefore, capable of disseminating or controlling the flow of information at a higher degree than beneficiary representatives and co-opts can. The centrality scores and the core-periphery analysis show that, as a group, neither parents nor beneficiary representatives are located toward the center of the networks in strategic positions to control the flow of information. In contrast with joint ventures, the governance of public-private partnerships is not distributed equally among parents, and other actors are included in the governance structure to mitigate partner opportunism (Rufin and Riviera-Santos, 2012). In the partnerships studied, this trend seems to be sharpened by a broader type of interdependencies: co-opts and beneficiary representatives. Nevertheless, the analyses show that three organizations (BMGF, WHO, and WB), which together are parents of IPM, GFATM, and GAVI, are the most important interlocks in the networks by all centrality measures considered, suggesting that parents play an important role in some cases.

In terms of the kind of information uncertainties these networks may tackle, the results show that innovation is possible, although it faces barriers to the effectiveness of transmission. Innovation is facilitated by a limited core-periphery shape with a core in which boards have relatively dense connections and a periphery in which committees are loosely connected. The barriers to the transmission of novel information come from the low cohesion of the overall network and the tendency of partnership boards and committees to cluster around themselves. However, the clustering tendency helps to effectively transmit specific information, such as implicit information and best practices, within the clusters (QQQQ). This may contribute with the sustainability of the network by helping to pass information between board members, such as when a new member joins the board (QQQQ). Overall, this is a case where both community structure and core-periphery structure are present in one network (Rombach et al., 2014). Nevertheless, the information trade-offs between both structures present at the same time and their effects on the network need further examination.

In terms of network structure, it is significant that the two types of partnerships tend to create a single network rather than two networks, which signals the interdependencies that exist between them. Nevertheless, two underlying factors may weaken the potential information flows explained thus far, culture and geographic distance. As Easterby-Smith et al. explain, studies on knowledge-transfer have shown that culture may affect people's understandings and uses of information, and geographic distance may delay knowledge-transfer (2008). The descriptive statistics indicate that most board members work for occidental organizations, many originating in the USA, which may reduce the barriers pointed out by Easterby-Smith et al. (2008). The network analysis shows that the boards of the partnerships located in the USA tend to remain close to the periphery, while Swiss and Canadian partnerships, such as NI, concentrate in the core. This suggests that partnership boards in the USA may be better at transmitting specific information and worse at innovation compared to the remaining partnerships, which are more diverse and interlocked. Further research should be conducted because culture and geographic distance may be less relevant for these global partnerships due to the development of global elites (i.e. Carroll and Carson, 2003; Heemskerk and Takes, 2016).

One weakness of this analysis is that it only examines the structural properties of the network and does not study the properties of the relations (Borgatti and Cross, 2003). This is due to the difficulty of collecting data on the actual dynamics within boards and committees. An analysis of the properties of the relations would reveal, for instance, who is more capable of transferring information and who is more capable of assimilating the transferred information (i.e. Lipparini, Lorenzoni, and Ferriani, 2014), pointing out the best paths for success in the circulation of information.

Conclusion

The aim of this paper was to examine whether or not the information network between partnerships built from interlocks may help deal with organizational interdependencies and strengthen the sector. The results show that global coordination and financing and product development partnerships tend to be interlocked rather than separated, although some tend to remain in the periphery. This suggests that, although the partnership approach may fragment the sector in some respects, as explained in the introduction, the interlocks may contribute to the circulation of information, which allows for coordination and the identification of innovative strategies for the sector as a result of the core-periphery shape the network tends to adopt.

Nevertheless, this potential has to be measured against the position of different interlock types in the networks. The results show that the largest number of board members and interlocks are co-opts rather than parents or beneficiary representatives, and co-opts include consultants, firms, research institutions, and implementing countries. This suggests that the partnerships in question share patterns of organizational interdependencies, which may be positive for the development of innovative strategies to develop the sector as a whole. However, the risk of collusion, which has fed the concerns of underrepresentation mentioned in the introduction, may be significant. It is important to note, though, that some parents remain the most central actors in the networks. Although there is risk of collusion, parents' mutual dependences with the partnerships and their interests in joint success tend to mitigate the risk. Overall, the paper points to the important role different types of interlocks play in the circulation of information as well as to the importance of considering the degree to which interlocks may facilitate or hinder this process depending on the position they hold in the network. As a result, while this study does not offer a conclusive answer to the question of whether or not interlocks help to innovate and develop the sector as a whole, it does shed light on one of the paths global partnerships could take to tackle some weaknesses.

To date, literature on interlocks, particularly those on global interlocks, tend to concentrate on their potential for the control of power. This aspect, as we pointed out, should not be neglected. Nevertheless, when it comes to nonprofit partnerships, it is important to look beyond this point and consider the effect of different types of interlocks, their potential to mitigate certain forms of uncertainty, and their ability to bridge a fragmented sector that may need to work in a more coordinated manner. This study also contributes to the literature on nonprofit board composition and efficiency by showing that not only are stakeholder representation and skills are relevant in board membership, but network baggage and position may also play a crucial role in tackling interdependencies. Further network research could contribute to our understanding of interdependencies between the kind partnerships studied by looking further into the interlocks to assess their quality and identify patterns of interorganizational dependencies.

References

Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. Ucinet 6 for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Borgatti, S.P. & Everett, M. G.1999. Models of core-periphery structures. *Social Networks*, 21, 375–395.

Borgatti, SP., Everett M.G. and Johnson, J. 2013. *Analyzing Social Networks*. Thousand Oaks: SAGE.

Brown, G. W. 2009. Multisectoralism, Participation, and Stakeholder Effectiveness: Increasing the Role of Nonstate Actors in the Global Fund to Fight AIDS, Tuberculosis, and Malaria. *Global Governance*, 15, 169–177.

Bull, B. 2010. The global elite, public-private partnerships, and multilateral governance. In Jennifer Clapp & Rorden Wilkinson (eds.) *Global Governance, Poverty and Inequality*, pp. 209–234. Abingdon: Routledge.

Buse, K. 2004. Governing Public-Private Infectious Disease Partnerships. *Brown Journal of World Affairs,* 10, 2, 225–242.

Buse, K. & Harmer, A. 2004. Power to the Partners?: The politics of public-private health partnerships. *Development*, 47, 2, 49–56.

Buse, K. & Hawke, S. 2015. Health in the sustainable development goals: ready for a paradigm shift? *Globalization and Health*, 11, 13, 1–8.

Buse, K. & Tanaka, S. 2011. Global Public-Private Health Partnerships: lessons learned from ten years of experience and evaluation. *International Dental Journal*, 61, 2, 2–10.

Carroll, W.K. & Carson, C. 2003. The network of global corporations and elite policy groups: a structure for transnational capitalist class formation? *Global Networks,* 3, 1, 29–57.

Carroll, W.K. & Sapinski J.P. 2011. Corporate Elites and Intercorporate Networks. In J. Scott & P.J. Carrinton (eds.) *The SAGE Handbook of Social Network Analysis* (pp. 180–195). Thousand Oaks: SAGE.

Casciaro, T. & Piskorski, M.J. 2005. Power Imbalance, Mutual Dependence, and Constraint Absorption: A Closer Look at Resource Dependence Theory. *Administrative Science Quarterly*, 50:2, 167–199.

Drees J.M. & Heugens, P. M. A. R. 2013. Synthesizing and Extending Resource Dependence Theory: A Meta-Analysis. *Journal of Management*, 20: 10, 1–33.

Easterby-Smith, M., Lyles M.A. & Tsang, E.W.K. 2008. Inter-Organizational Knowledge Transfer: Current Themes and Future Prospects. *Journal of Management Studies,* 45:4 677–690.

Eikenberry, A. 2006. Philanthropy and Governance. *Administrative Theory & Praxis,* 28, 4, 586–592.

Heemskerk, E.M. & Takes F. W. 2016. The Corporate Elite Community Structure of Global Capitalism. *New Political Economy,* 21, 1, 90–118.

Hodge, G. & Greve, C. 2007. Public–Private Partnerships: An International Performance Review. *Public Administration Review*, 67, 3, 545–558.

Lipparini, A., Lorenzoni, G. & Ferriani, S. 2014. From Core to Periphery and Back: A study on the deliberate shaping of knowledge flows in interfirm dyads and networks. *Strategic Management Journal*, 35: 578–595.

Martin, M. H. & Halachmi, A. 2012. Public-Private Partnerships in Global Health: Addressing Issues of Public Accountability, Risk Management and Governance. *Public Administration Quarterly*, 36, 2, 189–237.

Mizruchi, M.S. 1996. What Do Interlocks Do? An Analysis, Critique, and Assessment of Research on Interlocking Directorates. *Annual Review of Sociology*, 22, 271–298.

Nishtar, S. 2004. Public-private 'partnerships' in health – a global call to action. *Health Research Policy and Systems*, 2:5.

Petersen, V. 2015. Interlocking Directorates in the European Union: An Argument for Their Restriction. *European Business Law Review*, 821–864.

Petrovic, J., Kakabadse A. & Kakabadse, N.K.2006. International joint venture (IJV) directors' contribution to board effectiveness. Learning from the literature. *Management Decision*, 44:3, 346–366.

Pfeffer, J. 1972. Size and Composition of Corporate Boards of Directors: The Organization and its Environment. *Administrative Science Quarterly*, 17: 2, 218–228.

Pfeffer, J. & Nowak, P. 1976. Joint Ventures and Interorganizational Interdependence. *Administrative Science Quarterly*, 21:3, 398–418.

Pfeffer, J. & Salancik, G. 1978. *The External Control of Organizations*. New York: Harper and Row, Publishers.

Prell, C. 2012. *Social Network Analysis. History, Theory and Methodology*. Thousand Oaks: SAGE.

Reagans R & McEvily, B. 2003. Network Structure and Knowledge Transfer: The Effects of Cohesion and Range. *Administrative Science Quarterly*, 48:2, 240–267.

Rufin, C. & Riviera-Santos, M. 2012. Between Commonweal and Competition: Understanding the Governance of Public–Private Partnerships. *Journal of Management*, 38, 5, 1634–1654.

Sammarra, A. & Biggiero L. 2008. Heterogeneity and Specificity of Inter-Firm Knowledge Flows in Innovation Networks. *Journal of Management Studies* 45:4 800–829.

Shishido, Z. 1987. Conflicts of Interest and Fiduciary Duties in the Operation of a Joint Venture, Hastings Law Journal. 39, 63–123.

Skelcher, C. 2010. Governing Partnerships. In G.A Hodge & C Greve (eds.) *International Handbook on Public-Private Partnerships*, pp. 292–304. Cheltenham: Edward Elgar.

Wasserman, S. & Faust, K. 1994. *Social Network Analysis. Methods and Applications*. New York: Cambridge University Press.

Annex 1. List of parents and beneficiary representatives organizations in boards and committees

Organization	Board/Committee	Parent	Beneficiary representative
1000Days	GAINPC	0	1
ALA	TBASA	0	1
AntiTB	GFATMAFC	0	1
ASHA	TBAPAG	0	1
ATS	TBASA	0	1
BMGF	IPM	1	0
BMGF	IPMSAB	1	0
BMGF	GFATM	1	0
BMGF	GFATMSC	1	0
BMGF	GFATMAFC	1	0
BMGF	GAVI	1	0
BMGF	GAVIGC	1	0
BMZ	GFATM	1	0
BMZ	GFATMSC	1	0
BRAC	TBASA	0	1
Care	GAINPC	0	1
CCM	GFATM	0	1
CCMTL	GFATM	0	1
CGD	NI	0	1
DFAC	NI	1	0
DFID	GFATM	1	0
DoS	GFATM	1	0
FHI 360	IPMSAB	0	1
Fiocruz	DNDi	1	0
GBC	TBASA	0	1
GHA	TBASA	0	1
GNP+	GFATM	0	1
GNP+	GFATMSC	0	1
Help Pakistan	GAVIPPC	0	1
IAS	GFATM	0	1
ICMR	DNDi	1	0

ICMR	DNDiSAC	1	0
IPasteur	DNDi	1	0
IPasteur	DNDiSAC	1	0
MFAF	GFATM	1	0
MFAF	GFATMSC	1	0
MHM	DNDi	1	0
MHM	DNDiSAC	1	0
MSF	DNDi	1	0
MSF	DNDiSAC	1	0
OneFamily	MMVAPMAC	0	1
PATH	MMVAPMAC	0	1
PEPFAR	GFATMSC	1	0
PEPFAR	GFATMAFC	1	0
PEPFAR	GFATMEGC	1	0
PH	TBASA	0	1
PH	GFATM	0	1
ProjectSkopje	GFATM	0	1
PSI	TBA	0	1
PSI	TBASA	0	1
PSI	TBAPAG	0	1
R4D	NI	0	1
RBPT	TBASA	0	1
Results	NI	0	1
Results	TBASA	0	1
RTI	TBASA	0	1
SheDecides	GAVIEAC	0	1
TAG	TBASA	0	1
TBAlert	TBASA	0	1
UKAID	GFATMAFC	1	0
UNAIDS	GFATM	1	0
UNICEF	NI	1	0
UNICEF	GAVI	1	0
UNICEF	GAVIPPC	1	0
UNICEF	GAVIEAC	1	0
UNITAID	GFATMAFC	0	1

WB	NI	1	0
WB	GFATM	1	0
WB	GFATMAFC	1	0
WB	GAVI	1	0
WB	GAVIAFC	1	0
WHO	RBM	1	0
WHO	RBM	1	0
WHO	DNDi	1	0
WHO	GFATM	1	0
WHO	GFATMSC	1	0
WHO	GAVI	1	0
WHO	GAVIGC	1	0
WST	GFATM	0	1
Total		**44**	**35**