Network Analysis of Private Water Companies: Challenges, Collaborations, and Competition

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DECLARATION

I certify that the work contained in this thesis, or any part of it, has not been accepted in substance for any previous degree awarded to me, and is not concurrently being submitted for any degree other than that of Doctor of Philosophy being studied at the University of Greenwich. I also declare that this work is the result of my own investigations, except where otherwise identified by references and that the contents are not the outcome of any form of research misconduct.

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ABSTRACT

This thesis consists of four papers, which together address questions about the private participation in the water sector since early 1950s. Water sector, as an essential infrastructure sector, has been the topic of extant research, and private participation in this sector has also attracted a lot of attention among scholars and policy makers. Many studies in the existing literature focus on cases of private companies' involvement in the sector (for example, in specific regions or countries), while others discuss trends based on available data. This work attempts to build a multi-disciplinary framework in order to look at private participation in the sector from various aspects, including the overall trends of governments and companies' tendencies to work together on water projects, and companies' collaboration in projects. By investigating collaborations, some insight into competition between entities involved is also obtained. To achieve the goal for this study, World Bank database on Private Participation in Infrastructure (PPI), and Orbis database on companies' parent-subsidiary information (used for Veolia Environnement S.A. and Suez S.A.) are used. Various descriptive and statistical methods are then used to analyse the data, including Social Network Analysis (SNA) measures and metrics, Multiple Correspondence Analysis (MCA), and General Method of Moments (GMM).

The first paper attempts to provide a wholistic view of the associated literature, while the second paper and third paper focus on the World Bank PPI data and its analysis. The inspiration behind paper three is the studies by Gulati on formation of strategic alliances, specially "Where do interorganizational networks come from?" (Gulati & Gargiulo, 1999). The last paper discussed two multinational companies, Veolia Environnement S.A. and Suez S.A, which are known for the scope of their activities in the water sector. The results of analysis and the insight gained from this study have been discussed with close attention being paid to the specificities of the water sector. The descriptive analyses carried out in paper 2 document the extent, scope, and timeline of public-private partnerships in the water sector throughout the developing world, over almost 7 decades. The analyses show how commercial enterprises – both local/national and multinational – have seized the opportunities opened by privatisation policies in different national contexts. This chapter shows very clearly that water services are an international economic sector: if services are to be provided at infra-national level, providers are often positioned at supra-national level, and often operate in multiple national contexts simultaneously. The results of paper 3 suggest that there is an effect of the

global structure of public-private partnerships on each new partnership that is created; one of the interesting findings is that the more private companies had collaborated in projects with public entities, the more they did again in consequent years. It is for this reason that the case-study approach misses some important explanatory factors, and it is for this reason that my approach contributes to the existing knowledge. I also find that local factors matter, as seen in the case of China, and that dyad-level factors matter too, such as geographical proximity and similarity between a government and a private company. These results suggest that despite its elements of novelty, my research is still consistent with what previous literature has found. In the fourth paper, it is found that the two prominent environmental services companies, Veolia Environnement and Suez, follow different foreign penetration strategies, and through blockmodeling it is suggested that interaction between subsidiaries of the two firms is more or less between those in higher income countries. The analysis of these two companies, with specific attention paid to how their subsidiaries operate on a global level are discussed in view of the OLI paradigm, and reveals interesting insights which are useful for strategy decision making and policy implementations when it comes to private companies' involvement in the water sector.

CONTENTS

TABLES

FIGURES

List of Abbreviations and Acronyms

Abbreviation/Acronym	Name
ADB	Asian Development Bank
AFDB	African Development Bank
BCIE (also known as CABEI)	Central American Bank for Economic
CAF	Development Bank of Latin America
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
EU	European Union
GATS	General Agreement on Trade in Services
GDP	Gross Domestic Product
IADB	Inter-American Development Bank
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IDB	Islamic Development Bank
IFC	International Finance Corporation
IMF	International Monetary Fund
MIGA	Multilateral Investment Guarantee Agency
NADB	North American Development Bank
OECD	Organisation for Economic Co-operation and Development
UNECE	United Nations Economic Commission for Europe

Introduction

Water Infrastructures and Public-Private Partnerships

The last few decades have seen renewed scholarly engagement with the study of infrastructure systems (Edwards et al., 2009), broadly defined as basic services to industry and households (Martini & Lee, 1996). According to Edwards (2010: 8) infrastructures "are reliable, standardized, and widely accessible, at least within a community. For us, infrastructures reside in a naturalized background." They are typically taken for granted, so much so that it is only when they fail that they get noticed and invite deliberate action by users (Graham, 2010). If infrastructures are widely agreed to constitute a key input into the economy (Threadgold, 1996), they equally shape subjectivities and social life.

In particular, water infrastructures, including sewerage, waste water treatment and water supply, have recently attracted the attention of researchers interested in the social and economic effects of the ways in which water is collected, processed, channelled and distributed. Especially geographers and anthropologists have documented how the biophysical properties of water, the layout of canals and dams, the design of meters and pipes shape social spaces, reorganize relationships, and redistribute resources between people and groups (Anand, 2015; Jensen & Morita, 2015; Barnes, 2014; Meehan, 2014; Barnes & Alatout, 2012; Carse, 2012; Pritchard, 2011; Linton, 2010; McFarlane & Rutherford, 2008; Bijker, 2007; Bakker & Bridge, 2006; Braun, 2005).

Beyond the very materiality of the water infrastructure, the literature insists on all infrastructures being socio-technical in nature, in that their physical and technological bases are embedded in socio-economic contexts and require some form of organized structure – shared knowledge and common practices – to function (Edwards, 2002). Hence Jackson et al. (2007, cited in Edwards et al.,2009: 369) oppose the idea that infrastructures can be "built," at least in the usual sense of "deliberately designed and constructed to a plan", and they embrace instead the metaphor of "growing" an infrastructure, to capture the sense of an organic unfolding within an existing (and changing) environment.

In this thesis, I follow and extend this line of thought by studying the economic and political environment in which the water infrastructure "grows" – that is, is affected by it and in turn affects its development. Because water is a key sector with major repercussions on health, the natural environment, and the economy – so much so that it is sometimes construed to be a basic "human right", public ownership and control of water infrastructures are the norm in most countries (Hall & Lobina, 2006b). Yet some private water companies saw the light as early as the nineteenth century, notably the French giants Veolia Environnement and Suez; and in the last few decades, many governments especially in the developing and emerging world have sought the involvement of the private sector. I thus focus on the range of Private Participation in Infrastructure (PPI), in the form of concessions, and contracts among others, that ensure the development and management of water service infrastructures. Such contracts sometimes delegate to commercial companies only specific activities such as billing, maintenance and meter reading, over short periods of 1-3 years; more often, they involve complex service delivery arrangements whereby the private sector takes responsibility for the construction and operation of water facilities, in long-term relationships of up to 25-30 years (Cooper, 2003).

It is to satisfy their resource needs that public authorities enter projects with private-sector providers. In developing countries, where over a billion people lack access to drinking water and twice as many have no basic sanitation, developing the infrastructure constitutes a colossal task. Even industrial countries face major needs to replace aging infrastructure and comply with more stringent safety standards, while having to cope with shrinking public budgets (OECD, 2009). Against these challenges, contracts with private companies appear as a framework for the coordination of activities and the sharing of knowledge or resources to pursue joint objectives (Scott & Davis, 2007). They fit Williamson's definition of "hybrid governance" (1975), referring to governance solutions between markets and hierarchies, or Lazega and Mounier's notion of "joint governance" (2003), pertaining to the participation of private actors to public decision-making.

The choice of contracting out to private-sector companies is related to the history of privatisation and the alternating support it has enjoyed in policy circles, nationally and internationally. Privatisation and PPIs became increasingly popular in the 1980s, culminating in doubling the private share of the entire water sector in England and Wales in 1989, under the Thatcher government. Other governments followed suit and in the 1990s, international institutions such as the World Bank strongly supported water privatisation in developing, transition and emerging countries. The trend toward more private-sector involvement has not been linear, though, as past experiences have often been disappointing, not least because the anticipated investments and efficiency gains failed to materialize. What is more, concerns about fair and sustainable access to water have been at the heart of lively societal debates that have sometimes sharply polarised public opinion between supporters and opponents. Today, only a small fraction of water infrastructures worldwide is managed through PPIs, the great majority being fully under public control. In some cases, there has been a return to public service after an experience with private companies (Kishimoto et al., 2014). In this context, even policy-makers who favour privatisation and private involvement recognise the need for more appropriate institutional and regulatory frameworks (OECD, 2009).

Resource dependence theory (Pfeffer & Salancik, 1978) provides some clues as to the reasons why projects in the sector have not always been successful. Under these projects, both partners maintain a high degree of autonomy, leading to potential misalignments and risk of exposure to opportunistic behaviour (Gulati & Singh, 1998; Gulati, 1995a). Such risks are magnified in the water sector due to its natural monopoly characteristics stemming from high fixed costs, and the presence of externalities (for example on health, as mentioned above). Further, long-term relationships entail a high risk of dependence as the government gradually loses its capacity to provide the service directly (Cooper, 2003). Sometimes, such vulnerabilities are near-symmetrical, the private partner becoming entirely reliant on public funding (Malatesta & Smith, 2014); but they may give rise to power imbalances, most prominently when the private partner is a resource-rich large company and the government represents a low-income or developing country.

The Global Water Network

The literature on interorganisational relationships provides myriad examples of organisations that enter partnerships to pursue some mutual interest while remaining independent and autonomous (Cropper et al., 2010). Commitment to an external problem or opportunity is a major reason why interorganisational relationships emerge (Van de Ven, 1976). In particular, the formation of strategic alliances between firms is a way for them to gain the ability to manage uncertainties beyond their control, and to create enduring commitments, by combining resources through exchange, sharing, and co-development (Gulati & Gargiulo, 1999). If this theoretical framework has mostly been applied to the study of partnerships within the private sector so far, it can be extended to the water sector where commercial companies partner not only with other companies but also, to an extent, with public bodies.

To capture the intricacies of the public-private contractual solution for water infrastructure management, it is important to take a systemic view, considering that the environment in which these infrastructures unfold is a globalised one. Although the biophysical properties of water require delivery services and infrastructure to be implemented at sub-national (typically, municipal) level, policy decision-making is rarely confined to the local level, and often involves national governments and even international institutions such as the World Bank. On the private sector side, players are both local and non-local – including multinational companies, public companies operating abroad as private participants in competitive bidding, and industrial conglomerates seeking to diversify. In order to analyse the sector in a more systematic manner, I make use of a network framework, studying a global web of public-private water projects regardless of location and country of origin. It can be represented as a network of formal (contractual) ties between the actors involved, be they public authorities or private companies.

Looking at water infrastructure projects as a network enables a fine analysis of the dependencies they generate. It is only recently that network-analysis approaches, already successfully applied to settings where units are humans and relationships are informal (for example advice ties between employees of an organisation), have been extended to studies of formal (often, contractual) relationships between organised collectivities, for example trade flows between countries (De Benedictis et al., 2014; Smith, 2017). By considering the interdependencies generated as a result of carrying out water projects among governments and private companies, and implementing the notion of 'network', I am able to investigate how relationships can influence collaboration among entities involved other than pairs in direct contact with each other. For instance, by taking a network approach it is possible to investigate whether a company that is chosen by many governments to perform water services, is more likely to be chosen as a partner by another government than a competitor with no such prior involvement; this is a way in which the structure of interdependencies affects the decision of a company and a government to partner. By looking at cases, or considering only dyads, as in those entities directly involved, this level of analysis would not be possible. Hence the merits of using a network approach is rather evident considering the aim of this study, which plans to go beyond cases and investigates interdependencies.

In this thesis, I adopt this approach by using two different implementations of the network metaphor. In the first one, the network represents a set of dyads of government G_i and company C_j, in which the monads G_i and C_j matter as much as the relationship between them, measured as the number of ongoing water-related PPI projects that they share. What is more, the relation between G_i and C_j is not analysed in isolation, but accounting for the effect of, say, government G_k and company C_l on it. Put differently, the extent to which G_i contracts out water infrastructure-related tasks to company C_j cannot be considered independent from the fact that, for example, G_i also has water projects with company C_l, while C_j is also engaged in projects with a foreign government G_k. By accounting for such interdependences, I uncover how the structure of collaboration defined by projects between the public and the private sectors indirectly generates a structure of competition within the private sector (as companies compete for the same governments) and within the public sector (as governments compete for the same contractors).

In this perspective, I look at how governments and companies willing to enter a water-related contractual arrangement determine with whom to enter such an arrangement. If the government's decision to contract out part of the water infrastructure depends on the above-mentioned factors that previous research has already singled out – costs, demands, pressure from international institutions, political climate – the question remains open as to with whom to do so. Similarly, a private company which is prepared to bid for a water project, may choose to do so with different public authorities – locally or non-locally, at home or abroad. In both cases, obtaining information about the competencies, needs, and reliability of potential partners is a major challenge.

Along the same lines, I also build a network from the set of dyads whose members C_j and C_h are companies that form alliances to co-manage water-related PPI projects: ties between them are the number of ongoing projects in which they are both involved, whether for one or more governments. Technically, the main difference between the government G_i - company C_j network and the company C_j - company C_h one, is that the former consists of two distinct sets of actors, with ties between but not within sets ("two-mode" network in social network analysis terminology) while the latter only involves actors of the same type ("one-mode").

The case of PPI projects being awarded to consortia, or alliances, of companies instead of just one company, is not the most common; but when alliances do exist, they reveal highly relevant information as to the resources companies share, their complementarities, and the strategic thinking informing collaborative arrangements in a world of otherwise fierce competition. In particular, alliances between multinational and local companies are an important mode of entry into a foreign market in a global business environment.

With these networks, the questions I address are inspired by the problem looked at by Gulati and Gargiulo (1999) for the study of interorganisational alliances: How do organisations (both public and private) find cues that help them select potential partners? And how do these cues shape the formation of ties?

The other implementation of the network metaphor that I use is an "ego-network" that starting from a focal actor ("ego"), reconstitutes the whole set of its ties to others ("alter"). Here, I focus on two particular egos, Veolia Environnement and Suez, two historical French companies that have long dominated the globalised private water sector, and for each of them, I reconstitute the network of subsidiaries (and subsidiaries of subsidiaries, up to the tenth level) that they own, partly or fully, worldwide. For this part of the study, I follow the trend of research initiated by Bartlett & Ghoshal (1989; 1986) that sees multinational enterprises as highly decentralised structures, where subsidiaries play differentiated roles and even have large margins of decisional independence. Mapping the network that they form through ownership ties is a way to capture the multiple channels through which information and resources are shared between the different parties involved, and relationships are managed and monitored. Ownership ties can thus be taken as a proxy for a wider range of interactions – partly informal or non-observable. With this network, I aim to get more insight into the operations and strategies of major multinational companies and the competitive advantage they have created and enjoy, in light of the "Eclectic Paradigm" (Dunning, 1981).

Structure of the Thesis

This thesis is a collection of interrelated papers to address a set of varying research questions and topics that aim to better discuss features of the sector. To carry out this study with the main objective set out above, it is necessary to understand the sector, and the nature of Public Participation in Infrastructure (PPI) and the issues associated to them. Also, the data used needs to be thoroughly explored to get a comprehensive insight into its different dimensions and how they can be used in the analysis. Hence this study is structured as follows:

- Paper 1 reviews the literature on infrastructure industries, PPI, types of PPI, issues associated to PPI, interorganisational relationships and examples in the infrastructure industries, and brief notes about collaboration and competition behaviours. The aim of this paper is to provide a general theoretical understanding of all topics included in this research.

- Paper 2 focuses on the dataset used for analysis in paper 3, which forms the most crucial part of this thesis. In this paper, different aspects of the data are descriptively discussed, using visual tools, Social Network Analysis (SNA), and Multiple Correspondence Analysis (MCA). Specific attention is paid to highlight trends in line with the literature discussed in paper 1.
- Paper 3 is by itself an independent study, and at the same time integrated in the overall structure of this thesis. It addresses the question of how governments and private companies form strategic alliances in order to carry out water projects. A comprehensive literature review, followed by hypotheses provide the theoretical framework of this study. The specifics of the dataset constructed for this paper are explained and general method of moments (GMM) is used to analyse the data. The discussion attempts to link the findings to what we already know about the sector and provide a more global understanding, something that is missing in the previous studies.
- Paper 4 looks at the two cases of Veolia Environnement and Suez, two multinational companies which has been very important actors in the private water sector for decades.

The different papers are all related to each other in terms of the main subject they study and investigate; they all either discuss or analyse private participation in the water sector and they all use interorganisational relationships and more generally international business concepts to assist with the understanding of the nature of relationships and activities among governments and private companies. Papers 1 and 2 set the stage for what follows; paper 3 builds on paper 1 and especially on paper 2; paper 4 offers a different perspective, as it ‘zooms in’ into two widely-known companies that both the literature, as seen in paper 1, and the analysis of paper 3 indicate as very prominent.

The main objectives of the study can be summarised as follows:

- To document the global patterns of collaboration among private companies and governments involved in water-related projects and to represent them as a graph.
- To understand how private companies and governments select each other from among competitors to carry out water-related projects, once the political decision to form public-private partnerships has been made.

- To investigate the global penetration strategies and worldwide operations of two prominent actors in the sector, Veolia Environnement and Suez, as revealed by their parent-subsidiary networks.

It should be noted here that, for the purpose of this study, secondary data is collected and analysed, in different sections. I exploit the extraordinarily rich data assets made available by the World Bank, which has quasi-exhaustively recorded water-related private-public projects for several decades in all the countries in which it has, or has had, active programmes; as will be discussed in more detail later (paper 2), this source covers all low-and middle-income countries between the late 1940s and today. In this way, I am able to achieve my objective to retrace the global structure of interdependencies that shapes the private water sector in a large part of the world – documenting, among other things, the penetration of multinationals from the Western world into developing countries that were opening up their water sectors as a result of privatisation policies sponsored by major international institutions (including the World Bank itself). To get some additional insight on higher-income countries (whose privatisation policies have been more diverse as explained in paper 1) and to more finely detail the operations of the two major multinational companies I focus on in paper 4 (Veolia and Suez), I also use commercial and financial data from the Orbis dataset, a well-known provider of high-quality business information.

While rich and highly informative, these databases were not originally collected for research purposes and required substantial work to be useable. Especially the World Bank data suffered from occasional incompleteness and presented some inaccuracies that I needed to correct by hand, using a variety of more disparate and less systematic sources, such as the websites and annual reports of companies as well as the Pinsent Masons Water Yearbooks archives (discussed below). Also, the original sources included information that did not specifically pertain to water services, but to germane sectors: for the sake of focus, I therefore had to select solely the sections of the data that I deemed to be within the scope of this research. After data cleaning, coding and documentation required significant time and effort. The result is a more genuinely research-oriented dataset, which to the best of my knowledge is the first to extensively document private sector participation in the water sector worldwide. This dataset is per se an output of this research; as a future perspective, I plan to make it available to other researchers for further studies.

The richness of the dataset constructed in this way, its good fit with the purposes of my project, and the considerable amount of time involved in data preparation, advised against conducting further attempts to gather data of different nature (notably through some form of fieldwork, interviews or surveys). Such forms of data collection would have been time-consuming, but not essential to my purposes; I do consider them, though, for a future follow-up study.

Overall, it can be said that the nature of the data I use in this thesis is somehow primary as well as secondary. The raw data is secondary to the extent that it was collected for purposes other than research but the final datasets, that I have retrieved, cleaned, and integrated has been purposefully put together for the research and in this definite sense, it is closer to a primary dataset.

Before proceeding to paper 1, I am going to give a brief explanation of how this study has evolved from the start. It has been a long journey, in which many aspects of the initial proposal needed be rethought of. I came across the two companies, Veolia and Environnement and Suez, while studying Environmental Engineering. The two companies have been pioneers of provision of environmental services and I found their scope of business very interesting. I did my MA International Business dissertation on network analysis of the parent-subsidiary networks of the two companies, considering all sectors they were operating in, including but not restricted to water and wastewater. This was the first step to consider doing a PhD but with a focus on the companies' involvement in the water sector. But through investigating their cases and discussions with my supervisors, two of them member of Public Services International Research Unit (PSIRU), I decided to expand the scope and investigate the private sector as a whole and identify patterns of collaboration and possible competition. I explored different relevant data, namely the dataset compiled by PSIRU, as well as Water Yearbooks, and World Bank database of Private Participation in Infrastructure (PPI). Ultimately, it was decided to focus on the World Bank database, which provides rich information on PPI project in the water sector and reports different characteristics of the entities involved as well as the nature of projects. The initial steps taken to get to this point have formed the basis for this thesis. Hence, the outcome of these steps has been included in papers 1, and 4. Papers 2 and 3 are more interlinked with each other, and constitute the core of this thesis.

Paper 1- Private Participation in the Water Sector: Debates, Alliances, and Competition

1. Introduction

In the previous section, the themes of this study have been introduced and the aims and objectives were set out. It is evident that this work is of a multi-disciplinary nature, hence I find it necessary to dedicate the first part to reviewing the associated literature. What comes in the next papers, is the investigation of private participation in an infrastructure sector, water sector, considering the relationships involved between the entities as alliances, a form of interorganisational relationship. Therefore, in this part, first a brief explanations of infrastructure industries are given, then the literature on private participation in the water sector is reviewed, and finally the previous studies on interorganisational relationships, and some on collaboration in infrastructure industries and water sector are discussed.

The participation of the private sector in utility industries is closely related to how competition has evolved in associated sectors. If we look at the post-war period, we find that state ownership, vertical integration and monopoly were dominant features in the utility industries. Monopoly, specifically, was considered essential for preventing destructive competition in the market as was seen in the 1920s and 1930s. In 1980s, as will be discussed in the following sections, state ownership was abandoned, as a result of economic pressure on states for providing services, and as privatisation moves started to get under way, the merits of monopoly were questioned and the possibility of introducing competition into the market was considered.

2. Infrastructure Industries

There is no straightforward way of defining infrastructure. As mentioned in the Introduction, according to the literature, infrastructure provides "basic services to industry and households" (Martini & Lee, 1996), "key inputs into the economy" (Threadgold, 1996), and "a crucial input to economic activity and growth" (Department of Foreign Affairs Canberra, 1998), although the terms "basic", "key" and "crucial" can have different meaning based on the country and the period of time; for example, steel production was thought to be an infrastructure at some point in history. Generally, activities that relate to infrastructure include: energy (power generation, distribution, transmission, and supply), transport (roads, rail systems, bridges, and tunnels, etc.), water (sewerage, waste water treatment and water supply), telecommunications (telephones, WiFi, WiMaxm, Broadband, GSM, CDMA, etc.), and social infrastructure (hospitals, prisons, courts, museums, schools, and Government accommodation) (Grimsey & Lewis, 2002).

Investments in these infrastructures as well as some other types of fixed investments, such as office construction and property development, exhibit some specific characteristics (Adam, 1996; Dixit & Pindyck, 1994; Lewis, 1994): duration (infrastructure is long-lived with a long maturation period), illiquidity (the lumpiness and indivisibility of infrastructure projects makes for a limited secondary market), capital intensity (projects are large scale and highly geared), and valuation (projects are difficult to value because of taxation and pricing rules and embedded options and guarantees with market-based pricing not being applicable).

The common practice used to be that infrastructure had to be provided by government-owned enterprises; this was mainly done in Europe; or by regulated privately owned utilities; which was the approach in the United States. These approaches were followed because of some specific features found in infrastructure services, such as the existence of: "network services providing integrative activities that connect economic activity together; public goods, from which it is difficult (and perhaps not desirable) to exclude non-payers (the non-excludability principle); externalities, whereby benefits and costs are conferred upon those that are not a party to the transaction (e.g. spillovers); and natural monopolies, for which scale economies make it efficient to have only one provider (for example, of an electricity grid)" (Grimsey & Lewis, 2002: 108). I will expand more on these specific points later; for now, it suffices to say that improvements in these infrastructure industries are linked to enhancements in economic performance and poverty reduction specifically in developing countries.

In practice, public and private sectors are both involved in the provision of these services, although the degree of their involvement varies in different countries and different periods of time. Today, many policy makers and experts believe that governments should no longer engage in telecommunication and electricity sectors while the role of governments in providing water services is still the subject of extensive public debates. Likewise, the correct role of private sector in provision of water has been extensively debated in the scientific literature since 1980s.

Having briefly discussed the infrastructure industries, I move on to the specific sector of interest for this work, the water sector. The debates mentioned in this section, both within academia and in the public arena, are at the heart of the following part, section 3, where different aspects of private participation in the water sector are discussed. It is essential to emphasise that the literature on private water sector is not only extensive but comes from variety of resources that are either written by scholars or policy makers, advisors, think-tanks, industry bodies, and civil society organisations. Here, it has been tried to bring the different together and achieve a holistic review of the literature.

3. Private Participation in the Water Sector

Private participation in infrastructure (PPI), as the name suggests, refers to involvement of private sector in the delivery and financing of infrastructure services. Broadly speaking, the terms private sector participation (PSP) and public private partnership (PPP) also refer to the same thing. The World Bank initially suggested the terms to portray involvement of private sector which may be different from full privatisation; in a full privatisation, the public sector permanently sells the assets to a private investor. It is worth mentioning here that PPPs now tend to refer to concession contracts which include finance for capital investment, with the returns coming either (a) through consumer payments for a service (the classic concession), or (b) through regular payments by government. In either case, the deal usually lasts 25 years or so to enable the private firms to recoup all their capital, as well as profit, and the infrastructure is thenceforth the property of the government.

Much of the research on water privatisation is based on case studies (for example, Clarke et al, 2004; Bakker, 2003; Kerf, 1999; Triche, 1990) and there is still little knowledge about global patterns. One project which took an international approach and was done between 2001 and 2004, was the PRINWASS projects that critically examined different types of private sector involvement in the water sector in Argentina, Bolivia, Brazil, Kenya, Mexico, and Tanzania, as well as including some studies from Finland, Greece, and the United Kingdom for comparison [1]. Public Service International Research Unit does also provide studies on sectorial analyses, which tend to be in larger scales than case studies (for example, Lobina, 2017; Hall & Lobina 2008; 2006a; 2005). Some studies have been done by international institutions which have been heavily involved in the privatisation and private involvement debate, such as the World Bank and OECD, but these are usually a collection of research done on country cases. Nevertheless, even the studies that take a more holistic approach tend to report the trends in the sector, using some descriptive data analysis, and do not necessarily do

[1] See http://www.prinwass.org/index.shtml

more in-depth analyses when it comes to explaining the trends. Hence, there are still gaps in what is known about the specificities of private participation in the water sector, for example multi-disciplinary studies which use statistical methods to analyse the trends in the sector, or investigate “organisations” involved.

Private management of water supply infrastructure and services is a controversial topic because of some distinct characteristics of water sector. High degree of natural monopoly in the sector, water being considered a non-substitutable resource for life, strategic political and territorial importance associated to water supply, usage of a flow resource for agricultural, industrial, drinking water, or environmental functions causing conflicts and the need for long term capital investments in the infrastructure are only a few reasons why this topic is of high importance and why privatisation, in any form, is either supported or rejected by different scholars as well as policy makers. Although these debates are very vocal, the private sector provides water for only a small fragment of the world’s population. The global water market is estimated to be $185 billion, while private sector makes up 20% of the market (Water & Sewer Utilities Industry Profile, 2017).

In this work, I do not study full privatisation specifically, nor the political process bringing it about; I rather focus on the wider range of forms of private participation in the water sector, referred to in the literature as PPIs, PSPs, or PPPs. The next section provides some background on the different types of contracts that PPIs might involve.

3.1. Types of PPIs

PPIs in water sector can follow different models in various parts of the world depending on the degree of private sector involvement. The different types, and some examples, are summarised in the table below:

Table 1.1, Different Forms of PSP in Water Sector.

Note: Options, examples, type of ownership and funding, and operational entity are included. (Kessides, 2004, cited in Prasad, 2006: 682)

Option	Examples	Ownership	Financing	Operations
Service contract	Mexico City, Santiago-Chile, Madras	Public	Public	Public then some private
Management contract	Cartagena-Colombia, Gdansk-Poland, Johannesburg, Mali	Public	Public	Private
Lease contract or affermage	Cote d'Ivoire, Guinea, Czech Republic	Public	Public	Private
Concession	Buenos Aires-Argentina, Manilla, Cancun-Mexico, Jakarta	Public	Private	Private
Build-operate-Transfer (BOT) or build-own-operate-transfer contract (BOOT)	Mendoza- Argentina, Izmit-Turkey, Natal-South Africa	Private then public	Private	Private
Reverse BOOT	-	Public then private	Public	Private
Joint ownership	-	Private and public	Public	Private
Sale or full divestiture	England and Wales	Private	Private	Private

In service contracts, the overall management of the operation and maintenance of the sector is retained by the public sector which gives out 1 to 3-year contracts for specific services such as billing, maintenance, and meter reading. Although in this model public ownership is maintained, there is a lack of transparency and regulation since the contracts are not always negotiated openly (Kumar, 2012).

For developing countries, where the government may struggle to raise funds to invest in larger projects, private sector can be involved in construction and operation of water facilities. These "greenfield" projects, can take the form of build-operate-transfer (BOT), build-own-operate (BOO), and build-own-operate-transfer (BOOT). In such projects, the private companies finance and undertake the construction and operation of the projects, and to recoup the investment charge fees for the services. Hence, these projects tend to be long, typically 25-30 years, to ensure that the private companies receive a return for their investment. The private companies that take on these projects are usually multinational firms, and they generally obtain private financing; in some cases, international development banks may provide financial support to encourage private companies to invest in such projects in countries where there are uncertainties about the market.

Concessions, leases, and management contracts are commons ways of private sector involvement in provision of water and wastewater services. In concessions, the private companies do not own the assets, but they control the operation and management of services as well as providing financing for expansions and maintenance of the infrastructure. As mentioned above in these contracts, in which companies collect fees from customers, the duration is generally 20 years or more to allow the company to gain profit from its investment. Concession tend to be given to companies successful in competitive bidding. Rehabilitate, operate, transfer (ROT), rehabilitate, lease, or rent, transfer (RLT), and build, rehabilitate, operate, transfer (BROT) are forms of concessions where the private companies rehabilitate an existing infrastructure facility (brownfield projects).

Leases are very similar to concessions; but in leases the private body is not responsible for providing financing for improvement of the infrastructure and the responsibility lies with the owner. Also lease contracts are shorter in comparison, taking about 8 to 15 years. In management contracts, the operational control of a water company is given to a private firm, while the ownership as well as the responsibility for investment in infrastructure and capital expenses remains with the government. These types of contracts tend to be short, taking 3 to 7 years typically. In divestitures, 100% of the equity in a state-owned company in the sector (full divestiture), or part of the equity (partial divestiture), is sold to a private consortium. This private stake may or may not involve private management of the facility.

This section summarised the characteristics of different types of PPIs. In the following section, the literature on PPI from various aspects is looked at.

3.2. History of Private Participation in the Water Sector

Water services were traditionally provided by local government bodies such as city councils or municipalities. Private water companies have not been active players in the water sector for long; they were mostly created in 19th century, the same period when industrialisation was taking place; for example, Veolia Environnement, then Compagnie Générale des Eaux (CGE), was established in 1853 and Suez, then Compagnie Universelle du Canal Maritime de Suez, was founded in 1858. Concerns were raised about the situation in the water sector alongside other main utility sectors, such as telecommunications and electricity, after the First World War. The purpose for investing in water-related infrastructure, i.e. dams, canals, and networks, was to generate and support economic growth as well as maintaining social peace by having re-distributive policies (Moulart & Swyngedouw, 1989).

There were three main objectives in this period of expansion in water provision: creation of jobs, generation of demand for private sector investment, and provision of basic goods at subsidised rates such as water, education, and housing (Herrington & Price, 1987). In some cases, the provision of water was nationalised, for instance in the UK and many other developing countries. In other cases, the municipal authorities remained in control of the management but the state role, specifically in financing infrastructure projects, became stronger. The latter cases were seen in France, Ecuador, Spain, and Israel. In these cases, the national states also played an important role by establishing regulations for social, economic, and environmental aspects. These changes were also made in order to ensure the involvement of particular groups of stake holders such as consumer and unions.

In more recent times, approximately at the start of the global recession in 1970s, the interaction between public and private bodies in water sector changed dramatically. This period was associated with the end of state-led economic growth and the resulting move to more flexible forms of economic development by state guidance (Moulaert & Swyngedouw, 1989). The issues that led to changes in this period were growing economic problems in the form of high spending on social programmes and investments which resulted in budgetary deficits on state level. The changes that followed were the results of reconsidering state spending direction and consequent reduction in expenditure in the infrastructure sectors as well as industrial and welfare sectors (Ruys, 1997). A combination of subsidised water investments, low prices, and outdated water infrastructures put greater pressure on state budgets, especially when faced with growing water demand; this issue was more pronounced in the developing world. A range of “structural adjustment” programmes that were imposed for the purpose of stabilising the international monetary order, forced the states in the developing world to privatise, cut expenditure, and relax their regulations.

The lack of public funds for infrastructure forced governments to engage private sector companies, and enter long term contracts for financing, constructing and operation of projects requiring intensive capital. The aim for the public entity is to ensure achievement of sufficient value-for-money; while for the private entity, given low equity in projects, capital and operating costs need to be covered by direct operational revenues and financing obtained from financial institutions.

By early years of 20th century, the operations of private companies were already over-shadowed by the public sector since private companies did not have the capacity for large scale investments and they also needed higher rates of return in some market segments. The only companies that survived the municipalisation were those in France and Spain. But from the late 1980s, the private water companies started their expansion due to favourable political developments both nationally and internationally. Privatisation of water sector in England and Wales in 1989 by Thatcher influenced the entire sector considerably by doubling the private share of the market and creating new, financially-secured companies. Privatisation of water in England and Wales are considered as international exemplars in this sector. In these cases, privatisation was based on economic arguments about the lack of investment in a system made vulnerable by the lack of drivers for efficiency improvements. Private firms started demanding more concessions and profitable investments following the privatisation of water sector in England and Wales in 1989.

Water corporations and international institutions such as International Monetary Fund (IMF) and World Bank have strongly supported private involvement in the sector arguing that subsidising water promotes wasteful practices while commoditisation of water allows market forces, both in supply and demand, to fix the water tariff which will result in water consumption to be reduced and water conservation to be promoted. Another argument used in favour of privatisation is that private operators, if allowed in the sector, will provide capital which is essentially needed for infrastructure development. World Bank is among the international institutions that played a significant role in promoting private participation by providing the necessary loans to private water companies.

French companies were ideally placed in the water sector since water provision was unfolded through public and private provision in France. Hence, Suez and Vivendi (later Veolia), two French multinationals alongside a German multinational, RWE, were operating in more than 100 countries by the end of 1990s. European Union (EU), in the beginning of the new millennium, attempted to further promote water privatisation; for example by pushing for water service liberalisation to be included in the World Trade Organization's General Agreement on Trade in Services (GATS) but this was later blocked as water for human use was agreed not be included in GATS.

Here we should consider the special case of China in the overall history of private involvement in the sector. At the turn of the millennium, when the Chinese government had started reforms in the public sector, the wave of private participation in the water sector reached China. High economic growth and rapid rate of urbanisation meant that China had to address the issues of its water supply, including insufficient infrastructure, water shortage, and water pollution (Zhong et al., 2008). I will look closely to the case of China throughout this study.

The next section looks at some of the issues of PPIs in the water sector that have been repeatedly discussed in the associated literature.

3.3. Issues Associated to Private Participation in the Water Sector

Public policy for infrastructure industries has been subjected to considerable changes in the past 25 years due to issues of natural monopoly, competition, regulation, and the role of public and private sectors. The water sector has been one of the industries affected by such developments around the globe. But, unlike other infrastructure industries such as electricity and telecommunication, in which policy makers and advisors are generally in agreement with each other over the appropriate degree of industry unbundling, competition, the role of public and private sector and industry regulations, such degree of consensus cannot be found in the water sector (Balance & Taylor, 2005).

It is suggested that opposition to private involvement is mostly because of associated economic issues: prices, profits, jobs, and development. Private involvement in the sector is believed to increase the prices and making profits higher than justified while causing cuts in jobs. Opposition in developing countries is based on an additional factor, that decision making for water and energy sectors should be on the local level while considering all public interests. Opposition campaigns have taken place not only in developing countries but also in countries with various levels of national income (Hall et al., 2005).

It is argued that water has turned into an "economic" resource which is managed by market forces and this affects the public access to water; the governments of those countries which do not have the capital to run projects aimed at overcoming the water scarcity hand the control of this resource to private companies that in their turn are capitalising on the growing problem of water scarcity. The reports of World Bank's Private Participation in Infrastructure (PPI) suggest that while during 1984 to 1990 there were only 8 water and sewerage projects run by private firms in developing countries, the number has increased to 97 during 1990 and 1997 (Kumar, 2012).

The high degree of natural monopoly in the water sector is one of the main arguments against the ownership and/or management of water supply infrastructure by private entities. Moreover, water is regarded as a non-substitutable life resource which has tremendous political and territorial implications. These combined with the logistical challenges of mobilising large volumes of water for industrial and urban purposes leads to large and long-term capital investments. Since the private sector has not always had the incentive to provide such investments, public sector involvement is necessitated and justified.

The concerns associated with private participation in the sector can be categorised as followed (Kumar, 2012; Prasad, 2006):

1. Water is a resource for life, therefore decisions about allocation of water should not only consider financial benefits as there is much more at stake. One of the main dangers of private involvement and giving control of this resource to private firms is how the firms might exercise their monopoly in order to maximise their profits while affecting the lives of people.

2. There are allegations of bribery, misappropriation of funds, high consumer prices, etc., within the private water sector.

3. Management of water in a private sector is most probably based on scarcity and profit maximisation and not on long-term sustainability which is deemed less profitable.

4. Private involvement would steadily decrease the democratic involvement of citizens and their governments in management decisions of the water industry which would ultimately result in inability of the public to ensure that this important resource is efficiently managed. Also, if a private firm establishes monopoly in the water sector of a country, the government would most probably be unable to change the situation.

5. The existing records suggest that countries dealing with worst water crises are the ones with lowest Gross Domestic Product (GDP) and widespread poverty. By establishing monopoly in such countries, private firms would only provide water to those who can afford it.

What follows aims to discuss, in details, the above listed issues that have been extensively debated in the literature of water sector.

3.3.1. Efficiency

The fact that private water companies tend to focus on profit is one of the main unappealing factors since it goes against the notion of water being an essential resource for life. Efficiency in providing services has often been used to make favourable arguments for private participation in the sector. But empirical evidence suggests that efficiency is not much affected by public or private ownership. It is argued that efforts made to expand private presence in providing services since 1990 have failed since expectations of "delivering investment, efficiency and building effective water operators in developing countries" promoted by private water companies, donors and international institutions have not been met (Hall & Lobina, 2009: 1). Review of the economic effects of large-scale privatisation, a stronger form of PPI, in the UK confirmed that although efficiency has not significantly improved, distribution of income and wealth has been influenced. "The IMF has acknowledged the probability that curbs on public-sector investment in infrastructure have damaged economic growth, and that the evidence on the relative efficiency of the private sector is finely balanced. The WB, for its part, has published a lengthy report highlighting the limitations of privatisation, acknowledging that it promoted the policy with irrational exuberance" (Hall et al.,2005: 292).

3.3.2. Economic Good (Commodity) or Not?

The concept of water as an "economic good" was first introduced in a UN setting in 1992 in the Dublin Water Principles, but water has been seen as an economic good much before 1992. Although private water companies saw a period of success in Europe and United States, in the 19^{th} century, the demand for public ownership and management of such companies for the sake of public health increased. This incident did not result in water being treated as public good but it did put emphasis on water gaining a public-good nature which led to heavily subsidised publics systems being developed. Except France, the rest of the world followed this approach. The World Bank and other international institutions by late 1980s, discovered the merits of using private sector in providing public services which was followed by the issue of setting prices and tariffs. (Rogers et al., 2002)

Although there are many ways for promoting efficiency, sustainability, and equity in the water sector, price ceilings are conceptually the simplest options but at the same time, they are politically complicated to implement. For instance, the common approach of "command and control" practiced in many countries for management of water services means heavy involvement of governments for the purpose of active monitoring and measurement. However, taking price policies approach, also means significant intervention by government in order to ensure that issues of public good and equity are properly addressed.

Two of the most important reasons for bringing water supply under the control of state, either through regulation or public ownership of infrastructure, are the effects of lack of access to water on health and hygiene alongside the incentive of private firms not to extend coverage to poor, non-profitable consumers. Private sector participation, in most cases, entails some degree of commercialisation. This can be through changes in allocation principles (water becoming an economic good instead of a public good) and infrastructure management goals (cost recovery rather than security of supply), or through redefining principles underlying the business of water supply; water is not supplied as a service at subsidises rates to citizens as a right but rather viewed as a commodity which is sold to consumers on the basis of profit-making and willingness-to-pay rather than ability-to-pay.

Water supply, compared to other resources, has proven to be more difficult to commodify because of water's biophysical characteristics as well as human water use practices. Water is one of the heaviest substances that humans have been mobilising for their survival and the tension between public and private sector in water supply provision is partially due to this biophysical characteristic of water; water is expensive to transport relative to value per volume, requiring large-scale capital investments in infrastructure networks which act as an effective barrier to market entry. Therefore, water supply is considerably prone to monopolistic control, or natural monopoly in economic terms. As a result, fully commodifying water utilities is undoubtedly a troublesome task compared to other utility services such as gas, electricity, and telecommunication. This is the reason why in the past century, water supply management, particularly but not exclusively in the Organisation for Economic Co-operation and Development (OECD) countries, has been controlled dominantly by the state as owner, manager and regulator of infrastructure.

As mentioned before, access to water among poor communities is negatively influenced under private sector participation (PSP) since the cost increases and non-paying customers are disconnected. The concession type of PSP model that involves private sector investment has become quite popular among the policy makers. By implementing the concession model, it is expected that the private sector would provide capital and efficiency in the provision of water supply services. The private sector, quite naturally, requires a reasonable return on its investments as well as recovery of its invested capital in operations such as network repairs and maintenance and expansion. But, in most cases, the already-established connections prices and tariffs are much lower than a level which could ensure financial sustainability. Hence, the private sector increases the connection prices and tariffs following its involvement in the provision of water services. The poorer community would then face difficulties in finding the financial resources for making the payment of these increased connection fees and therefore the demand for new connections from this community would reduce resulting in network expansion to be halted in poorer areas which in its turn means less access to services among the poorer community. Because of the increased tariffs imposed by PSPs, the poor community would be more and more unable to pay resulting in increased payment defaults and disconnected connections. It should be noted that the existence of non-paying customers is not only restricted to situation where provision of water services is handled by private sector, but defaulting customers are treated with more leniency by public sector compared to private firms; disconnections are imposed as the last resort for political and other reasons. Apart from issues related to customers and their financial situations, other characteristics of poor areas in developing countries make them unattractive targets for private sector. The poor neighbourhoods are usually located in far off areas with extremely congested urban development and lack of land use planning and because of these characteristics, the cost of providing connections are substantially higher in such areas which is not desirable for private firms' profit- making goals. Two examples of such situations are poor neighbourhood in Bangkok and Mexico City where private partners refused to provide connections. Alternate sources of supply are then sought by the poor community in the absence of water supply networks; the alternate sources such as private water vendors offer substantially lower tariffs which is as a favourable decision-making factor for the poor when choosing their source of water supply. This shift from private sector supplier to water vendor mean less demand for network connections. (Bakker, 2007)

If appropriate measures are not taken, there is a risk that short term plans dominate the long-term investments that are very much needed for expansion and improvement of the networks. Generally, private sector is involved by the public sector to provide water supply services because of challenges faced in operating the existing infrastructure as well as expanding infrastructure to meet the demands of new users. When concession agreements are signed, the private sector is then expected to work on both improving existing infrastructure and creating new infrastructure. But, the private sector focus on creating new infrastructure can be affected by a number of factors which might result in the private sector to focus primarily on the existing infrastructure. Firstly, many uncertainties, legal, political, regulatory, etc., surround the start-up phase of a new infrastructure project which causes private sector to be reluctant in locking up capital investments in these early phases. Secondly, by working on and improving the existing infrastructures, the private partner has ample opportunities to showcase the improvements to stakeholders while locking up less investment. These factors can be seen in the case study of private sector water utility in Belize City (Mustafa & Reeder, 2009). In this case study, the private sector achieved revenue maximisation by using the existing infrastructure as well as showcasing improvements in short-term by executing operations such as streamlining the management systems, reconfiguration of the water supply network for improved metring, installation of water metres, repair and maintenance of network and detection and elimination of leaks. At the same time, the long-term plans for expanding the network and improvements in terms of efficiency and quality were compromised. Another example of private partner efforts for maximising revenue in short is the case study of water utility in Mexico City; the private sector in this case performed tasks of metre reading, billing, updating the registrar of networks, metre maintenance and pipeline repairs.

Contrary to the issues and cases mentioned above, there are others wherein the problems of making long-term improvements in the network and services have been addressed by various measures. Performance targets for water coverage, sewerage coverage, and unaccounted-for water can be specified in the contract documents. Also, a contractual requirement can be given where the private provider must create a strategy for investment in network expansion. Regulatory supervision can be present in order to control and maintain service quality, protect consumers, and approve and supervise the execution of expansion plans and investments according to contract specifications. Because of these measures, the private sector is more likely to allocate enough resources for improvement of access and quality in the long-term.

3.3.3. Natural Monopoly

It has been repeatedly emphasised in the literature that the private water sector worldwide is unlikely to be competitive. Although, as mentioned before, private water companies still serve a comparatively small population than public ones, it is essential to understand the nature of competition between private water companies themselves and also between private and public actors in order to understand different aspects of private involvement. The water supply and sanitation services sector is mainly dominated by public authorities, yet these public operators rarely expand their activities beyond local level. Hence, private water companies with international operations are involved in a sector where other competitors do not wish to go beyond their established local service. The number of private companies with international operations is small; they are mainly focused in the high-income countries and the two French companies, Suez and Veolia are the most dominant in terms of market share; the companies, in 2012, had a combined market share of 69 percent for water distribution and 55 percent for water treatment (Bloomberg, 2012). The small number of private actors in the sector is thought to be one of the reasons why competition level is low. Another factor limiting competition is explained by "the lack of opportunities for competitive tendering". The length of water concessions is usually quite long, 25-30 years and even much longer in cases, with the incumbent often having an advantage after the end of the concession (Hall & Lobina, 2007: 69).

The private water market in Europe has been "overwhelmingly dominated by Suez and Veolia" (Hall & Lobina, 2010: 3). Hall and Lobina (2010) state that the two companies are believed to be considerably dependant on state capital, from international development banks such as European Bank for Reconstruction and Development (EBRD) and International Finance Corporation (IFC), to the French government. The majority of European water operators are still owned by public companies; no major water services privatisation occurred within the EU for the period of 2007-2010 however a case of re-municipalisation has happened in 2010 in France which involved both Suez and Veolia. In 2010, Veolia won a new contract, beating Suez, to supply services for the region of Ile-de-France (Paris and its surrounding areas), when local council mayors changed their mind about re-municipalisation of water services in city of Paris that was decided upon earlier the same year. Private water companies are being helped by the public sector in the form of financing aids, state investment in shares and developing strategy. The EBRD was reported to have made equity investment of the value of £175 million in Veolia Voda, Veolia's subsidiary in Central and Eastern Europe since 2007. The IFC has also invested in this subsidiary's business and other Veolia's international water companies. EBRD has also made similar investment actions for Suez's operations in Eastern and Central Europe. The financing acts of EBRD, and other similar institutions such as OECD and United Nations Economic Commission for Europe (UNECE), have been promoting the possible privatised water markets for companies in Central and Eastern Europe and former Soviet Union. Although some private companies have become more prominent in the market in the recent years, such as Fomento de Construcciones Y Contratas SA (Spanish), RWE (German) and Saur (French), the two leading companies still enjoy a relative stronghold.

Water supply and sanitation services provision is often described as the typical definition of a natural monopoly. This concept of natural monopoly reflects on the technological and associated cost attributes implying that a single firm can produce the services at a lower cost compared to several firms. Such natural monopolies occur when the largest supplier in the industry, or the first local supplier, has a considerable cost advantage. This is usually the case in industries where capital costs are large enough to create barriers to entry and this can be seen clearly in the water industry.

In the last two decades, much effort, by means of transformations in public policies, has been spent on introducing more competition into sectors that are considered as natural monopolies. Policy makers have suggested that monopolies should be broken up before more competition is introduced. This suggestion is based on the idea that competitive elements of a utility and natural monopolies should be separate from each other in order to prevent "competition distortion". As a result, in most utility industries, competition has been introduced at the production stage and local monopolies have been maintained at transmission and distribution in some cases.

Among utility industries, the water sector seems to be different compared to others and direct competition as well as separation of production stage (and introducing competition at this stage) have not really been implemented in this sector. Water services are still seen as natural monopolies which must be regulated by public authorities. Since there are similarities between water and other utility industries in which competition has been successfully introduced, this issue is rather surprising. For example, in electricity and gas sectors, competition is observed at the production stages while natural monopoly can be seen, to some extent, at the distribution stage. The water pipes network in naturally monopolistic and the same applies to gas pipes network and electricity wires, hence the existence of natural monopolies at the distribution stage in these sectors; while no reason can be found for limiting competition at the production stage in the water sector.

According to basic economics, the price of a service should be at least as much as the marginal cost of providing that service. Rogers et al. (1998) argue that in the water sector for sustainability and efficiency reasons, the water tariff should not only match the supply cost (operation and management as well as capital costs), but also economic externality costs and opportunity costs, but often the tariffs are actually lower than the supply costs only.

Price policies raise two major issues: the implementation of the price policy, and setting prices. These questions can be answered according to the property rights of water in different countries.

3.3.4. Health and Poverty, Externalities

It is not clear if the improved efficiency resulting from private participation in the water sector can lead to improved public health and reduction in poverty. It is possible that private water companies provide services that are not of high quality because significant health externalities present in the sector are not taken into consideration; in such cases their involvement actually lead to negative outcomes for public health. Also, the poorer tiers of society might be affected because of increased prices, enforced payments for services and inequality in provision of services (private companies might only invest in high income areas). In such cases, although private involvement might lead to efficiency gains, but this is obtained through exclusion of the poor from access to water services which in its turn impacts the health of this group of consumers. Significant externalities are also present in the water sector. Water-related diseases are mostly contagious which generates positive externalities in the provision of clean water. On the other hand, proper treatment of wastewater prevents negative externalities as a result of polluted natural water bodies.

One other special characteristic of water supply is the dependence of human life on drinkable water; at survival level, the demand for water is fully price inelastic, but at other non-survival levels the demand does show price elasticity. (Galiani et al., 2005)

Another factor that is discussed is whether private participation has been successful in achieving the UN Millennium Development Goals (MDG) of reducing the number of people without access to safe drinking water and sanitation. It is argued that according to evidence, private finance in water sector has not improved progress towards above mentioned MDG; in contrast to what is usually assumed water privatisation in the past 20 years has negatively affected water and sanitation MDG specifically for poor communities worldwide. In different regions, private participation has had an impact on providing water and sanitation services; no investment by private sector meant no extension of water distribution systems in South Asia, 90 percent of contracts in Sub-Saharan Africa have either come to an end or been the subject of disagreement between public and private sectors. The amount of financial aid to the water sector has been largely reduced as a result of “misplaced expectations” on the private water sector. This fact shows the gravity of situation when it is pointed out that financial aid by donors has always outweighed the private companies’ investments. It is also stated that since private companies are concerned about profit-making, putting them in control of the water and sanitation services meant that investments have not been made in areas with greater needs which are poor regions with higher risks of losing investments. Also, profit-making activities such as “pre-pay meters, massive price rises and disconnections for failure to pay” (Hall & Lobina, 2006a: 52) have been practiced by private water companies in developing countries. It is concluded with respects to the evidence that private sector, the same way as public, is not efficient in providing water and sanitation services.

3.3.5. Corruption and Bad Governance

The likelihood of corruption in the water sector is increased because of some specific characteristic of the sector, according to the Swedish Water House, the Stockholm Institute, and the Water Integrity Network (Sta˚lgren, 2006). These characteristics are: large-scale construction and monopolies, public sector involvement, technical complexity (this leads to decreased public transparency and asymmetry of information), high demand for water services (this contributes to the supplier holding powerful positions and also encourages bribery), and frequent inter-relations between consumers and suppliers (this fosters flexible actions).

Because the above-mentioned characteristics are present in both rich and poor countries, the water sector is not free of corruption anywhere in the world. To give some example of corruption, Lyonnaise des Eaux in France faced prosecution for bribing the Mayor of Grenoble for getting a water contract; two of Generale des Eaux’s executives admitted that they made illegal payments to officials in the island of La Reunion for a water deal; multinational companies’ consultants, Siemens, Pirelli, BICC, Marubeni and Tomen, faced conviction because of bribing for getting contracts in Singapore. In developing countries, corruption is not only seen in high-level dealing but it is prevalent and consumers face corruption directly (Asthana, 2008).

Studies in 2006 found positive correlation between corruption in the water sector and corruption perception index, with a negative correlation between corruption in the water sector and progress in water reforms, and negative correlation between corruption in the water sector and level of service (Kenny, 2006). Although ethical values are increasingly considered important factors in provision of improved water supplies, such values emphasise sharing of water rather than the corruption issue which is said to be the least confronted challenge in the sector (Berg, 2007).

Governance literature shows some tolerance for corruption through “good enough governance” stream (Grindle, 2007), but at the same time international agencies describe corruption as “a cancer that eats into social and economic fabric of development” (Bitarabeho, 2003, cited in Asthana, 2008: 182). The solution promoted by international institutions such as the World Bank for tackling corruption is to liberalise, globalise, privatise and decentralise; by decentralisation the attention focused on local governments and governance and corruption challenges are then shifted to the local level (World Bank, 2007; 1997). The literature even goes as far as suggesting that decentralisation can create “clean” and “integral” clusters in corrupt surroundings (Elshorst & O’Leary, 2005).

In the sector, there are many forms of corruption: contractors bribing engineers assessing tender documents for example; or supporting programmes at international level that are not likely to address local needs.

It has been estimated that 20% to 70% of resources can be saved in the water sector if transparency is improved and corruption is eliminated (Shordt, et al., 2006). There is a strong focus on construction in the sector “with characteristics that expose it to corruption: competition for contracts, numerous levels of official approvals and permits, and the uniqueness of the projects, opportunities for delays and overruns, and the need for rapid work” (Transparency International, 2005: 36). Estache and Kouassi (2002), compared productivity of 21 water utility companies in Africa finding that almost two-thirds of their operating costs arise because of corruption. Considering their findings, good governance and transparency can result in increased resources which would help in achieving the Millennium Development Goals.

In the last few decades, international agencies strongly advocated major reforms in governance, in the form of decentralisation and private participation, for improving efficiency and reducing corruption. But, these reforms did not provide solutions as quickly as expected and they also brought in new challenges (Bailey, 2003).

Kolstad and Fjeldstad (2006) show that decentralisation and corruption have a complex relation which depends on variables including degree of social and economic equity, the complexity of the services, the flexibility and simplicity of regulatory systems, and local capacity. Asthana (2008) shows similar finding for the water sector in India, providing evidence that the local elite can benefit from the services as a result of decentralisation. For instance, in the case that the government requires 10% contribution for new services, it is possible that local leaders pay and then use the services for their convenience. One important factor to consider about decentralisation is that inefficiency and corruption will occur if local level capacity, leadership, transparent management, system, and staff competencies are disregarded (Bailey, 2003).

An issue which needs to be investigated further is the civil society group and their contribution in providing an insight into accountability; NGOs reported in the past that their efforts for ensuring transparency were compromised by employees of local governments hiring them who were offenders themselves.

The relationship between private sector and corruption is also still a subject of extensive debate. For example, high rates of PPP failures were observed in the 1990s (Braadbaart, 2005; Budds & McGranahan, 2003). In the early phase, the PPPs did lead to improvements but during later stages the improvements were "overshadowed by a wave of contract renegotiations, allegations of collusion and corruption and courtroom battles". Many of such partnerships were not properly designed which made them "susceptible to macroeconomic shocks and political opportunism". The debates are still ongoing but it might be useful to focus on a sustainable solution for maximising effectiveness and minimising corruption for both public and private sector instead of trying to prove whether public sector is better or worse than the private one.

3.4. Conclusions

The aim of this part of the work was to provide a review of the literature surrounding private participation in the water sector, focusing on its history and associated issues. It is evident that the water sector is somewhat unique in its characteristics, therefore it was essential to understand the different aspects of private involvement in the sector before we can proceed to achieve the aims of this study through analysis of PPIs.

One of the insights from the preceding discussion is that PPIs are complex relationships that require reaching a difficult balance between the interests and viewpoints of very diverse, if not opposite, actors. While the literature often assumes a sort of permanent state of collective competition between the views that defend privatisation on the one hand, and the alternative of a public-sector service on the other, PPIs mostly require concertation, agreement and even some division of labour between participating public and private-sector bodies. Each and every PPI is the observable trace of relationships and interactions occurring between governments (or other public authorities at national or sub-national level) and private water companies. Such interactions are explicit and result in contracts of one of the types listed above; and may involve more informal, largely unobservable interactions between representatives of the two sides in the negotiation and execution of the contract. At times, these interactions may involve multiple parties, notably when a contract is awarded to a consortium of private companies. To understand the underlying social processes, it is useful to refer to the literature on interorganisational relationships, which is reviewed in the next part, section 4, in line with the multi-disciplinary nature of the work.

4. Interorganisational Relationships

Interorganisational relationships, as the name suggests, refer to relationships between and among organisations. The organisations can be of non-profit, business, or private nature and the relationships can range from dyadic, between two organisations, to multiplicitous, among large networks of many organisations. The relationship between such organisations refers to transaction of resources such as money, facilities and materials, customer and clients, and staff.

Research on Interorganisational relations, IOR, focuses on the "properties and overall pattern of relations between and among organizations that are pursuing a mutual interest while also remaining independent and autonomous, thus retaining separate interests" (Cropper et al., 2010: 9). It has been argued that interorganisational relationships emerge mostly because of "internal needs for resources or commitment to an external problem or opportunity" (Van de Ven, 1976: 28).

Four forms of interaction have been suggested by the literature: dyadic linkages, organisation sets, action sets, and networks (Whetten & Aldrich, 1979). The dyadic form is the simplest one that IOR can take and it involves two organisations to either collaborate or less formally coordinate in order to accomplish a common goal. Organisation sets, as labelled by Evan (1972) refers to the total sum of interorganisational linkages established by an organisation. Action sets refer to the coalition of organisations working alongside each other in order to achieve a specific purpose (Whetten, 1981). The fourth form of IOR is a network which includes all the interactions between organisations in a population; the population can itself be organised into dyads, organisation sets, or actions sets.

Interorganisational acts can also take different forms; bridging, franchising, collaboration, alliances, working together, networking, contracting, outsourcing, cooperation, and partnering are just a few of the commonly used terms for interorganisational acts (Cropper et al., 2010). Among these terms, strategic alliance has undoubtedly been discussed extensively in the IOR research; some associated literature is discussed in paper 3 to set out the theoretical framework for that paper. But, to prepare for the rest of this work, this section looks at the existing literature on collaboration within the service sector, and the water sector, to help outline the concept in this case. Again, understanding different types of relationships in the sector is essential for investigation of PPIs and for paving the path to discuss why PPIs are considered strategic alliances in paper 3 of this work; as we see in that paper strategic alliances are defined as a form of voluntary interorganisational cooperation, which involve considerable "exchange, sharing, or co-development", and create enduring commitments between partners (Gulati & Gargiulo, 1999: 1440).

4.1. Collaboration in Water Sector

In the past 40 years, governments around the world have changed the way they operate and work with private institutions which has been characterised by scholars as the hollowing of the state, which implies relying on any type of contractor to provide services, (Milward & Provan, 1993) and "a revolution that no one noticed" (Salamon, 2002: 15). What has supported this public management revolution can be categorised into six main ideas: "the search for greater productivity; more reliance on private markets to achieve public ends; a stronger orientation towards service; more decentralization from national to sub-national government; increased ability to conceive and monitor public policy; and increased tactics to enhance accountability for results" (Kettl, 2005, as cited in Milward & Provan, 2006: 8). Different ways of working with private businesses have been developed by the public sector as these ideas have become acceptable. The governments can contract with private entities buying staff, services and expertise through "purchase of service" contracts; or support innovation by either sponsoring research or providing infrastructure through public-private partnerships; or work collaboratively with other sectors and receive resources and expertise as a partner rather than a purchaser or supporter across organisational boundaries (Link, 2006; Van Slyke, 2003; DeHoog & Salamon, 2002; Romzek & Johnston, 2002).

Various terms, such as "public-private partnerships", "collaborations", "strategic alliances", and "joint ventures" have been used in the literature which shows the diversity of form among interorganisational service delivery. Scholars have attempted to make distinctions between these different forms through classification. One characteristic used for classification of collaborative service delivery arrangements is by considering the level at which they occur; policy level, organisational level, programme level, and client level (Kagan & Neville, 1993; Martin et al., 1983; Agranoff & Pattakos, 1979). At any of these levels, the collaborative effort might aim to either improve systems or services. The purpose of collaboration is therefore distinct from the level at which it occurs. Another approach is to conceptualise the variations in intensity of relationships, from informal to formal, along a continuum (Cigler, 2001; Himmelman, 1996; Kagan & Neville, 1993). At one end of the continuum is cooperation, supported by personal and informal relationships, while at the other end there is formalised service integration; two or more organisations working together to provide new services to their mutual clients. Coordination, in which organisations attempt to calibrate their actions while remaining independent and collaboration, in which organisations share resources, rewards, and authority lie between the two extremes. Collaboration, specifically, can occur through various mechanisms, such as joint budgeting, joint planning or integrating staff. The mentioned approaches for distinguishing between different forms of collaborative service delivery are only two of the various ones suggested by scholars.

In the water sector, PPIs (or alternatively PPPs, and PSPs) are an important form of collaboration; they are not only forms of collaboration but also a form of privatisation as discussed earlier. Various types of such relationships have already been outlined. The previous section has focused specifically on PPIs, which can be considered, a form of collaboration between private and public entities.

Before concluding, an overview of competitive conditions in the water sector is in order. If PPIs are forms of collaboration, they occur in very specific market structures that constrain the choices of both companies and contract-awarding public authorities. The next section details the specificities of competitive conditions in the water sector and explains why it exhibits features that favor concentration of market power (in the form of natural monopolies and oligopolies). These elements provide important contextual information that will help frame the remainder of this research.

4.2. Competition

Competition is defined by Stigler (1987: 531) as “a rivalry between individuals (or groups or nations), and it arises whenever two or more parties strive for something that all cannot obtain”. In the business world, competitors are those firms whose strategic choices can directly influence one another. Firms can also indirectly compete with each other; indirect competition occurs when a firm strategic choice influence the performance of another firm but only through the strategic choices of a third firm. The likely nature of competition in a market can be reasonably assessed through measures of market structures; i.e. the number and distribution of firms in a market. In previous parts, the notion of monopoly in the water sector has been mentioned; since competition can take different forms: perfect competition, monopoly and oligopoly; a brief discussion of the associated literature is provided here. Also, some works within the literature on competition in the water sector are discussed to set the scene for later parts of this work.

In the case of a perfectly competitive market, there are many sellers offering a homogeneous product to consumers who shop around for the best price. In this case, there is only a single market price for a product which is set based on the interaction of sellers and buyers but it cannot be controlled by any of them. In markets under perfect competition conditions, the price competition is fierce and sellers are bound to identical prices which are generally reduced to marginal costs (Besanko et al., 2009). It is essential to emphasise that in the case of perfect competition, sellers do not have any control over the price.

Monopoly power is described as “the ability to act in an unconstrained way” (Fisher, 1997: 677); this can be in the form of increasing price or reducing quality. Therefore, a firm is monopolist if it faces little or no competition in its output market. Monopoly is the focus of this section; not only the water and sanitation sector but most of utility industries exhibit monopolistic characteristics which are discussed here in details.

In monopolistic and perfectly competitive markets, pricing and production strategies of sellers are not influenced by their rivals, but this is only the case in markets with many sellers. If, however, there are only few sellers in the market, it is reasonable to expect that rivals' pricing and production strategies affect one another. This is called an oligopoly.

In the following section, section 4.3, the nature of competition in utility industries, specifically in water and sanitation sector, is discussed.

4.3. Competition in Utility Industries and in Water Sector

In the previous parts, it was explained that although state ownership and monopoly were dominant in the utility industries in the post-war period, from 1980s, privatisation and therefore competition were introduced to the market. When designing a policy for introduction of competition into utility industries, some conceptual issues have to be considered. All utilities contain systems and most of these show considerable elements of natural monopoly. Production and supply competition cannot be introduced to all parts of utilities and it is essential to identify the different types of competition that can be applied to utilities (Helm & Jenkinson, 1998).

The concept of natural monopoly does not take the actual number of sellers in a market into consideration but it refers to the relationship between demand and the technology of supply. "If the entire demand within a relevant market can be satisfied at lower cost by one firm rather than by two or more, the market is a natural monopoly, whatever the actual number of firms in it" (Posner, 1968: 548). Markets exhibiting natural monopoly characteristics are thought to have various economic performance problems: excessive prices, production inefficiencies, costly duplication of facilities, and poor service quality (Joskow, 2007). In such markets, if there are more than one firm, two scenarios are likely to happen: either the number of firms will be reduced to one through mergers or failure, or production will keep consuming more resources than necessary. Competition is short-lived in the first scenario, and in the second one inefficiency is a major concern. Therefore, under the conditions of natural monopoly, competition cannot be used as a practical regulatory mechanism and hence direct controls should be put in place to ensure that performance is satisfactory. These controls can be over profits, specific rates, quality of service, extensions, and abandonments of service, and even permission to enter the business. Such controls have been applied mainly to public utility companies: gas, water, and electricity, and are known as "public utility regulation".

In some utility industries, such as electricity and telecommunication, monopoly power is disappearing because of technological innovation and development of competitive substitutes.

But this is not the case in the water and sanitation sector; monopoly is likely to stay as a long-term feature in this sector as it is not possible to build different systems and facilities in the same physical region. Water sector can be divided into different functions. As it can be seen in table 1.2, only two segments of the functions along the supply delivery and waste disposal chain are naturally competitive: the construction of capacity and plumbing services. The two segments of distribution of supplies to consumers and removal of sewage are classic system monopolies. Bulk supply provision and water and sewage treatment are normally spatial monopolies because they involve transporting heavy water products which results in high costs.

Table 1.2, Competitive Characteristics of Water Industry Functions.

Note: Stages in the supply chain of water industry and their competitive characteristic. (Rees, 1998: 97)

Resource Allocation and Use Regulation	*Natural Monopoly per Hydrological Unit*
Capacity Construction . . . . *(including storage water treatment and sewage treatment)*	*Competitive*
Bulk Supply Generation.	*Oligopolistic (in places monopolistic)*
Bulk Supply Transmission.	*Areal Monopolies*
Water Treatment.	*'n' Local Monopolies (at best oligopolistic)*
Local Supply Distribution.	*'n' Local Monopolies*
Local Sewerage Network and Interconnected Storm Water Network	*'n' Local Monopolies*
Sewerage Treatment	*'n' Local Monopolies (at best duopoly)*
Appliance Sales, Plumbing Services . . . . *(e.g. quality testing)*	*Competitive*

Although the water industry continues to exhibit many monopolistic characteristics, there are also elements of competition. Water utilities compete with each other on various fronts: “extending services to unserved or underserved area; engaging in acquisitions and mergers (voluntary); bidding for operations contracts; bypassing the utility (including self-supply); purchasing water on wholesale markets; trading water rights (alternative uses); maintaining a service and quality image (bottled water); promoting public versus private ownership;

contesting markets, ownership, take-overs; and participating in convergence acquisitions" (Beecher, 2001: 328).

The options available for managing natural monopolies, for example in the case of water and sanitation sector, have been described by Milton Friedman as follows: "There is only a choice among three evils: private unregulated monopoly, private monopoly regulated by the state, and public monopoly" (Friedman, 2009: 128). Considering both public and private entities in water sector and paying close attention to the notion of monopoly, four institutional regimes can be identified in the sector: "outright public provision of water; government-supported natural monopoly with regulated price (the English model); government-supported natural monopoly with regulated rate of return (the American model); and government-controlled franchise, lease, or concession agreement (the French model)" (Cowen & Cowen, 1998: 22).

In a similar categorisation, four different models in provision of water and sewerage services can be identified (figure 1.2): Finnish-Scandinavian-Dutch (regulated municipal public monopoly with private sector only competing for non-core operations); English-Welsh (regulated regional private monopoly); French (competition for regulated municipal monopoly rights); and developing and transition economies (centralised unregulated public monopoly). Considering these models and limitations of natural monopoly, it can be seen that most competition happens in the Finnish-Scandinavian-Dutch model; production related activities except those core operations are outsourced to the private sector and this is done based on competition. In the French model, oligopolistic competition exists between local monopolies.

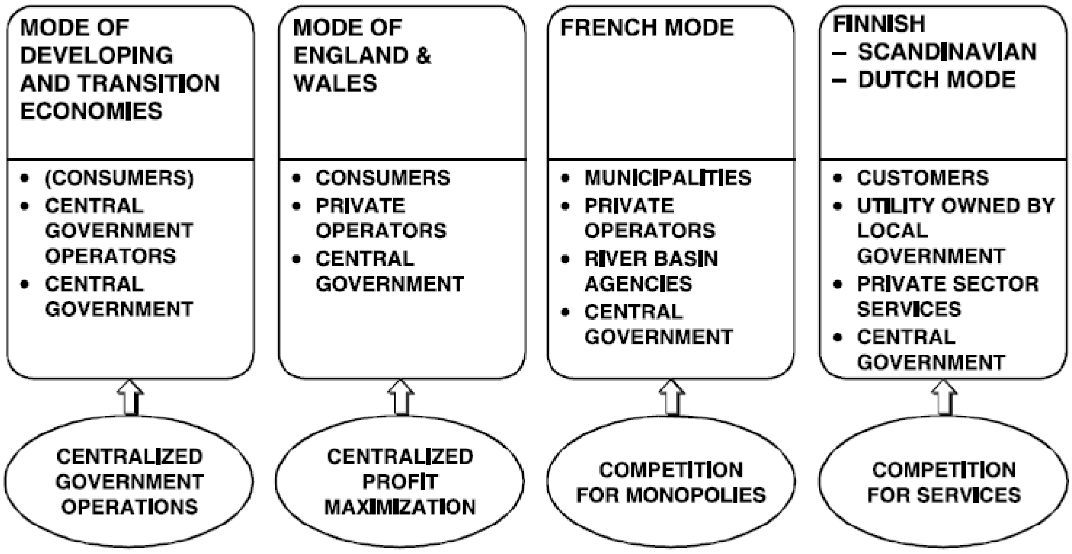

Figure 1.1, Management Options for Urban Water and Sanitation Services.

Note: Different options identified by the literature, their characteristics (in terms of consumers and governments involved) are included. (Hukka &Katko, 2003: 115)

As it was mentioned before, regulation is necessary in the water sector because of natural monopoly characteristic of water and sanitation services. But the question is whether in privatised water sectors, regulations is required or deregulation. According to Beecher (2001), deregulation might not be the best option for the water industry. By deregulating, it is likely to experience continuous and considerable market failures, in the forms of monopolistic tendencies toward negative externalities, and inequitable outcomes. This is the consequence of over-relying on markets to manage the water services. Hence, when services are already privatised, regulating the private sector ensures that public interest is protected.

For developing countries, where governments have shown poor performance as owners and regulators, Cowen and Cowen (1998) have suggested unregulated private monopolies. In this model, there is no price regulation, no rate-of-return regulation, and no surreptitious regulation through antitrust law. In an unregulated private monopoly market, there is an incentive to bring in as many buyers as possible in order to maximise profits. It is argued that by introducing this system, the number of water connections will significantly increase. But there are issues of partial exclusion, bargaining and rent seeking costs, potential price gauging, and credibility of a laissez-faire regime and government pre-committing to it. Rees (1998) has stated that the option suggested by Cowen and Cowen is not feasible as regulations are needed for customer protection in a privatised water sector.

In unregulated private monopolies in water sector, output volumes, quality of the service and investment levels are lower than under competitive conditions. But the prices are higher and are set to discriminate against customers with inelastic demands (Herrington & Price, 1987). Parker (1997, cited in Rees, 1998: 95) stated that “a privately-owned monopoly is not an attractive outcome, particularly in industries providing basic consumer services (e.g. water and sewerage services) and where the price elasticity of demand (the responsiveness of consumer demand to price) is low”. In the other form of managing water services, public-private partnerships, it is also argued that PPPs may not be able to increase competition but rather change a public natural monopoly to a private monopoly (Hukka & Katko, 2003).

4.4. The Water Supply Netchain

We saw above (see table 1.2 for summary) that different segments of the water sector have different competitive structures, due to high fixed costs for some functions, but not all of them. Thus, it seems useful to look at water operations in terms of a combination of functions and areas of activity that feed into one another, as in a complex supply chain. It is interesting to point out here the literature that combines supply chain analysis and network analysis. In their work, Lazzarini et al. (2001: 7), introduced the concept of netchains, as a response to the disconnection between supply chain analysis and network analysis, both approaches that study interorganisational collaboration, focusing on interdependencies. Netchains are defined “a set of networks comprised of horizontal ties between firms within a particular industry or group, such that these networks (or layers) are sequentially arranged based on the vertical ties between firms in different layers” (Lazzarini et al., 2001: 7); a simple representation of this concept is seen in figure 1.2.

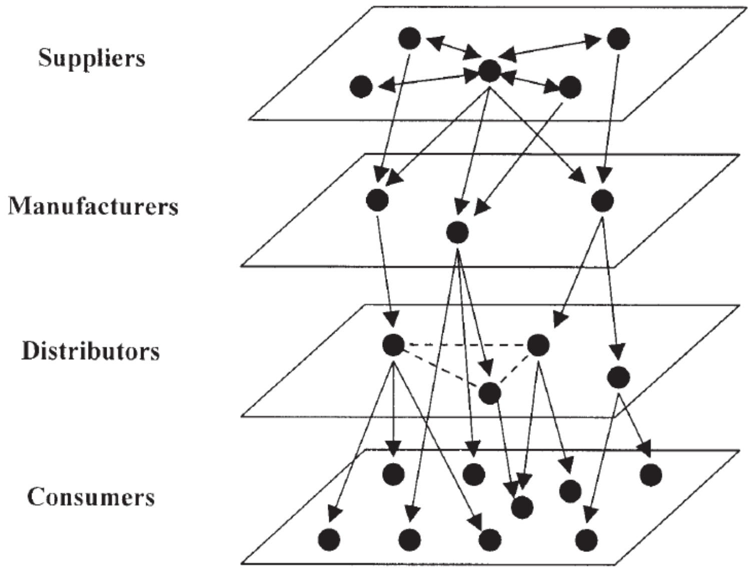

Figure 1.2, An Example of a Generic Netchain.

Note: Different stages of the supply chain and how networks can also be included in the concept are illustrated. (Lazzarini et al., 2001: 8)

In the case of water, such a structure exhibits further layers of complexity insofar as these varied actors operate at different geographical scales – global, national and local; that natural monopoly cost structures concern only some of these layers; and that public-sector actors and regulatory frameworks are as relevant as private-sector commercial firms. The network representation is helpful as it makes this complex structure of interdependencies explicit and visible, both vertically and horizontally.

4.5.Conclusions

This section has provided some discussions on IOR, as well as providing some information about collaboration and competition in the utility industries and in the water sector. Lastly it has looked briefly at the concept of netchains, to illustrate how network analysis and supply chain analysis can be considered together while studying the water sector and its unique competitive structure at different stages of the supply chain. The rationale behind these discussions is to better understand the relationships between private and public bodies in the sector, in order to follow the research provided in this work. There has been extensive research done on the water sector, privatisation, and PPIs, but collaboration and relationships between water organisations have been under-researched. This chapter has shown that there is promising insight from the IOR literature that could shed further light on the sector and specifically on PPIs. If the involvement of private sector in providing such important services to the communities has not been without controversies, most researchers so far have focused on the downstream stages of the supply chain and the effects on (and reactions of) final consumers. The choices of companies and governments that engage in PPIs – that is, the more upstream stages of the supply chain/network – are less well understood, although they are no less important in determining final outcomes and shaping the future of the sector. Are any global patterns visible, or is each case different from the others? Is there continuity in the choices of governments and companies over time? To what extent do commercial companies ally with one another to win more PPI contracts? How do historical transformations (such as the advent of more market-oriented approaches first in Eastern Europe, and more recently in China) affect the sector worldwide? To address these and similar questions, it is important to study PPIs, albeit in decline, considering various aspects of such relationships, and taking novel approaches into consideration. This study aims to take the research on PPIs to a different, global level, and therefore contributing to the knowledge of the field, and providing a platform for future research on the topic.

In the next papers, I have looked at relationships between governments and private companies involved in PPI water projects from different aspects, and considered their relationships to be strategic alliances, which can be thought of as collaborative relationships. Although competition is not investigated in this work independently, in the discussion of this work I make use of patterns of collaboration to highlight some behaviour between entities involved which can be considered competitive.

Paper 2- Descriptive Analysis of Private Participation in the Water Sector Data

1. Introduction

The aim of this section is to provide detailed background information on my empirical setting, using the data obtained from the World Bank dataset for the purpose of this study. In this part, I first introduce the source of data, and then proceed to explain the different information recorded by the data and provide some graphical representation of the information interesting for this study. Finally, I look at the data using descriptive statistics, graphical representations, some Network Analysis, and Multiple Correspondence Analysis (MCA), to detect underlying patterns in the data.

As mentioned in the Introduction, other sources of data, such as Pinsent Masons Water Yearbooks, were also considered for this study. But at the end, it was decided to make use of the World Bank database on Private Participation in Infrastructure, as the information was more systematically structured by this source, the important aspects of the data required for analysis in this study were almost all available, and the source has been continuously updated hence it made it possible to do an up-to-date investigation. For the purpose of uniformity, it has been decided not to use more than one source, and only consider the World Bank database.

The information in this database is about water projects in those countries with middle and low income (based on the categorisation of the World Bank) [2]. Based on the discussions in paper 1, it is evident that waves of private participation in both developed and developing countries have transferred water control and/or management services, and lively controversies have marked the history of private involvement in the water sector, notably in light of a tension between the profit-maximizing approaches of private companies and the social benefits that might derive from unrestricted access to potable water and wastewater infrastructure, especially in middle and low-income countries. Therefore, in this study I aim to focus on middle and low-income countries, rather than more developed, high-income countries, as they have been the subject of more controversial debates. Also, it is expected that projects in high-income countries are fundamentally different in type of service provided

[2] See https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

from those in middle and low-income countries. Considering this choice, the World Bank database is an appropriate source for the required information.

2. World Bank Private Participation in Infrastructure (PPI) Database

The main source of data for this part and the following paper is the World Bank Private Participation in Infrastructure (PPI) Database. The database is compiled using publicly available sources and hence it is publicly available itself; also, its reliability depends on the accuracy of these sources. The following sources are used by the World Bank research team for the purpose of compiling this database:

- Commercial news databases such as Factiva, Business News America, ISI Emerging markets, and the Economist Intelligence Unit's databases
- Specialised and industry publications such as Thomson Financial's Project Finance International, Euromoney's Project Finance, Media Analytics' Global Water Intelligence, Pisent Masons' Water Yearbooks, and Platt's Power in Asia
- Government websites and reports
- Internet resources such as web sites of project companies, privatisation or PPP agencies, and regulatory agencies
- Sponsor information primarily through their web sites, annual reports, press releases, and financial reports such as 10K and 20F forms submitted to the NYSE
- Multilateral development agencies primarily through information on their websites, annual reports, and other studies

(World Bank, 2017a)

Information is also requested from or verified with project companies, sponsors, and regulatory agencies, if necessary. As far as possible, account is taken of the fact that the public sources used to construct this database may not contain accurate or all information that is required. For example, the website for this database mentions that different investment commitments may have been reported for some projects; in such cases the database used the investment figure which is most likely to be accurate. In cases where information on contractual obligations or investment commitments are not readily available, the dataset still includes the projects, but with limited information.

This database provides information about the contractual arrangements for public infrastructure projects in low, lower middle, and upper middle-income countries (based on the categorisation of the World Bank) in the period of 1949 to 2016. The countries included are categorised in six regions: East Asia and the Pacific, Europe and Central Asia, Latin America and the Caribbean, the Middle East and North Africa, South Asia, and Sub-Saharan Africa. The database records those contracts which have reached financial closure, and in which the private parties have assumed operating risks. The projects that are included in the database are not all fully privately financed, operated, or owned; in some cases, there is also public participation. Sectors in infrastructure, with high capital costs and traditionally served by the public sector, are included in the database. For the purpose of this paper, I have retrieved the data on the water sector which includes potable water generation and distribution, sewerage, collection, and treatment activities. It should be noted here that the database was last accessed and information gathered was updated in February 2017 for this study.

The database covers projects which are owned or managed by private companies, where private parties have at least 20% participation in the contract, in the above-mentioned categories of countries. For divestitures, those with at least 5% of equity owned by private parties are included. Private participation in projects are assumed if a private sponsor is, at least, partially responsible for operating costs and associated risks. This responsibility falls on the private sponsor by having the rights to operate solely, or in conjunction with a public entity, or by owning a share of equity in the project. The projects are classified in four groups in the database: management and lease contracts, brownfield projects, greenfield projects, and divestitures. In management and lease contracts, operational risks are partially transferred to a private sponsor through contractual obligations. In the other three categories, the operational risks are transferred to a private sponsor by contractual obligations and /or equity ownership in the project. It should be noted that, since these four categories cannot always be clearly distinguished from each other, and because some projects may have characteristics of more than one category, these cases have been categorised in the group which better reflects the risk borne by the private sector. A private sponsor is defined in the database as a company which is controlled and majority owned by private parties. Those state-owned companies or their subsidiaries which participate in projects located in foreign countries are also considered private investors. But, those partially divested state-owned companies or their subsidiaries which are majority owned by government bodies are not considered private sponsors in their own countries.

As mentioned before, the database includes projects which have reached financial or contractual closure. This status varies among different types of private participation:

- In the case of management and lease contracts, a contract authorising the start of management and lease services must be signed with the private consortium which is assuming the operation of the services.
- In the case of brownfield projects, contractual closure is reached when the concession agreement is signed and the date for taking over the operations is set.
- In the case of greenfield projects, financial closure is the date when a legally binding commitment of equity holders and/or debt financiers to provide or mobilise funding for the full cost of the project exists, and the conditions for funding have been met and the first tranche of funding is mobilised. In cases where this information is not available, construction start date is considered as an estimate for the financial closure date.
- In the case of divestiture project, the equity holders must have a legally binding commitment to acquire the assets of the facility; such commitment usually occurs at the signing of the share purchase contract.

The below information is recorded in the database:

- Project characteristics including:
  - Country, location, region, income group, and IDA status [3] of the project
  - Financial closure year, financial closure month, investment year, contract period, and project status
  - Project name
  - Sector, subsector, and segment
  - Type and subtype of PPI
  - Capacity type, capacity, and technology
- Sponsors (companies), their country of origin, and their shares and commitments
- Percentage private
- Bid criteria, award method, and number of bids
- Government granting contract, direct or indirect government support and their values, fees to government, physical assets, total investment

[3] IDA status determines whether countries are eligible to receive IDA (the International Development Association) resources.

- Main revenue source, and other revenue sources.
- Multi-lateral and bilateral support from international institutions (such as International Finance Corporation, European Investment Bank, etc.)
- Funding year, total debt funding, and debt equity grant ratio
- Project banks
- Unsolicited proposal, public disclosure, and description of source

The projects can have different status: active (for those which are about to start construction, or under construction, or operational), concluded (for those whereby the contract period has expired, and it was neither extended nor renewed by the operator or the government), cancelled (for those from which the private parties have exited by either selling or transferring economic interest back to the government before fulfilling the contract terms, or by removing management and personnel, or by ceasing operation, service provision, or construction for 15 percent or more of the license or concession period, following the revocation of the license or repudiation of the contract), and distressed (for those where the government or the operator has either requested contract termination or are in international arbitration).

While inspecting the data obtained from the World Bank database, I realised that for the projects where there have been reinvestments, multiple entries have been included. Such entries have been separated from the ones solely containing the information on when the project financial closure years are. All names, especially names of companies have been checked for the whole data, and anomalies have been corrected. Since no termination date has been reported for the projects, expected termination dates are calculated using the financial closure date and project duration; it should be emphasised that these dates are "expected" ones and they may not be correct for those projects which have terminated earlier than set out in the contracts. For missing information, first the whole data was consulted and some could be retrieved when it was reported elsewhere in the data. For missing information on companies' country of headquarters, manual searches have resulted in retrieving the majority of unknown information, with only two cases remaining as missing. Some of the characteristics reported in the data, included a large number of unavailable information; considering this point and also what has been of interest for this study, some characteristics have not been taken into account.

After cleaning the data, the dataset includes 975 projects recorded between 1949 and 2016, in 65 countries and with the presence of 453 companies. The table below shows one row of the data with all the characteristics which are considered in this work, as an example. It should be noted that although the projects were in low, lower middle, and upper middle-income countries, the origin of some companies were in high income countries. In the next section, the different aspects of the data are summarised and discussed using tables and graphs.

Table 2.1, A Sample of the Data.

Note: The different headings show the variety of information available. This example is about a specific project in Brazil.

Region	**Country**	**IncomeGroup**
Latin America and the Caribbean	Brazil	Upper middle income
IDA Status	**Financial closure year**	**Expected Termination**
Non-IDA	2007	2037
Project name	**Type of PPI**	**Subtype of PPI**
Comodoro Water and Wastewater	Brownfield	Build, rehabilitate, operate, and transfer
Project status	**Subsector**	**Segment**
Active	Water Utility	Water utility with sewerage
ContractPeriod	**GovtGrantingContract**	**DirectGovtSupport**
30	Local/Municipal	Not Applicable
InDirectGovtSupport	**InvestmentYear**	**PercentPrivate**
Not Applicable	2007	100
AwardMethod	**TotalInvestment (USD Million)**	**MultiLateralSupport**
Competitive bidding	1	No
Sponsors (Companies)	**Share (%)**	**Country**
Agrimat Engenharia Industria e Comercio	100	Brazil

2.1. Summary of Data

In this section, the different information reported in the data which is important for this study, as outlined in table 2.1, has been summarised with the help of graphical representation.

The projects included in the data have been carried out in six different regions, according to categorisation of the World Bank. As mentioned before, 65 countries in these regions are included in the data. The figures below show the spread of projects in the regions and the countries where the majority of the projects have been carried out.

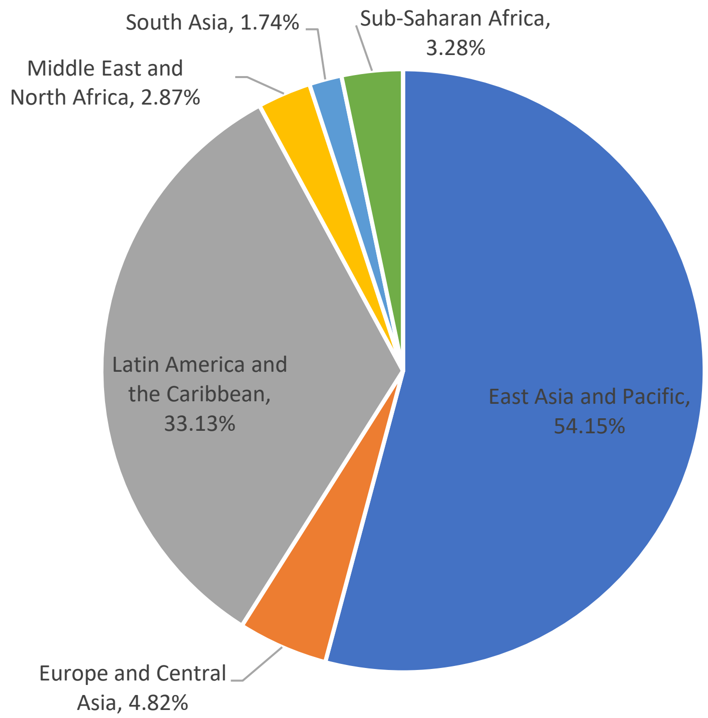

Figure 2.1, Distribution of Projects in Regions.

Note: Projects are distributed in six different regions. The pie chart shows the regional distribution of the total number of projects between 1949 and 2016.

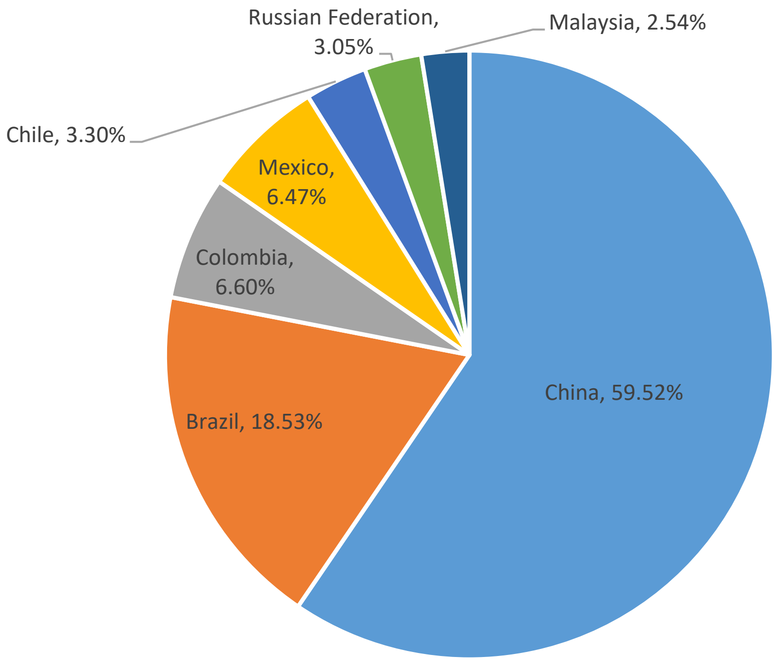

Figure 2.2, Distribution of Projects in Countries.

Note: Only the top seven countries in terms of the total number of projects between 1949 and 2016 are included.

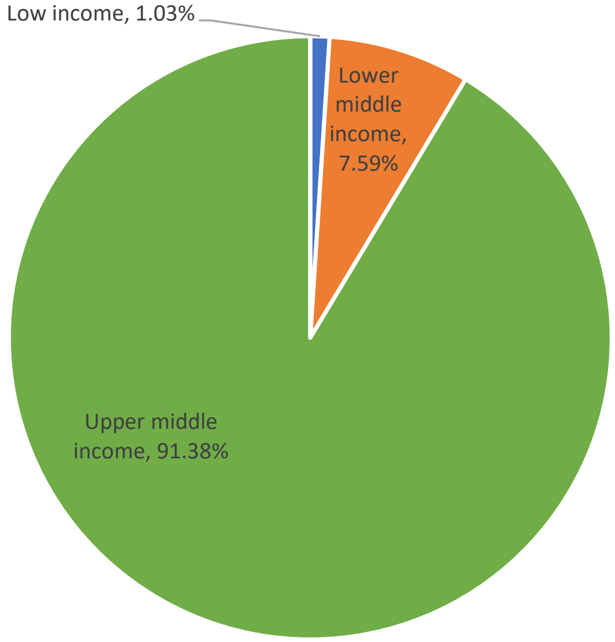

Figure 2.3, Distribution of Projects Based on Income Groups.

Note: The categorisation of countries income is by the World Bank. The projects are restricted to those in low and middle-income countries.

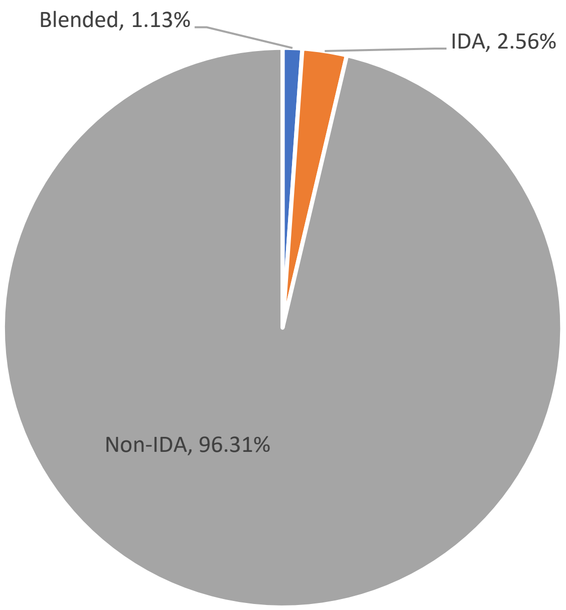

Figure 2.4, IDA Status of Countries.

Note: Most of the countries where the projects have been carried out are not member of the International Development Association (IDA).

From the above two figures, it is clearly seen that most of the projects have been in East Asia and Pacific, and specifically in China. Figures 2.3 and 2.4 above demonstrates that the majority of projects have been in upper middle-income countries, and that most of the projects have/are taken place in countries not eligible to receive IDA (the International Development Association) resources.

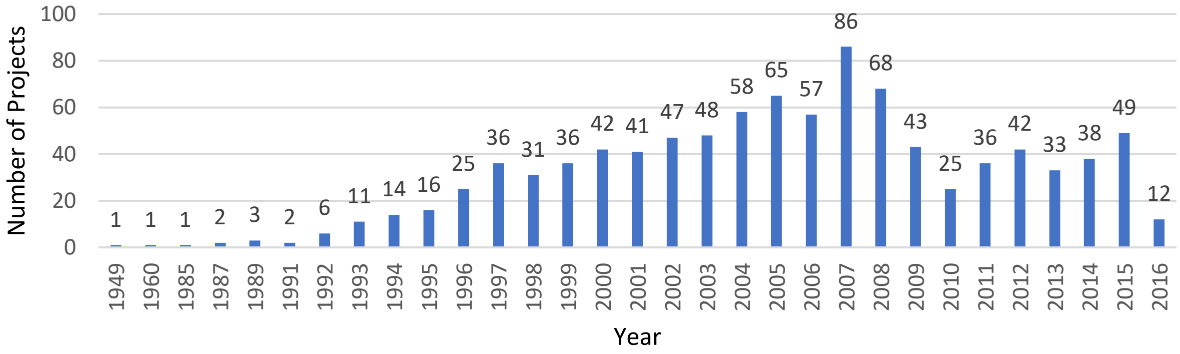

Figure 2.5, Distribution of Projects Based on Closure Years.

Note: The graph shows the gradual increase in interest in PPI project until the second half of the first decade of 2000s, and the changing patterns afterwards.

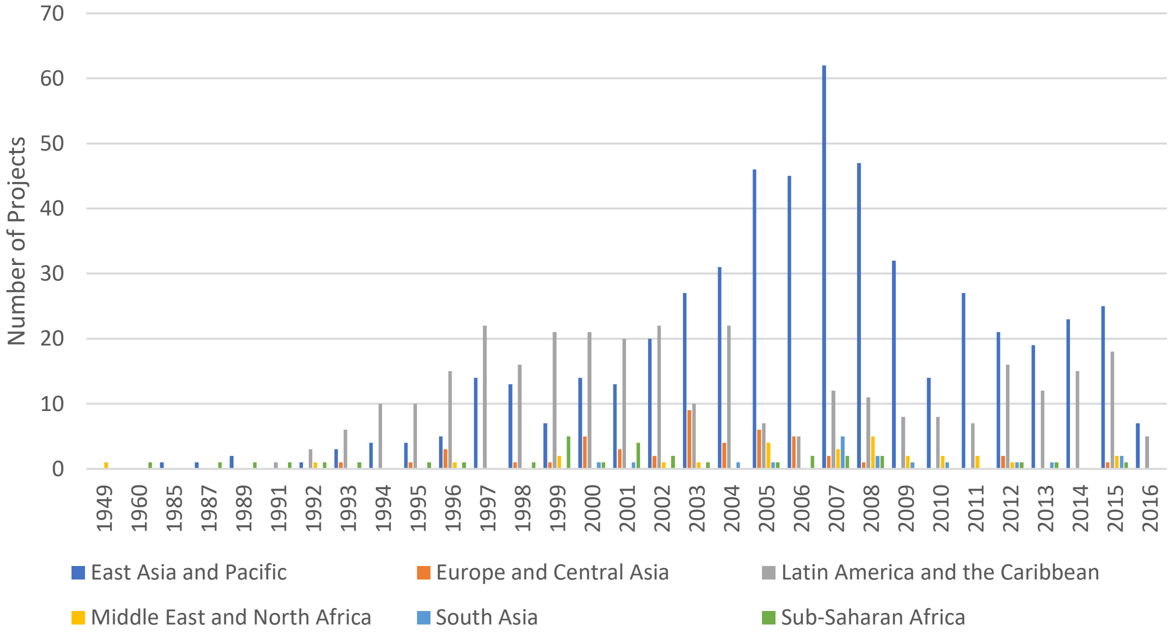

Figure 2.6, Number of Projects by Year and by Region.

Note: The occurrence of PPI projects has been different in various regions over the years; Latin America has seen the majority of numbers until early 2000s, and East Asia and Pacific in the following years.

The projects tend to cover a long period (as seen in figure 2.8 below) and it is of interest to see those periods where the majority of closure dates fall into. The two figures above show the gradual increase followed by decrease of private companies' participation in the sector, as well as the changing trend in various regions. Two regions seem to have more pronounced fluctuating numbers of projects, Latin America and Caribbean, and East Asia and Pacific; the cases of these regions have been discussed in paper 1 (section 3.2). Very few projects started before 1990; although this may have to do with the recoding of data, it is also in-line with the associated literature on private participation in water sector which states that private involvement in the sector was rare in 1980s, and significantly increased during the 1990s (see Bakker, 2013 for example). But by late 1990s, the private involvement in the sector started to decline, as a result of financial crises which influenced the foreign direct investment flows; from 2000 onward investment was globally significantly lower, excluding in China (Bakker, 2013). These patterns could be seen, to some extent, in the figures above, but since China seems to follow a different trend and the numbers of projects in China are quite substantial, we should look at its case separately and highlight the temporal differences between China and the rest of the world. The numbers for 2016 may be lower than actual number of projects, if there is a delay in updating the database, hence conclusions made on the involvement of private companies in 2016 should be made with caution.

As seen above, almost half of total projects with private participation have been carried out in China; this corresponds to 469 out of 975 of the total number of projects present in the dataset. The figure below shows the spread of financial closure dates of these 469 projects based on the years.

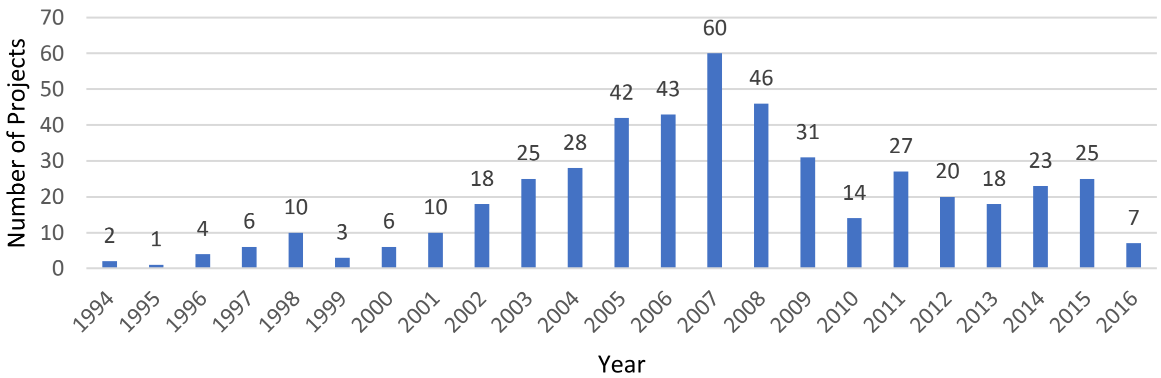

Figure 2.7, Distribution of Projects in China based on Financial Closure Years.

Note: The number of PPI projects in China has gradually increase from early 1990s, to reach its peak in 2007, followed by a decline.

The different pattern in China can be explained by the literature of private participation in the water sector. In the past four decades, China has seen rapid economic development accompanied by urbanisation. Statistics show that in 2016, urban population accounted for 57% of the country's total population, compared to 18% in 1978 (World Bank, 2017b). This rapid rate of urbanisation has undoubtedly affected investment and maintenance of urban infrastructure, including water and wastewater service. A report by World Bank in 2009 stated that China faced problems in lowering costs and improving operational efficiency in its water sector which was mainly run by local governments; water utilities were unable to provide adequate water pressure to more than 40% of the service area, as well as high leakage rates (World Bank, 2009). To overcome such issue, private participation in water sector has been encouraged in China since early 1990s. Private investors were allowed in to the urban water sector in a pilot basis in 1992, this was followed by formal nationwide private entry in 2002 (Jiang & Zheng, 2014).

As mentioned before, projects have varying durations, but the majority are for 20 years and longer. It is important to point out here that 144 cases have unavailable duration information in the data. The average duration is 22 years for cases with available information, the minimum is 1 and the maximum is 95 years respectively, with a standard deviation of 17.

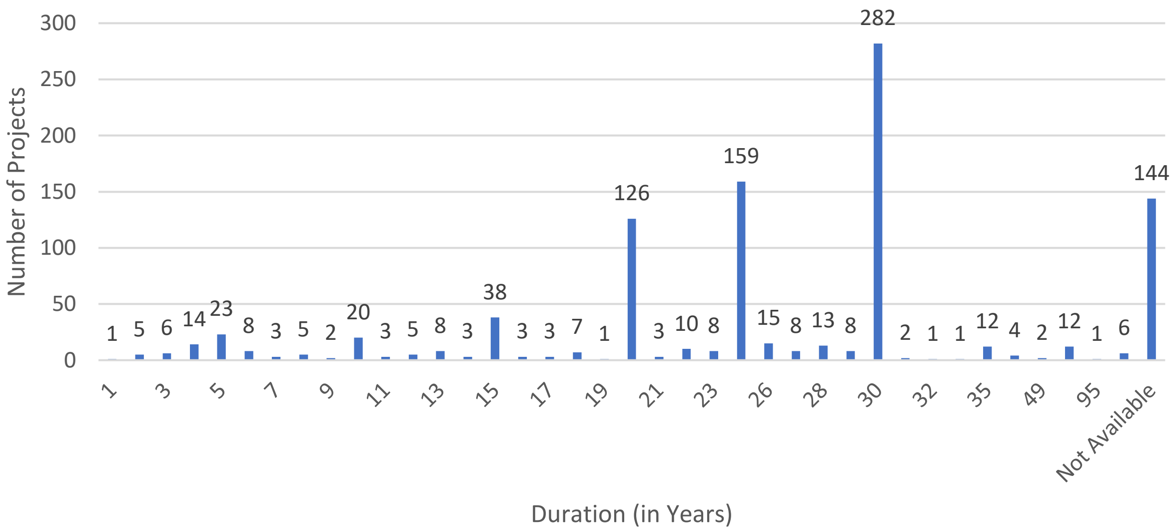

Figure 2.8, Duration of Projects in Years.

Note: The majority of PPI projects are more than 20 years long.

Private involvement in the projects differ from one case to another, but as clearly depicted in the figure below, the majority are 100% private.

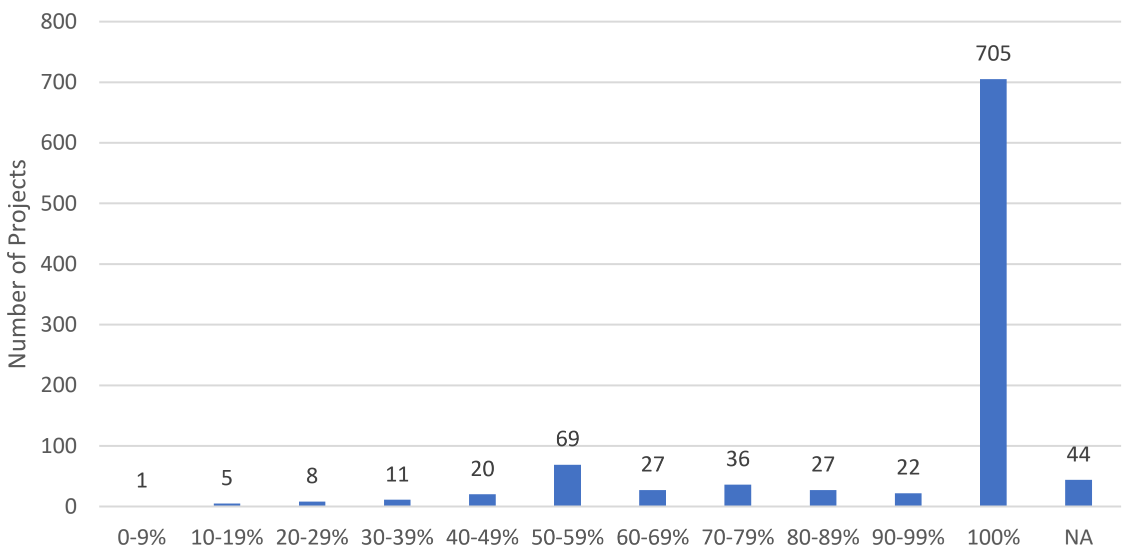

Figure 2.9, Percentage Private in Projects.

Note: Although PPI projects do not need to be 100% private, the majority are, followed by those that are 50-59% private.

It has been mentioned before that the PPI projects have been classified in various groups based on their types, subtypes, subsectors, and segments. It should be noted here that the primary sector for all the projects is water and sewerage. The four figures below show the distributions of projects based on these four categorisations; these categorisations have been introduced in paper 1 (section 3.1).

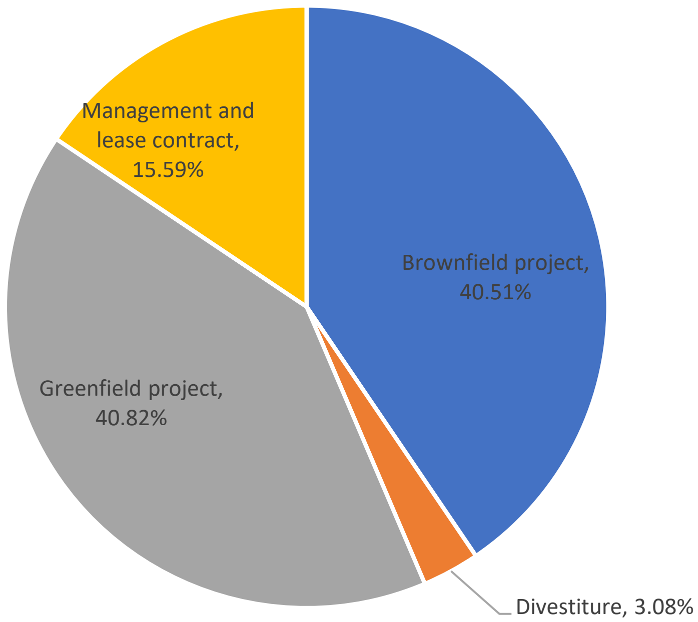

Figure 2.10, Distribution of Projects Based on Types of PPI.

Note: Four different types of PPIs are reported in the data; most projects are greenfield or brownfield ones.

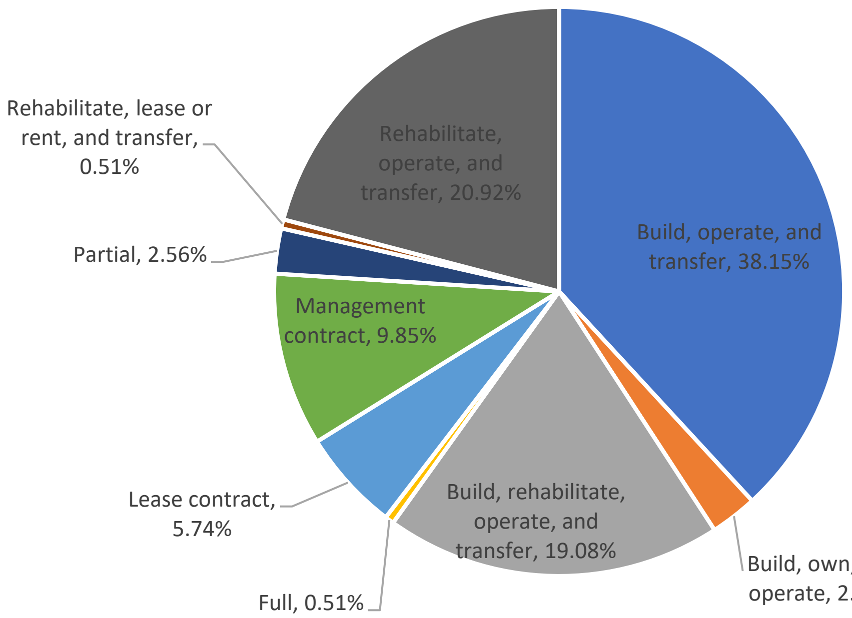

Figure 2.11, Distribution of Projects Based on Subtypes of PPI.

Note: Within the four types of PPIs, there are nine different subtypes. The graph suggests that majority of projects have elements of build, operate, rehabilitate, or transfer.

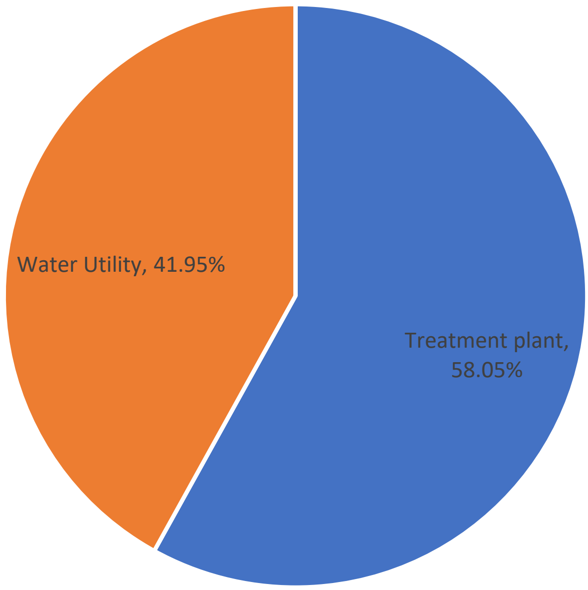

Figure 2.12, Distribution of Projects Based on Subsectors.

Note: The PPI projects have mostly been put in place for treatment of water and sewerage.

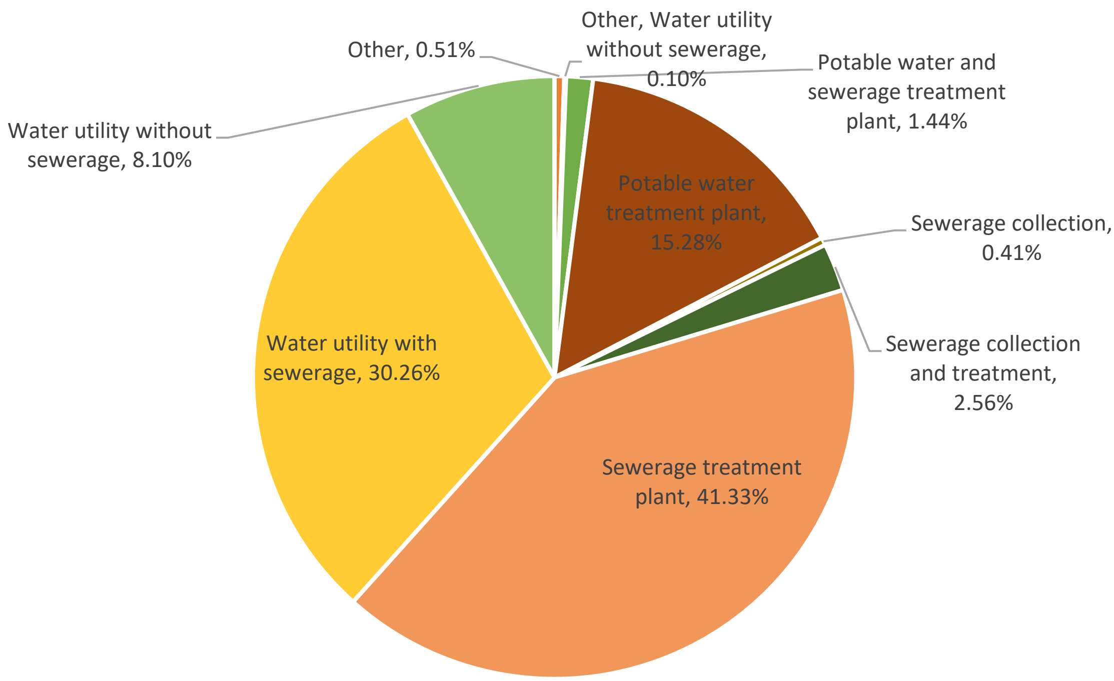

Figure 2.13, Distribution of Projects Based on Segments.

Note: The variations of activities fulfilled by PPI projects are seen in this pie chart; sewerage treatment seems to be the mostly done activity.

The projects listed in the dataset can have any of the four statuses as seen in the figure below. As clearly depicted in figure 2.14, most of the projects are still running. Considering the common long durations for projects, as illustrated in figure 2.8, it is expected that most are not yet concluded. Among the ones that are not active anymore, the ones that have not been successful; i.e. they have either been cancelled or are/were distressed, form 6.46% of the projects. But the difference in the number of those that are concluded (6.26%) and those that are/were distressed and are cancelled (6.46%) is not significant.

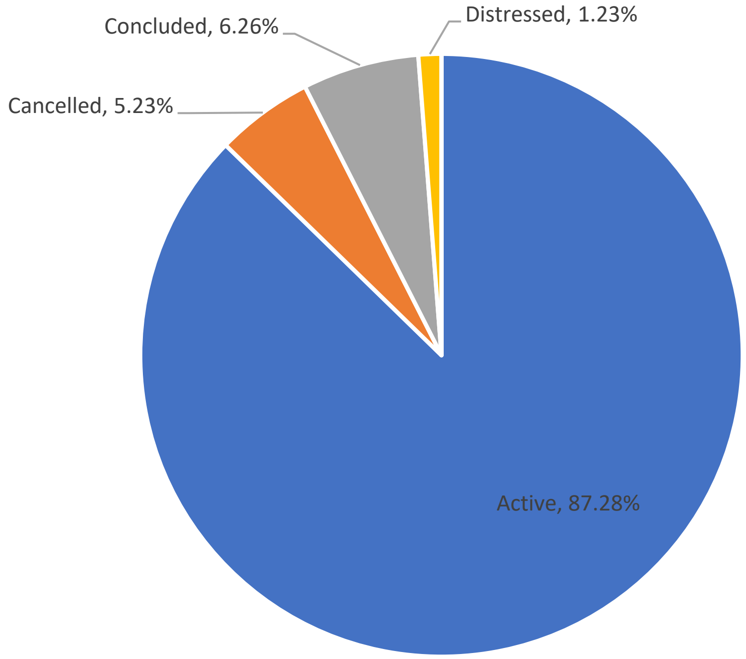

Figure 2.14, Project Status.

Note: The majority of the PPI projects, reported in the data for 1949 to 2016, are still active, the number of distressed and cancelled ones is not very significant.

Another interesting insight we can obtain from the data is identifying the project granting entities. As seen in the figure below, most of the projects are granted by local/municipal bodies; this is consistent with what is known on the water sector, that the water services are mostly managed at sub-national level.

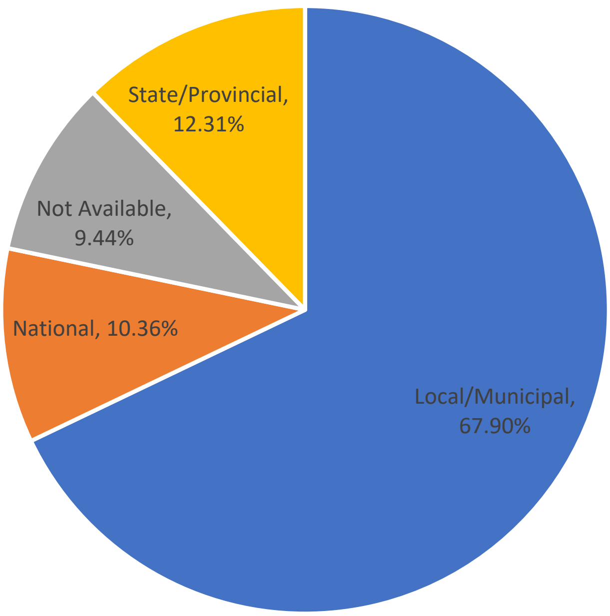

Figure 2.15, Government Granting Bodies.

Note: PPI projects can be awarded by different government entities on various levels. Local/municipal bodies have awarded most of the PPI projects over the years.

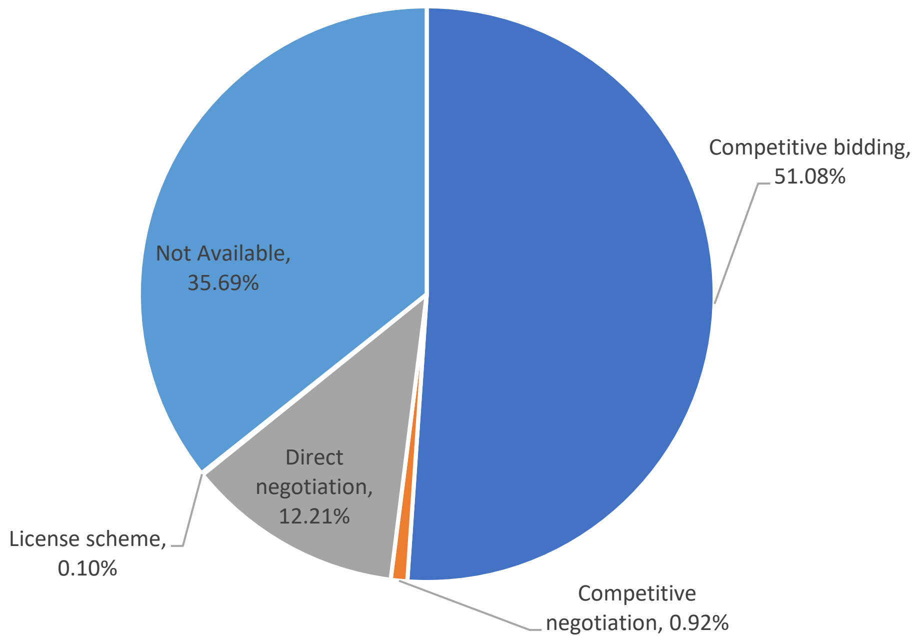

Figure 2.16, Award Methods.

Note: Within the available data, most PPI projects have been awarded by competitive bidding.

Although there is a lot of information missing regarding the methods by which these projects have been awarded (approximately 36% of the cases), in most of known cases the companies have been involved in competitive bidding. The direct method by which the governments support the projects are only known for 153 projects; capital subsidy supported/support 70 projects while 83 have made use of revenue subsidy. Information on indirect government support is available for 84 projects; 63 used/use payment guarantees, 18 are in receipt of revenue guarantee, 3 each have used/use debt guarantee, exchange rate guarantee, and tax deduction/government credit.

In this section, the main components of the data have been described with the help of some graphs and charts. Understanding the data and what it provides in terms of various information is of paramount importance for clarifying why the steps explained in the next sections have been taken for the analysis of the data. Section 2.2 below looks at another interesting insight we can gain from the data: how these projects have been financially supported by international institutions.

2.2. Multilateral Support

Another interesting information that is found in the data which can help understand the sector is the multilateral support given to some of the projects by international institutions. The importance of the involvement of some of these institutions have been discussed in paper 1 (section 3.2). For 76 out of the 975 projects in 39 countries multilateral support is reported; the name of the institutions [4] providing the support, the year it was provided, the type of it, and the amount is specified. For 36 out of these 77 projects in 22 countries, more than one institution has provided support or one institutions has provided support in multiple years. The graph below shows the distribution of types of support among projects by different institutions. It can be clearly seen that the majority of financial support has been received in the form of loans.

[4] For full names of these institutions, refer to the List of Abbreviations and Acronyms.

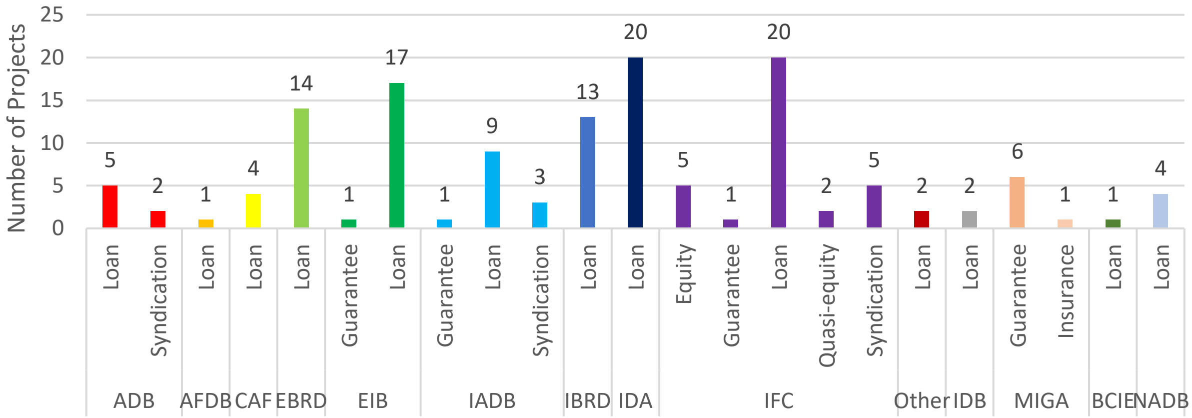

Figure 2.17, Number of Project that Received Financial Support by Type and by Institution.

Note: Different international institutions have provided financial support to the PPI projects; the financial support can take different forms. Loans seem to be the most common type of support, and IDA, IFC, and EIB have provided support to most of the projects.

The involvement of this institutions has varied throughout the years. The plot below shows the total amount of support provided by each institution each year. It can be seen that not only different institutions have been more involved at certain periods, but also the amount of their support has varied significantly in different years; While in 1990s, EIB, IFC, IADB, and ADB were providing more support, in late 2000s, it is EBRD and CAF that have been more involved. Also, there is a significant decrease of the total amount provided between 2000 and 2008. To make sure this observation is not influenced by the number of support incidences that have happened each year, we look at the distribution of number of times that support was provided in each year, as depicted in figure 2.19.

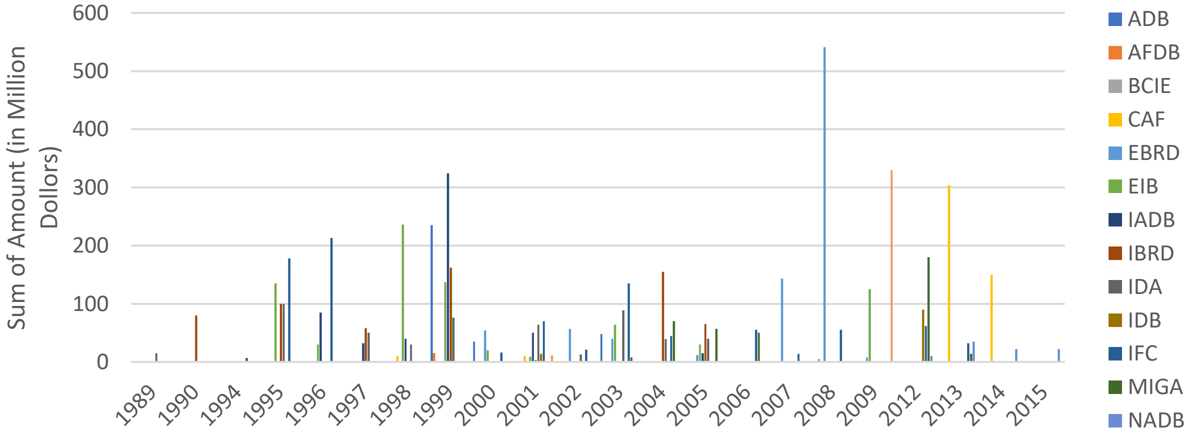

Figure 2.18, Total Amount of Support by Institution per Year.

Note: The peak of the amount of financial support, over $500 million, is in 2008, provided by EBRD.

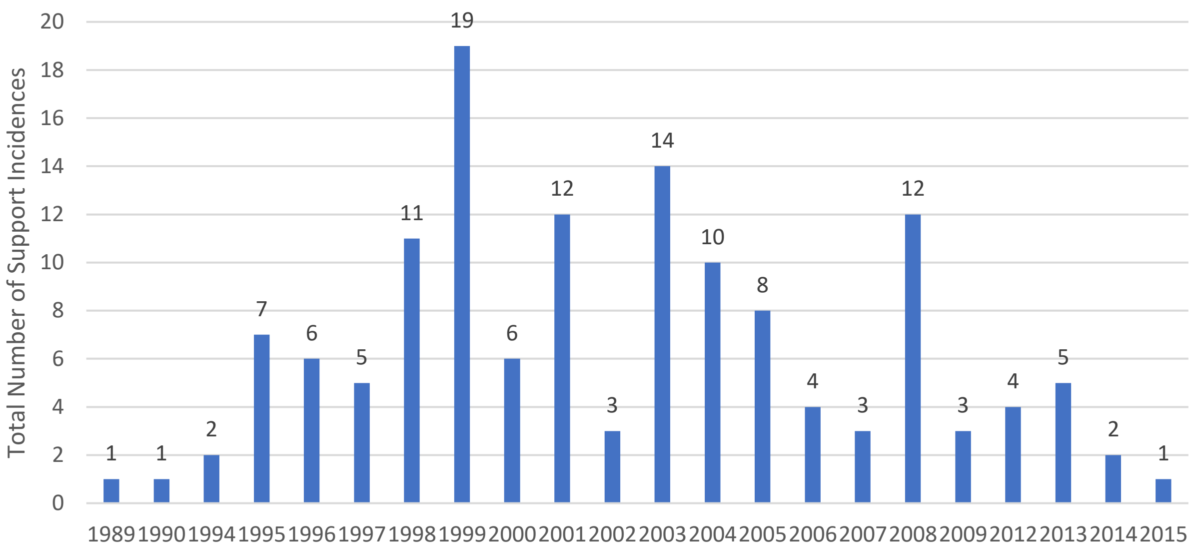

Figure 2.19, Distribution of Support Incidences per Year.

Note: The projects with the closure data of 1999 have received more financial support from international institutions compared to rest. Overall, more support has been provided to these projects after 2000s.

The two figures above clearly illustrate that early 2000s have seen quite a few number of support incidences, especially when compared with later years, but at the same time with less amount of money being provided. This is the era when the private participation in the sector was on the decline. As mentioned before support has been provided for various countries and some have received multiple support from one or more intuitions. The figure below shows the involvement of different institutions for each country; IFC has supported Argentina and Russia several times and EBRD has done the same for Russia.

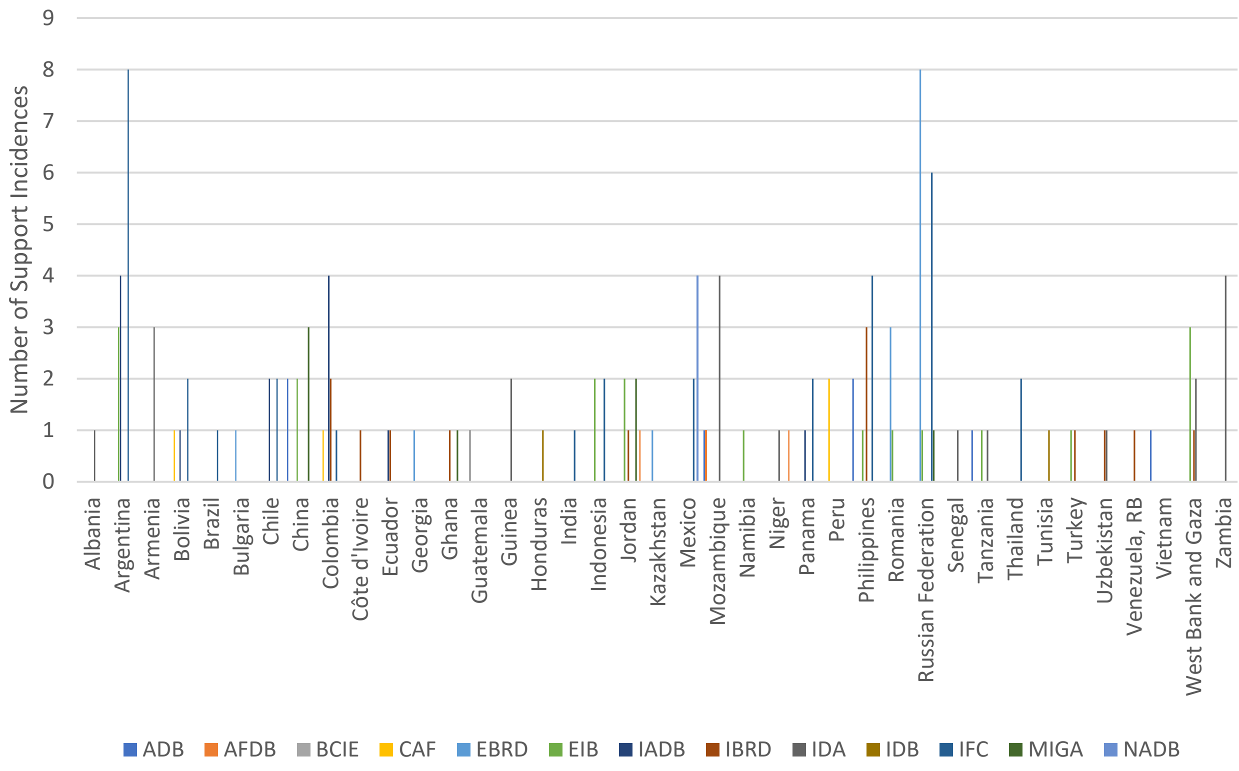

Figure 2.20, Number of Support Incidences by Institution per Country.

Note: The number of PPI projects in Russian Federation (from EBRD, IFC, MIGA, and EIB) and Argentina (from IFC, EIB, and IADB) that have received financial support significant.

Lastly, 78 companies have been involved in the projects which have received multilateral support; Veolia Environnement and Suez, the two largest multinational enterprises in this sector to which paper 4 is dedicated are both in the list, present in 12 and 13 projects out of 76 respectively.

2.3. A Note on Shares of Companies in Projects

As mentioned earlier, companies can have different shares in PPI projects. Out of 739 projects carried out by only one company, 500 have been awarded fully to the private company involved, i.e. the share of the company has been 100%, while in others the share of private company involved is less than 100% and hence there is some involvement by the public sector. The majority of these projects (287 out of 500) are in China and Chinese private companies have carried out more 100% share projects than any other company.

But among the projects in which more than one company has been involved (236 out of 975), the situation is different. From among well-known companies, Suez is a very prominent actor in this type of projects being involved in 44 projects (highest number by accompany) while

Veolia has contributed to 12 projects. It is also interesting to see that Suez has taken the majority or equal shares to its partners in 33 projects out of 44. In the rest of the projects, the distribution of shares has varied, with some cases of equal shares between partners and in others a visible leader in terms of having majority shares. This variation in share is considered in the construction of the dataset which is analysed in paper 3.

In the following sections, sections 3 and 4, the discussed data is analysed using Multiple Correspondence Analysis method and by descriptive Network Analysis measures.

3. Data Analysis: Multiple Correspondence Analysis

In the last section, an overview of the data used for this study and the different variables reported in the dataset was provided. The majority of the present variables are of categorical nature. The graphical representation of the data, as outlined by the last section has provided some insight into the dataset and the distribution of variables. But it is of interest to discover patterns of relationships between the various variables; this has been achieved by conducting Multiple Correspondence Analysis (MCA), which is an extension of Correspondence Analysis (CA). MCA has been extensively discussed in the literature, some of the early examples of using MCA are the works of Greenacre and Hastie (1987), Nishisato (1986), and Jambu and Lebeaux (1983). MCA is a method for analysing the pattern of relationships of several categorical dependent variables. The method is used to sum up and to simplify the data by reducing the dimensionality of the data set. This method could be considered as a generalisation to Principal Component Analysis, where variables are categorical instead of quantitative.

By using an indicator matrix, a matrix with only 0 and 1 entries, and applying a standard correspondence analysis on this matrix, MCA is obtained. Abdi and Valentin (2007) explain in their work that MCA can be used to analyse either a set of observations which could be described by a set of nominal variables or quantitative variables which are recorded as "bins". For the case of nominal variables, each variable has several categories and each category is coded as a binary variable; for example, in the data for subsector (water utility vs. treatment plant), the nominal variable has two categories, and the pattern for water utility is 1 0 while for treatment plant it is 0 1. For the case of quantitative variables, range of numbers are to be coded as nominal variables with different categories based on how the range is separated into subranges. The procedure of recoding of variables in MCA is essentially recoding the variables as dummies for the indicator matrix (Greenacre, 2017).

Husson and Josse (2014) define three main objectives for MCA:

- By investigating the similarities between individuals from a multi-dimensional perspective, MCA provides a topology of such individuals.
- MCA assesses the relationship between variables and associations between categories.
- MCA brings together the investigation of individuals and categories, so that individuals can be characterised using the variables.

It is evident that performing MCA analysis on the data provides useful information about the relationship between the different variables, which could then help in explaining patterns of private participation in the water sector.

3.1. MCA Indicator Matrix Algorithm

Assuming Q nominal variables, each nominal variable (q) having J_q categories J being the total number of categories:

$$J = \sum_q J_q$$

The indicator matrix, Z, then has J columns, and is composed of a set of sub-tables, Z_q; each of these sub-tables correspond to one variable and they are stacked side by side. The total inertia of the indicator matrix is equal to the average of the sub-tables' inertias.

$$inertia(Z) = \frac{1}{Q}\sum_q inertia(Z_q) = \frac{1}{Q}\sum_q (J_q - 1) = \frac{J - Q}{Q}$$

With $J_q - 1$ being the dimensionality of sub-table Z_q which equals to its total inertia, and $J - Q$ being the dimensionality of Z. We can also state that the average inertia per dimension is $\frac{1}{Q}$.

Another way of structuring data of MCA is the use of "Burt" Matrix, which is a complete set of pairwise cross tabulations (Greenacre, 2017).

3.2. Data preparation for MCA

In previous sections, a general description of the data and its various variables has been provided. For the purpose of MCA analysis, this dataset comprising of different projects has been used. In this dataset, each row includes all the information for a project which could have been carried out by one or more participating private company. For MCA analysis, I consider each project as one entity, regardless of the companies and countries involved, and hence the dataset includes information on 975 projects in 975 rows.

The following table shows variables that have been included in the dataset for MCA analysis, as well as different categories for each variable, the last column in the table corresponds to the number of occurrence for each category of variable.

Table 2.2, MCA Variables and Categories.

Note: The table summarises the data used for MCA: the first column corresponds to variables, the second one to the different categories of variables, and the third to how many times the categories have occurred in the dataset.

Variable	Category	No Occurrence
Region	South Asia	17
	East Asia and Pacific	528
	Middle East and North Africa	28
	Sub-Saharan Africa	32
	Europe and Central Asia	47
	Latin America and the Caribbean	323
Type of PPI	Greenfield project	398
	Brownfield project	395
	Management and lease contract	152
	Divestiture	30
Subtype of PPI	Build, operate, and transfer	372
	Build, own, and operate	26
	Build, rehabilitate, operate, and transfer	186
	Rehabilitate, operate, and transfer	204
	Rehabilitate, lease or rent, and transfer	5
	Lease contract	56
	Management contract	96
	Partial	25
	Full	5

Project status	Active Concluded Cancelled Distressed	851 61 51 12
Subsector	Treatment plant Water Utility	566 409
Segment	Water utility with sewerage Water utility without sewerage Potable water treatment plant Potable water and sewerage treatment plant Sewerage collection Sewerage treatment plant Sewerage collection and treatment Other	295 79 149 14 4 403 25 6

The aim of doing MCA in this part is to identify patterns regarding the projects, hence the above variables among all, which describe various aspects of projects, have been chosen. Section 3.3 below discussed the results of the MCA.

3.3. MCA Results and Discussion

The analysed dataset, as explained before, includes 975 projects (individuals) and 34 categories among 6 different variables. It can be construed as a cloud of projects which could be represented in a space of 34 dimensions. The MCA consists in projecting this cloud onto its "principal directions", thereby reducing the dimensionality of this space. Here, the first two dimensions of the MCA express 23.6% of the total dataset inertia; that means that 23.6% of total variability in the cloud of individuals (and variables) is explained by the plane. This value is greater than the reference value that equals 9.54%, the variability explained by this plane is thus significant (the reference value is the 0.95-quantile of the inertia percentages distribution obtained by simulating 372 data tables of equivalent size on the basis of a uniform distribution). However, this is a small percentage and the first plane just represents a part of the data variability: hence, we cannot limit ourselves to studying the cloud solely via its projections onto the first two axes. From these observations, it is interesting to consider the next dimensions which also express a high percentage of the total inertia. An estimation of the right number of axes to interpret suggests restricting the analysis to the description of the first 8 of them. These axes present an amount of inertia greater than those obtained by the 0.95-quantile of random distributions (55.01% against 35.41%). This observation suggests that only these axes are carrying a real information. Therefore, the description will stand to these axes. The below table shows the eigenvalues for the first 8 dimensions, while the figure shows the inertia distribution. [5]

Table 2.3, Eigenvalues for MCA Analysis.

Note: For the eight dimensions, corresponding eigen values and variance percentages are reported. The 8 dimensions add up to 55.01% of variances.

	Eigenvalue	Variance Percent	Cumulative Variance Percent
Dim.1	0.63	14.03	14.03
Dim.2	0.43	9.59	23.62
Dim.3	0.34	7.55	31.17
Dim.4	0.25	5.52	36.69
Dim.5	0.22	4.92	41.61
Dim.6	0.22	4.78	46.39
Dim.7	0.20	4.45	50.84
Dim.8	0.19	4.17	55.01

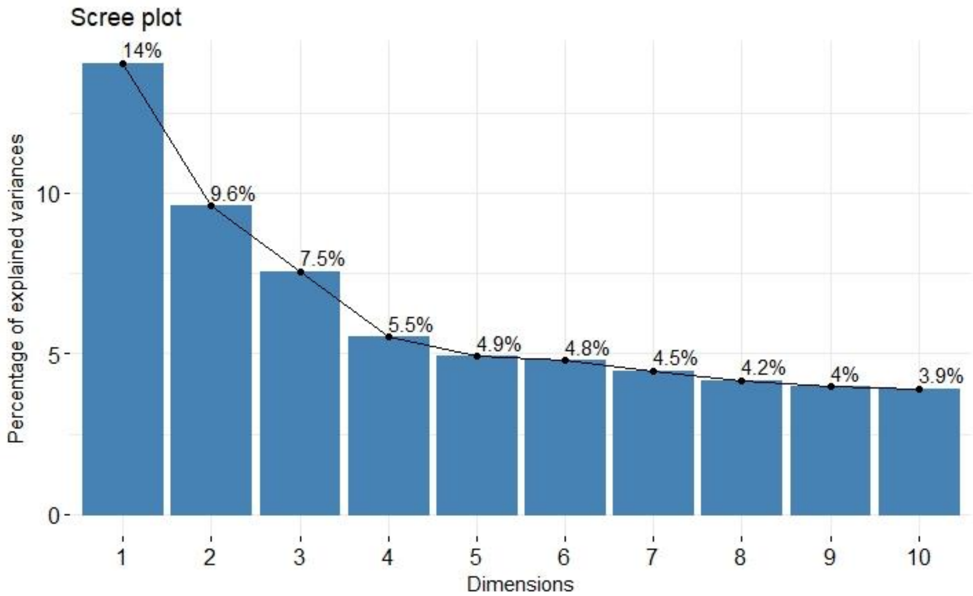

Figure 2.21, Decomposition of the Total Inertia on the Components of the MCA.

Note: The first two dimensions express 23.6% of the total dataset inertia. This value is greater than the reference value that equals 9.54%.

[5] See Appendix 2 for additional information on MCA results.

The two figures below show the factor maps for individuals (projects) and the variables in dimensions 1 and 2. The distance between any pair of points in these plots shows a measure of their similarity (or dissimilarity).

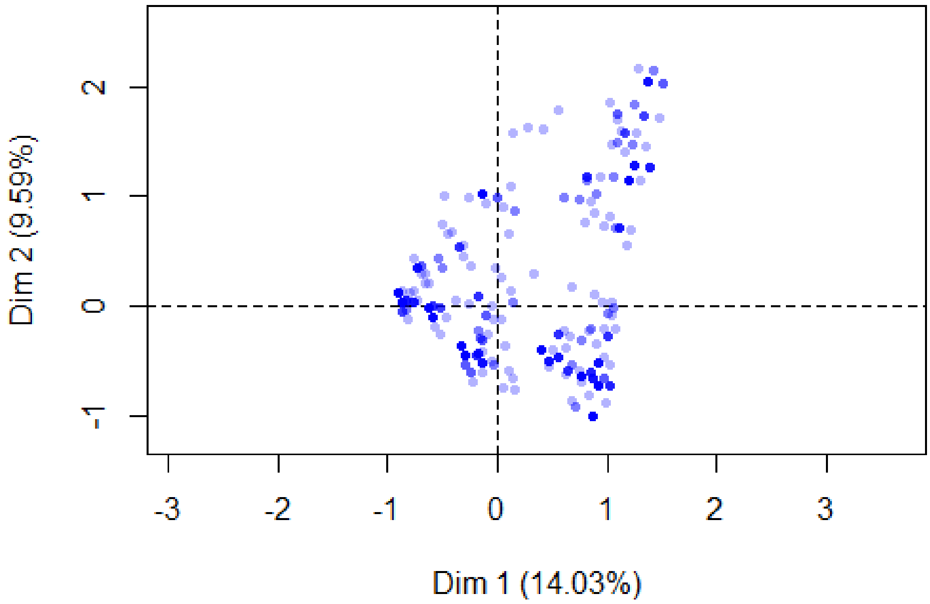

Figure 2.22, Individuals factor map (MCA) for Dimensions 1 and 2.

Note: The factor map shows projects and variables in dimensions 1 and 2 Distance between any pair shows a measure of their similarity.

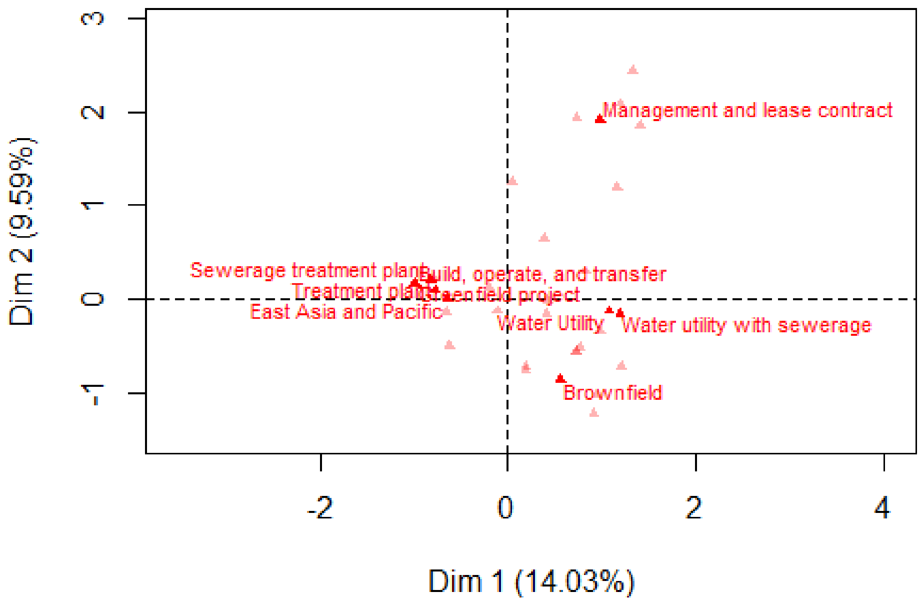

Figure 2.23, Variables factor map (MCA) for Dimensions 1 and 2.

Note: The labelled variables are those the best shown on the plane; they include variables of region, sector, subsector, type, and subtype.

From the results, we can deduce that the dimensions 1 and 2 do not sufficiently discriminate individuals, that is, do not bring to light factors whose frequency differs significantly from the mean. For dimensions 3 and 4, the results are as follows:

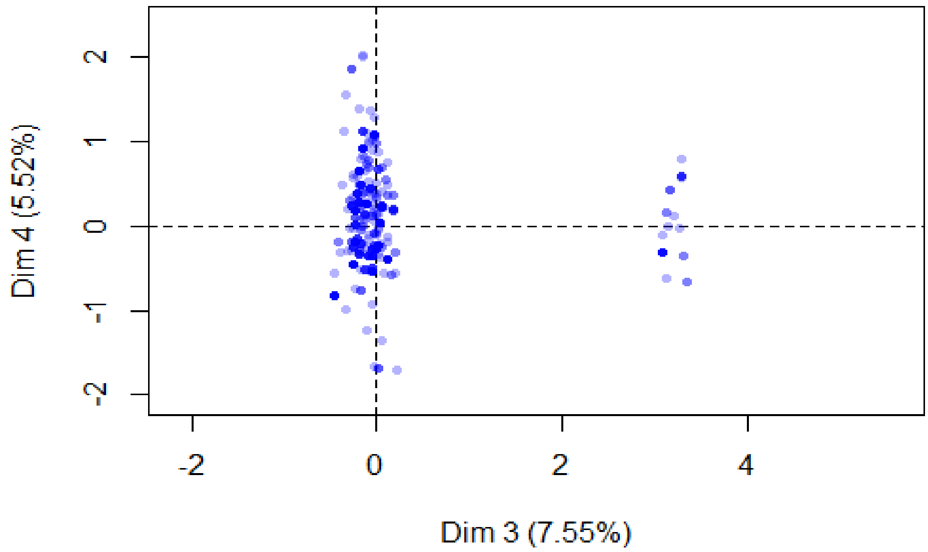

Figure 2.24, Individuals factor map (MCA) for Dimensions 3 and 4.

Note: The factor map shows projects and variables in dimensions 3 and 4 Distance between any pair shows a measure of their similarity.

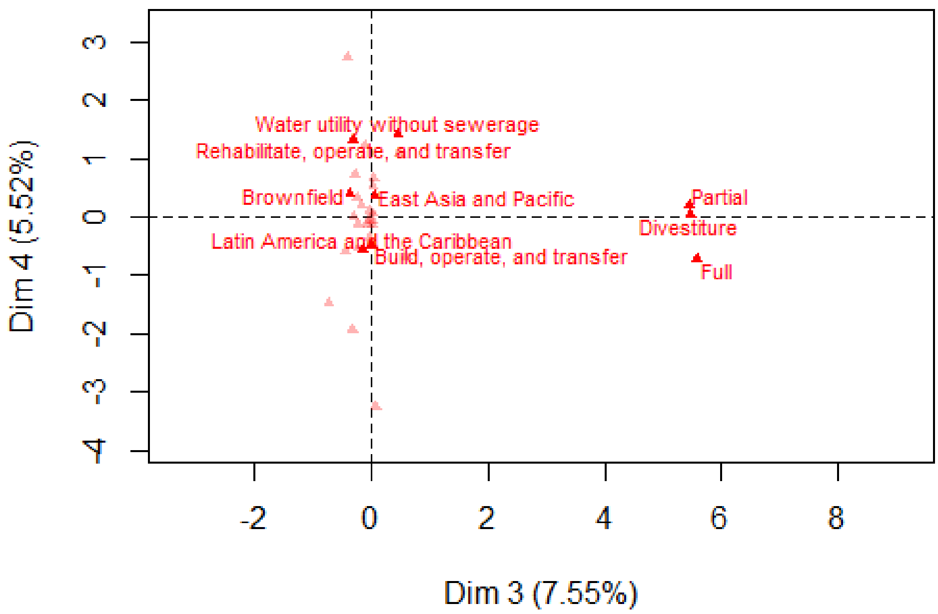

Figure 2.25, Variables factor map (MCA) for Dimensions 3 and 4.

Note: The labelled variables are those the best shown on the plane; they include variables of region, sector, subsector, type, and subtype.

The **dimension 3** opposes individuals characterized by a strongly positive coordinate on the axis (to the right of the graph) to individuals characterized by a strongly negative coordinate on the axis (to the left of the graph). Note that the factor *Divestiture* is highly correlated with the dimension (correlation of 0.02). This factor could therefore summarize itself the dimension 3; while factor *Partial* also shows correlation with this dimension. The **dimension 4** opposes individuals characterized by a strongly positive coordinate on the axis (to the top of the graph) to individuals characterized by a strongly negative coordinate on the axis (to the bottom of the graph). Factors *East Asia and Pacific* and *Build, operate, and transfer* show correlation with this dimension.

For dimensions 5 and 6, the results suggest the following.

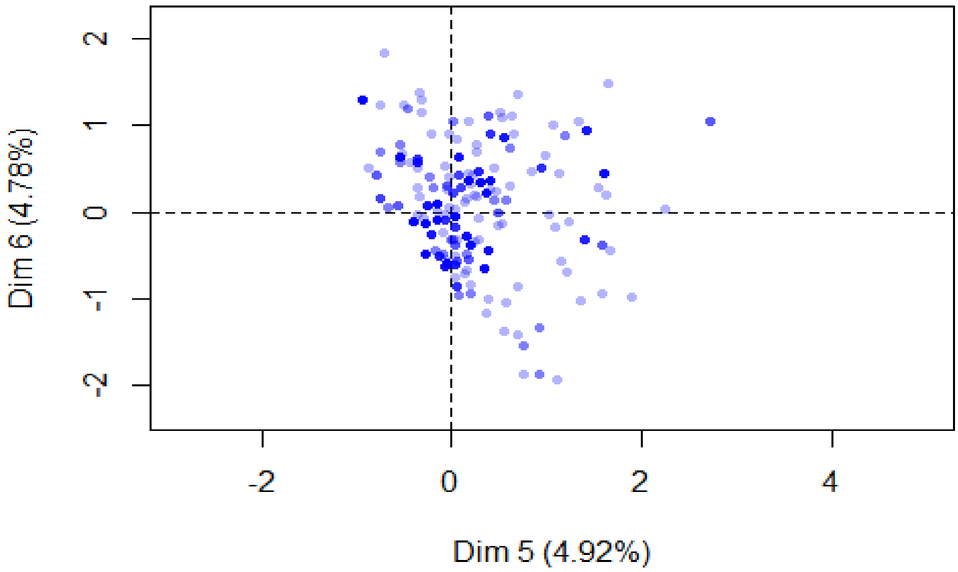

Figure 2.26, Individuals factor map (MCA) for Dimensions 5 and 6.

Note: The factor map shows projects and variables in dimensions 5 and 6. Distance between any pair shows a measure of their similarity.

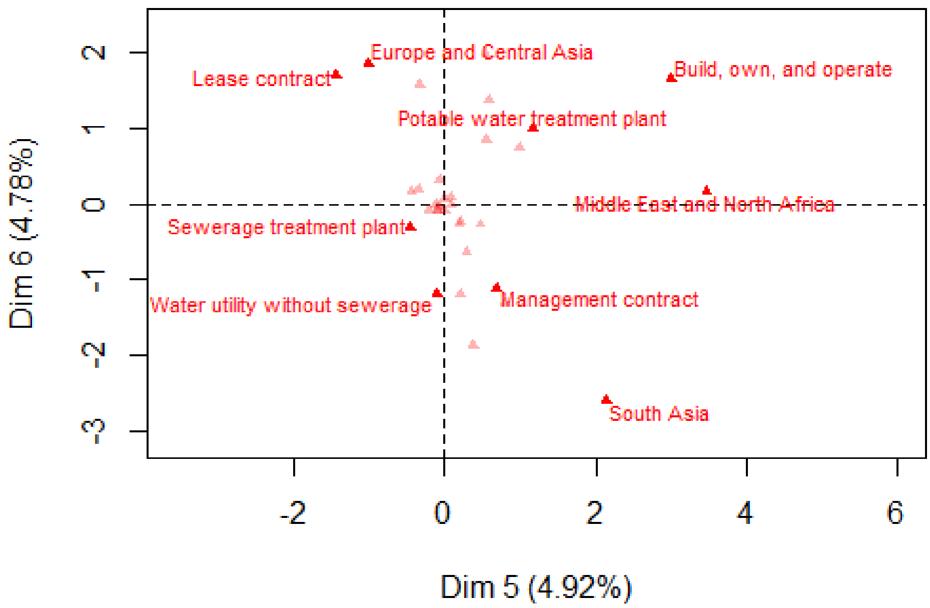

Figure 2.27, Variables factor map (MCA) for Dimensions 3 and 4.

Note: The labelled variables are those the best shown on the plane; they include variables of region, sector, subsector, type, and subtype.

The **dimension 5** opposes individuals characterized by a strongly positive coordinate on the axis (to the right of the graph) to individuals characterized by a strongly negative coordinate on the axis (to the left of the graph). *Middle East and North Africa* is the factor correlated with this dimension. The **dimension 6** opposes individuals characterized by a strongly positive coordinate on the axis (to the top of the graph) to individuals characterized by a strongly negative coordinate on the axis (to the bottom of the graph). And for this dimension, factor *Water utility without sewerage* shows correlation.

And for dimensions 7 and 8, we see the followings:

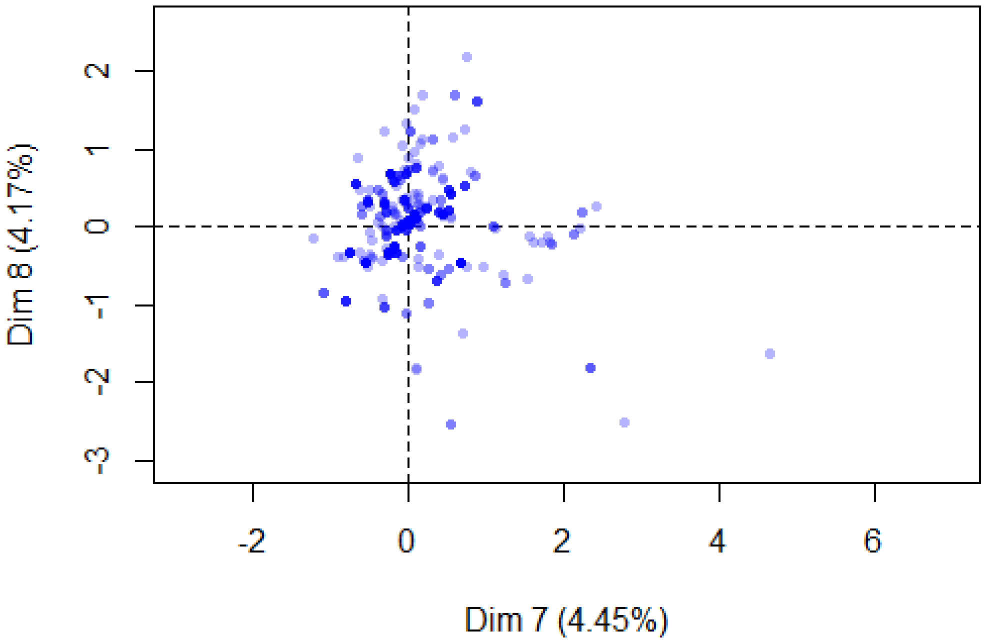

Figure 2.28, Individuals factor map (MCA) for Dimensions 7 and 8.

Note: The factor map shows projects and variables in dimensions 7 and 8 Distance between any pair shows a measure of their similarity.

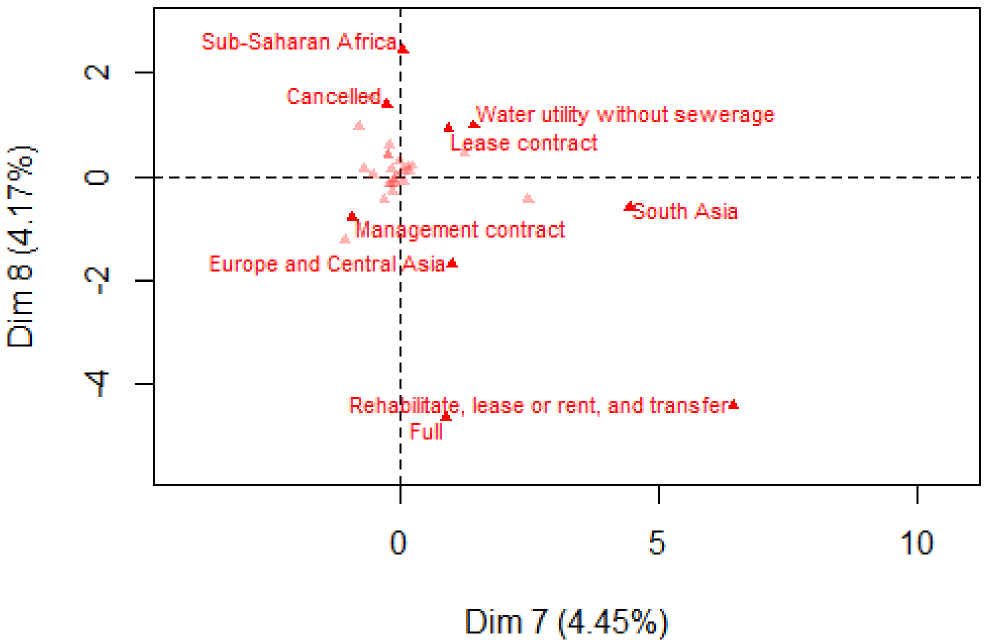

Figure 2.29, Variables factor map (MCA) for Dimensions 3 and 4.

Note: The labelled variables are those the best shown on the plane; they include variables of region, sector, subsector, type, and subtype.

The **dimension 7** opposes individuals characterized by a strongly positive coordinate on the axis (to the right of the graph) to individuals characterized by a strongly negative coordinate on the axis (to the left of the graph). None of the factors show significant correlation with this dimension. The **dimension 8** opposes individuals characterized by a strongly positive coordinate on the axis (to the top of the graph) to individuals characterized by a strongly negative coordinate on the axis (to the bottom of the graph). Factors *Sub-Saharan Africa* and *Cancelled* (to some extent) show correlation with dimension 8. Overall the results of MCA highlight some important dimensions, but without revealing very strong differences between the factors.

However, it is possible to expand upon an MCA with classification methods, which can be helpful to build classes and typologies by distinguishing several types of individuals. In particular hierarchical ascending classification is applied here, using the 8 dimensions identified above to partition the population of projects into homogeneous clusters, characterized by low within-variability and high between-variability (figure 2.30 and table 2.4).

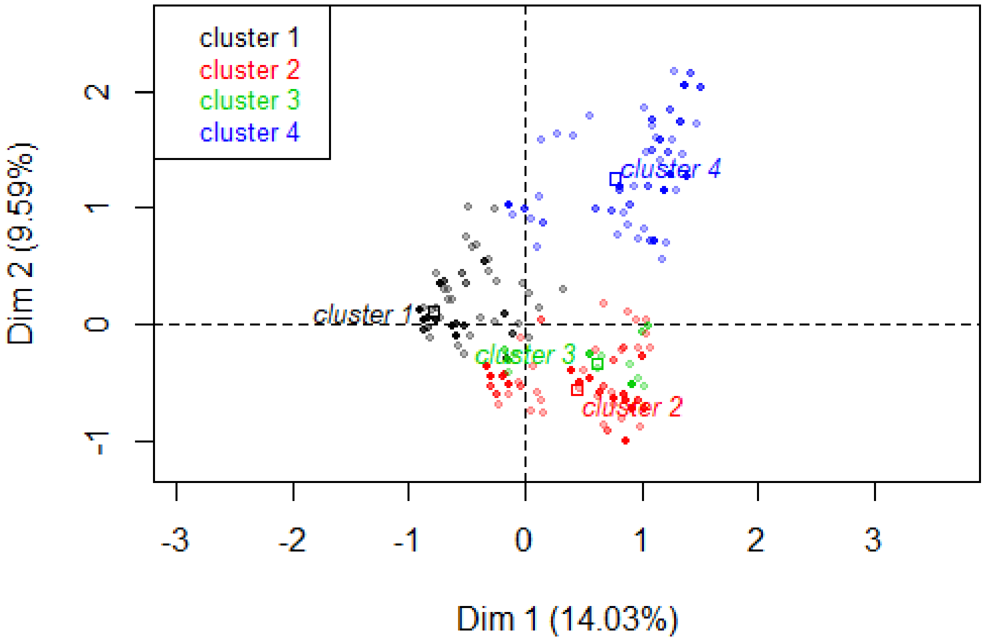

Figure 2.30, Ascending Hierarchical Classification of the individuals.

Note: Four cluster are identified made of individuals sharing groups of factors, also see table 2.4.

The classification made on individuals reveals 4 clusters. Looking at the clusters identified by MCA analysis, as depicted in the figure above, these clusters are made of individuals sharing groups of factors as shown in the table below. Green cells indicate high frequency for factors, while yellow cells show low frequency for factors. It can be seen that:

- Cluster 1 includes projects run primarily in East Asia and Pacific, in the subsector of treatment plant for either potable water or sewerage. These are mainly greenfield projects, are still active today, and the types of PPI involved are Build, Operate and Transfer as well as Build, Own and Operate.
- Cluster 4 is neatly distinct from cluster 1 as indicated by its positioning in the plane. It mostly includes projects run in Europe, the Middle East and Africa, in the subsector of water utility (with and without sewerage). They are mostly management and lease contracts, and are often concluded as of today.
- Clusters 2 and 3 are clearly separate from 1 and 4, but less strongly distinguishable from each other. Cluster 2 is notable for the presence of distressed projects, mostly located in Latin America and having to do with water utility; they were mostly brownfield projects of Build, Rehabilitate, Operate, and Transfer type. Cluster 3 includes divestiture projects in the subsector of water utility, whether full or partial, with no clear geographical tendency and a diverse range of statuses.

Cluster 1 seems to refer to the more recent trends of private participation in water sector, centered around China and where many projects are still active. Cluster 2, on the other hand covers the previous period where projects were carried out mostly in Latin America and cancellations have occurred as a result of municipalisation. These observations are in-line with the history of the sector discussed in Paper 1.

Table 2.4. Factors in Clusters.

Note: Factors are grouped based on the category of variables. Green cells indicate high frequency for factors, while yellow cells show low frequency for factors.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Region	East Asia and Pacific	East Asia and Pacific	East Asia and Pacific	East Asia and Pacific
	Europe and Central Asia	Europe and Central Asia	Europe and Central Asia	Europe and Central Asia
	Latin America and the Caribbean	Latin America and the Caribbean	Latin America and the Caribbean	Latin America and the Caribbean
	Middle East and North Africa	Middle East and North Africa	Middle East and North Africa	Middle East and North Africa
	South Asia	South Asia	South Asia	South Asia
	Sub-Saharan Africa	Sub-Saharan Africa	Sub-Saharan Africa	Sub-Saharan Africa
Subsector	Treatment plant	Treatment plant	Treatment plant	Treatment plant
	Water Utility	Water Utility	Water Utility	Water Utility
Segment	Potable water and sewerage treatment plant	Potable water and sewerage treatment plant	Potable water and sewerage treatment plant	Potable water and sewerage treatment plant
	Potable water treatment plant	Potable water treatment plant	Potable water treatment plant	Potable water treatment plant
	Sewerage collection	Sewerage collection	Sewerage collection	Sewerage collection
	Sewerage collection and treatment	Sewerage collection and treatment	Sewerage collection and treatment	Sewerage collection and treatment
	Sewerage treatment plant	Sewerage treatment plant	Sewerage treatment plant	Sewerage treatment plant
	Water utility with sewerage	Water utility with sewerage	Water utility with sewerage	Water utility with sewerage
	Water utility without sewerage	Water utility without sewerage	Water utility without sewerage	Water utility without sewerage
	another	another	another	another
Type of PPI	Brownfield Project	Brownfield Project	Brownfield Project	Brownfield Project
	Divestiture	Divestiture	Divestiture	Divestiture
	Greenfield project	Greenfield project	Greenfield project	Greenfield project
	Management and lease contract	Management and lease contract	Management and lease contract	Management and lease contract
Subtype of PPI	Build, operate, and transfer	Build, operate, and transfer	Build, operate, and transfer	Build, operate, and transfer
	Build, own, and operate	Build, own, and operate	Build, own, and operate	Build, own, and operate
	Build, rehabilitate, operate, and transfer	Build, rehabilitate, operate, and transfer	Build, rehabilitate, operate, and transfer	Build, rehabilitate, operate, and transfer
	Full	Full	Full	Full
	Lease contract	Lease contract	Lease contract	Lease contract
	Management contract	Management contract	Management contract	Management contract
	Partial	Partial	Partial	Partial
	Rehabilitate, lease or rent, and transfer	Rehabilitate, lease or rent, and transfer	Rehabilitate, lease or rent, and transfer	Rehabilitate, lease or rent, and transfer
	Rehabilitate, operate, and transfer	Rehabilitate, operate, and transfer	Rehabilitate, operate, and transfer	Rehabilitate, operate, and transfer
Project status	Active	Active	Active	Active
	Cancelled	Cancelled	Cancelled	Cancelled
	Concluded	Concluded	Concluded	Concluded
	Distressed	Distressed	Distressed	Distressed

4. Data Analysis: Data as Networks

We can consider the data illustrated in the previous sections in terms of governments, where water projects are/have taken place, and private companies involved in the projects having formed relationships together with the aim of carrying out works and fulfilling contractual obligations. In other words, it is possible to re-shape the dataset to see it in relational perspective, interpreting projects as vehicles for the formation of relationships between governments and companies, and placing emphasis on the agency of the latter. In this perspective, the basic unit of observation is no longer the project, but the relationship (whether actual or potential) between any two entities (governments and projects) that may be involved in one or more joint projects. I will expand on this idea in the following paper, but for now, I descriptively investigate the networks which arise from such relationships.

As explained in the previous section, the data used in this study includes 65 countries, and 453 private companies, and it covers the period of 1949 to 2016. Therefore, we can think of the data as two networks: one being a two-mode network for each year in that period, with one mode being the countries (governments) and the other being the private companies, and one being a one-mode network with only private companies and their relationships together. The entities in the network have ties with each other based on the projects they have been/are involved in; i.e. a project between Government G_i, and companies C_j and C_k, at time t, results in ties between G_i and C_j, G_i and C_k, and C_j and C_k (in some projects more than one company has been involved). The figure below shows the networks constructed on this basis, with all the projects being present. In this figure, countries (governments) are depicted in yellow circles, while private companies are illustrated in red diamonds. The green lines represent ties between countries (governments) and companies, and the blue lines show ties between private companies created as a result of them being involved in the same projects. It should be noted here that since the network is rather large and for the sake of clear visualisation, the number of times two entities have had relationships is not illustrated in this figure; this is the concept known as "Strength of the Ties" in Social Network Analysis. But this concept will be investigated in the next chapter in the form of a dependent variable in analysis. The positions of China in the overall network, as having the majority of ties with companies, has been highlighted in the figure below.

All the following network figures have been visualised by Visone [6].

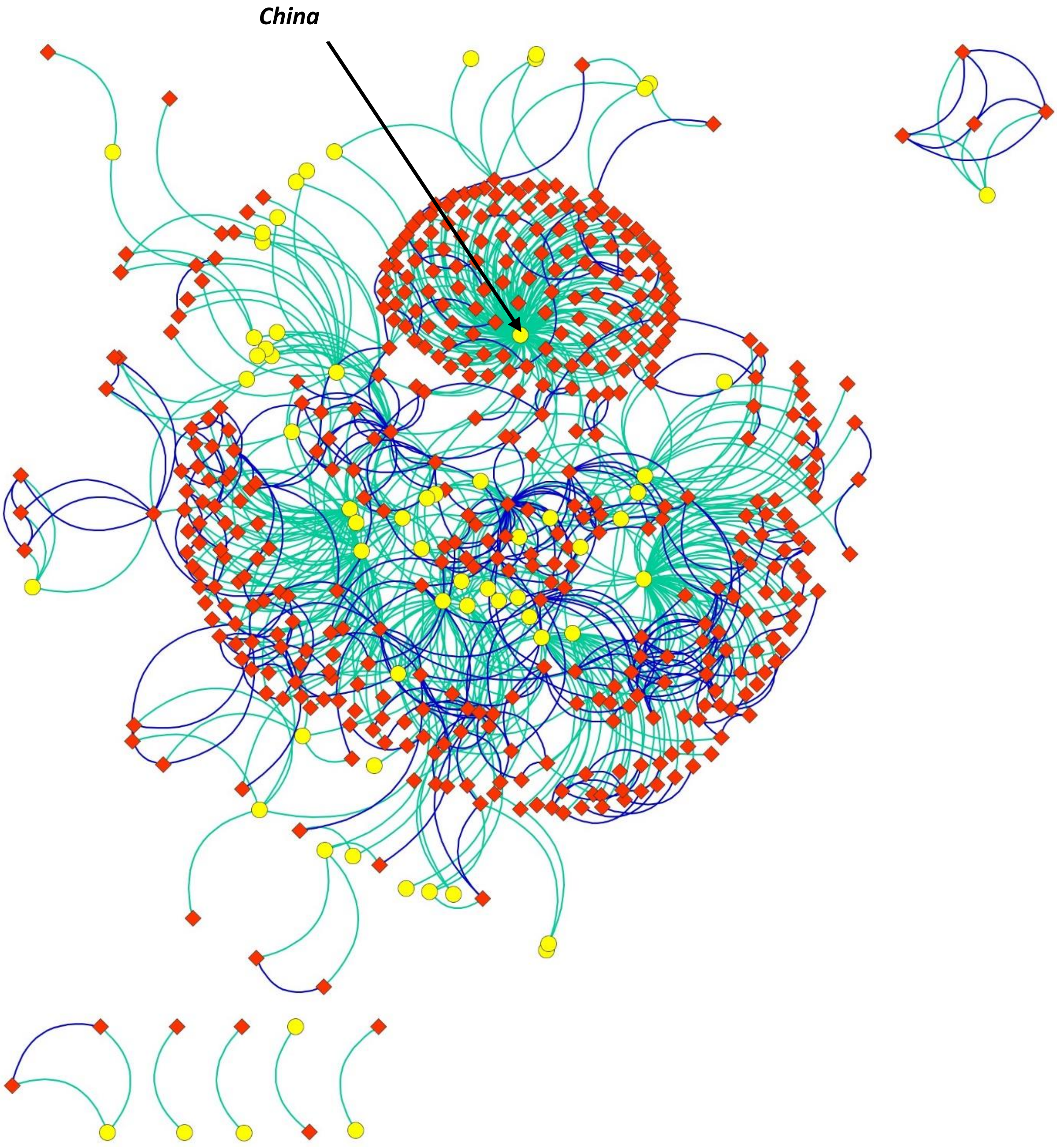

Figure 2.31, Networks of Relationship between Governments and Companies, and Companies with each other, Involved in Water Projects from 1949 to 2016.

Note: Countries (governments): Yellow Circles & Private Companies: Red Diamonds. Relationships based on carrying out projects between countries (government) and private companies are shown by blue arcs, and green arcs show relationships between private companies while carrying out projects together.

[6] See http://visone.info/html/about.html

The figure above illustrated that the network is by and large a fully connected one, with a main component which includes almost all actors. The network figure is an aggregate of all networks for each year, hence connectedness is perhaps over emphasised; but it still provides a reliable picture of the data because projects last for long periods of time and ties formed through projects can be seen as almost cumulative over time. This overall connectedness confirms that it is appropriate to adopt a comprehensive approach – as I do in this study- by looking at the system as a whole instead of investigating case studies. Although case studies can provide in-depth detail, they neglect the fact that each case is part of a more global structure of interdependencies, involving countries and companies that interact on multiple settings. This overall connectedness also confirms that the water sector is a globalised one, with a complex interplay of national/local and multinational companies that depend on each other to get projects from different public-sector authorities.

The two different relationships, i.e. one being between countries (governments) and companies, and the other between companies only, are illustrated separately in the figures below. Out of 975 projects in the data, 739 (76%) are carried out by only one private company: thus, the second network refers only to one subset of the data. In both figures, strength of the ties is represented by the thickness; the thicker lines represent two entities having more relationships with each other.

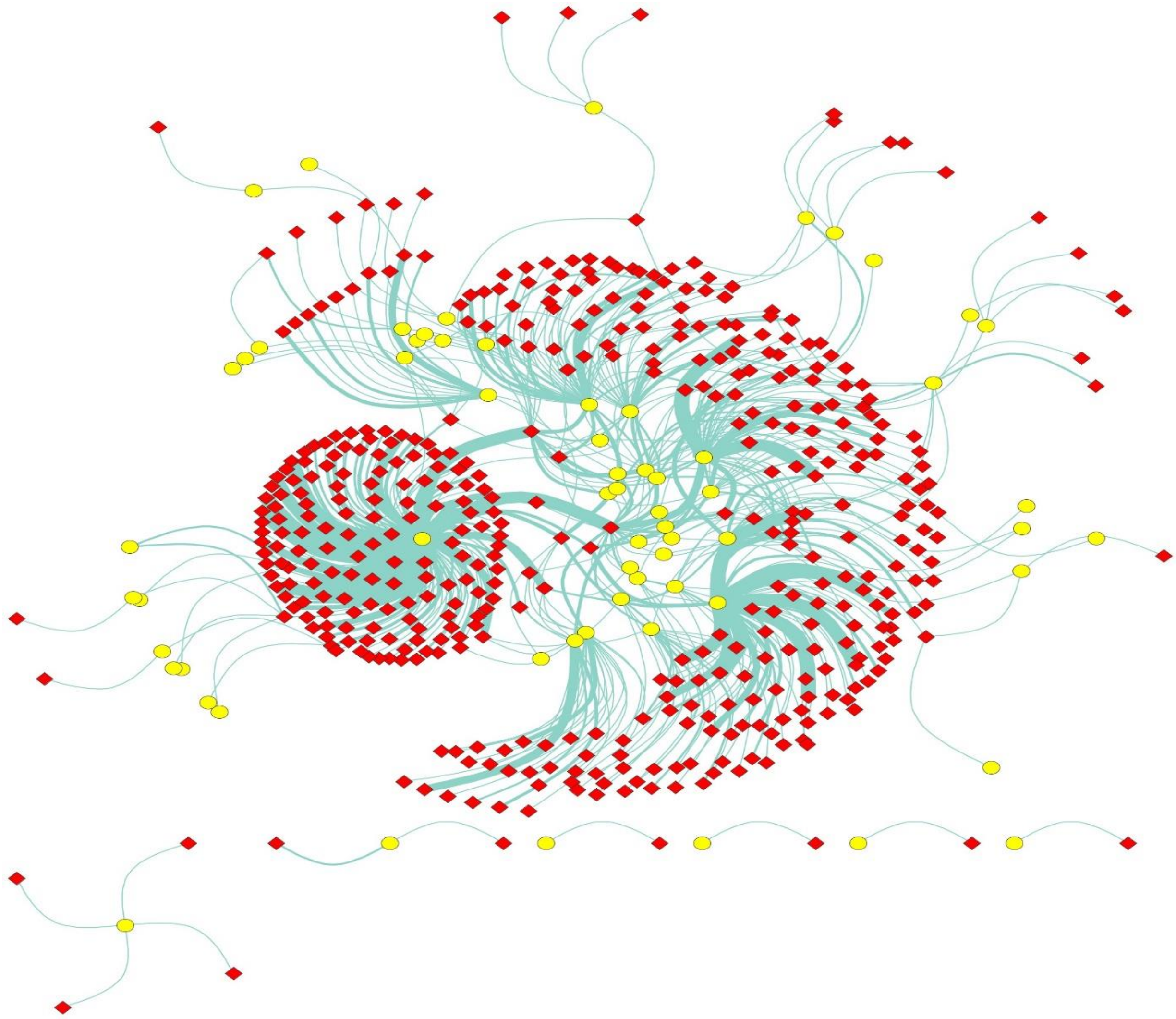

Figure 2.32, Two-Mode Network of Governments and Companies Involved in Water Projects from 1949 to 2016

Note: Countries (governments): Yellow Circles & Private Companies: Red Diamonds. Relationships between countries (governments) and private companies are presented by green arcs, and are based on projects carried out by private companies in the countries. The thickness of arcs represents numbers of projects the entities have been involved in; the thicker the arc is between a country and a private company, the more projects the private company has carried out in the country in the period of 1949 to 2016.

The network picture above [7] conveys the idea of hierarchy between companies; while some are visibly holding more central positions and are connected to multiple governments, others only have ties to single governments, denoting dependence. Also, many companies having single relationships with governments, have several competitors which also have ties to the same governments.

[7] For some snapshot of how this network have evolved over the time, see Appendix 1.

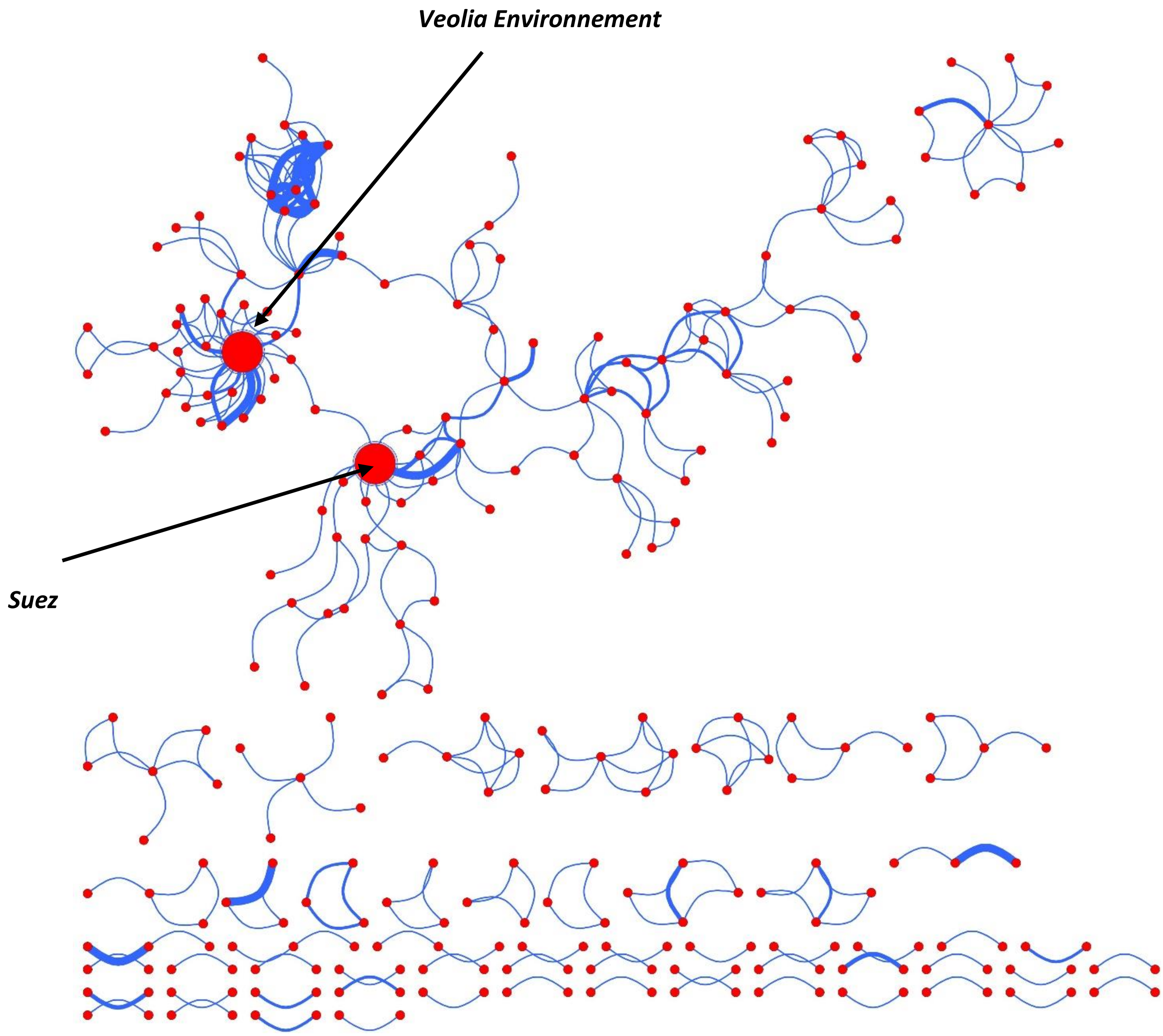

Figure 2.33, One-Mode Network of Companies Involved in Water Projects from 1949 to 2016.

Note: The two prominent companies in the sector, Veolia and Suez are highlighted in this figure. The relationships between the private companies, depicted by blue arcs, are based on projects two companies have worked on together, and the thickness of arcs show the number of such projects.

In the above figure, the two French companies, Veolia Environnement and Suez, which are important actors in the private water sector and are discussed in more details in paper 4, are illustrated in larger node sizes. Both companies are in the main component of this network, which is overall much less connected than the previous two-mode one, with many small groups separated from it. This suggests that these major multinationals have used alliances with other companies, in the form of working together on same projects, as a key strategy to achieve their leading position worldwide. Although Veolia and Suez are indirectly connected, through two intermediate companies, they are part of separate clusters, but still within the main component, which suggests an almost similar position in the network; this can be regarded as a confirmation of the two companies being each other's' competitors.

Performing 2-mode centrality analysis on the network depicted in figure 2.32, the results for the top ten countries (governments) and companies regarding their centrality measures [8] (normalised) is shown below. China seems to hold an important position in the overall network, followed by South American countries; the two cases have been discussed in paper 1. The companies with higher centrality measures in the network are all international companies with their headquarters in France, Spain, Germany, the UK, and Malaysia.

Table 2.5, Centrality Measures for Top Ten Countries (Governments) in the Two-Mode Network.

Note: Three centrality measures, degree, betweenness, and eigenvector are considered and the results for top ten countries are reported. China takes the lead for all three measurements.

Country	**Degree**	**Country**	**Betweenness**
China	0.351	China	0.517
Brazil	0.150	Brazil	0.220
Mexico	0.088	Mexico	0.138
Colombia	0.088	Colombia	0.136
Argentina	0.062	Argentina	0.094
Malaysia	0.051	Malaysia	0.066
Chile	0.042	Chile	0.055
India	0.038	India	0.053
Indonesia	0.038	Indonesia	0.051
Algeria	0.035	Russian Federation	0.049
Country	**Eigenvector**		
China	0.991		
Malaysia	0.048		
Mexico	0.046		
Colombia	0.043		
Brazil	0.042		
Argentina	0.038		
Algeria	0.028		
India	0.027		
Thailand	0.022		
Chile	0.021		

[8] Degree centrality: counts the number of ties held by each node.
Eigenvector centrality: considers nodes connected to other high degree nodes as highly central.
Betweenness centrality: measures the number of times a node lies on the shortest path between other nodes.

Table 2.6, Centrality Measures for Top Ten Companies in the Two-Mode Network.

Note: Three centrality measures, degree, betweenness, and eigenvector are considered and the results for top ten private companies are reported. Suez and Veolia take the lead for all three measurements.

Company	Degree	Company	Betweenness
SUEZ	0.354	SUEZ	0.317
Veolia Environnement	0.277	Veolia Environnement	0.144
Biwater	0.169	Fomento de Construcciones y Contratas SA (FCC)	0.683
Others	0.108	Tyco International	0.670
Fomento de Construcciones y Contratas SA (FCC)	0.108	Saur	0.608
Saur	0.108	Aguas de Barcelona	0.557
Aguas de Barcelona	0.092	Abengoa	0.526
Abengoa	0.092	Biwater	0.538
RWE	0.077	RWE	0.614
Amiantit Group	0.077	Ranhill Bhd	0.608
Company	**Eigenvector**		
SUEZ	0.117		
Veolia Environnement	0.105		
Fomento de Construcciones y Contratas SA (FCC)	0.093		
RWE	0.087		
Ranhill Bhd	0.086		
Saur	0.085		
Tyco International	0.085		
Salcon Bhd	0.083		
Taliworks Corp. Bhd.	0.082		
Berlinwasser International AG	0.081		

For the one-mode network of companies working together on same projects, the results for top ten centrality measures are as shown in the table below. The results are normalised and the network is considered to be undirected [9]. The results suggest that among those projects run by two or more companies, French, Brazilian, British, and American companies have occupied more important positions in the overall network than others.

[9] In an undirected network, the direction of the ties is not considered, as in the tie between A and B represents a reciprocated relationship between A and B.

Table 2.7, Centrality Measures for Top Ten Companies in One-Mode Network.

Note: The network used here is the one based on the relationships of private companies when carrying out projects together. Three centrality measures, degree, betweenness, and eigenvector are considered and the results for top ten private companies are reported. Suez takes the lead for all three measurements.

Company	**Degree**	**Company**	**Betweenness**
SUEZ	0.095057	SUEZ	0.080126
Veolia Environnement	0.04943	Veolia Environnement	0.072906
Odebrecht SA	0.034221	Mitsui	0.070927
Construtora Cowan LTDA	0.034221	Tyco International	0.067026
Construtora Queiroz Galvao	0.034221	Odebrecht SA	0.051246
Tyco International	0.030418	Khatib & Alami	0.047279
Carioca Christiani-Nielsen Engenharia S.A.	0.030418	Sacyr Vallehermoso SA (SyV)	0.044408
Biwater	0.030418	Acciona	0.038867
Sacyr Vallehermoso SA (SyV)	0.026616	Grana y Montero SA	0.03157
Fomento de Construcciones y Contratas SA (FCC)	0.026616	ACS Group (Actividades de Construccion y Servicios)	0.028154

Company	**Eigenvector**
Construtora Cowan LTDA	0.567238
Construtora Queiroz Galvao	0.567238
Carioca Christiani-Nielsen Engenharia S.A.	0.524174
Trana Construcoes Ltda	0.484803
Odebrecht SA	0.417826
Developer SA	0.383538
Grupo Somague	0.333768
Grupo Solvi	0.319619
EIT Empresa Tecnica Industrial	0.305912
Erco Engenharia	0.305912

5. Conclusions

The aim of this paper was to illustrate the steps taken in the construction of the database and to explore the different aspects of the data which has been used in this paper and the next one. This data is found to provide rich information regarding the private participation in the water sector, covering a wide range of low- and middle-income countries for more than 60 years. I have examined different variables associated to the PPI water projects that are reported in the data, as well as exploring the data via some descriptive analysis, through multiple correspondence analysis and social network analysis. I have also tried to investigate some interesting aspects of the data, which are in-line with the literature on the sector. Overall, this chapter has aimed to give the reader a comprehensive understanding of the data used in the major part of this study, without theoretical *a priori* and letting the data "speak for themselves" so to speak. In particular, the MCA approach was meant to extract key structuring information from the dataset, bringing to light similarities and differences across cases (water projects) and revealing interdependencies between variables, considering each of them in light of the others, in multi-dimensional perspective. It was possible in this way to identify important dividing lines, along spatio-temporal dimensions as well as more technical aspects related to the type, sector and status of water projects.

In turn, social network analysis and visualization required a re-shaping of the dataset and enabled to see it in a different light, placing emphasis on the agency of the human and organizational actors (governments and companies) involved in private water projects, and their relationships with each other. In addition to revealing a high degree of connectivity in the network, made possible by a few multinational enterprises and governments, it made apparent the growing role of key actors, notably China on the side of governments, and Suez and Veolia Environnement on the side of companies.

This understanding is deemed essential as in the next paper a more theoretically-informed statistical analysis of the data is carried out with the aim of answering questions on how governments and private companies form alliances in the water sector to carry out these projects. Furthermore, given the data does contain a lot of information, I will be outlining some ideas for future studies on this data in the Conclusion of this study.

Paper 3- Alliance Formation in Private Water Sector

1. Introduction

As explained in paper 1, strategic alliances, a form of voluntary interorganisational cooperation, involve considerable "exchange, sharing, or co-development", and create enduring commitments between partners (Gulati & Gargiulo, 1999: 1440). In such relationships, organisations gain the ability to manage uncertainties created by environmental factors beyond their control by combining resources. Strategic alliances formed between firms, and the causes and consequences of such partnerships have been an attractive topic for strategy and organisational researchers.

Part of the literature discussing alliances, behaviour of firms in alliances, and impact on performance because of these partnerships have focused on either the firm or the alliance as the unit of analysis. This stream of work has identified characteristics of firms which can influence their tendency to enter alliances or their choice of partners, and attributes of alliances which can influence formal relations that organise firms. There are also studies which have examined the formation and performance of alliances by investigating the role of the external environment, primarily looking at economic incentives and the structure of competition rather than the underlying social fabric. For example, literature inspired by Williamson (1985) has taken the transaction costs into consideration, arguing that firms are more likely to be exposed to "small numbers bargaining" as well as other forms of opportunistic behaviour when the competition is at a low level; small numbers bargaining shows the degree to which an organisation has alternative sources of supply to meet its demand. Pfeffer and Nowak (1976) have discussed the resource dependency, arguing that firms are more likely to enter joint ventures in order to mitigate competitive pressures at intermediate levels of industry concentration. Other studies have taken into consideration the firm and industry level factors which cause firms to enter alliances. It has been suggested that existing competencies of firms, or the lack of them, can drive firms into new alliances and hence benefit from new opportunities (Andrews, 1997).

The themes and examples mentioned above have all focused on firms and alliances as units of analysis, and external factors related to competitive terms, while other studies have put more focus on the actions of other firms as well as relationships in which firms are embedded. The new studies (sometimes also inspired by resource dependency theory) take into consideration the interactive attributes of the markets, and how firms gain market information through their interactions within the market. While Hayek (1949) argues that interaction through the market was sufficient and prices transmit all the information that firms need to make decisions, an idea which is at the basis of all free-market ideologies, White (1981) had a more realistic approach and tried to move beyond price-based interactions to place emphasis on non-market interactions, notably through social ties, as vehicles to channel extra information. Hence, although strategic alliances are technically exchanged within dyads, as in two entities having a relationship, it is still important to consider the impact of social networks in which the firms are embedded. This has led to an extensive strand of research in economic sociology, investigating how economic actions are affected by social structures and embeddedness in these social structures.

The sociology researchers have discussed the behaviour of organisations in terms of embeddedness in social networks. Granovetter (1985: 482) states that the notion of embeddedness empathises on the argument that "behaviour and institutions to be analysed are so constrained by ongoing social relations that to construe them as independent is a grievous misunderstanding". He investigated the embeddedness of economic action in structures of social relations, in modern industrial society; in a later work Granovetter (1992) discusses how economic goals and activities are embedded in socially oriented goals and structures. Powell et al. (1996; 1999) focus on biotechnology industry and how innovation and performance of firms are influenced by their embeddedness in networks. These are a few examples within the literature which has contributed to the knowledge of organisational networks and strategic alliances. But in these studies, and other similar ones, scholars have regarded formation of networks as driven by exogenous factors; in this perspective firms enter alliances and form ties so that they can manage uncertainties in the environment and address their resource needs and hence firms prefer partners with resources and capabilities so they can cope with these exogenous constraints. This approach, although beneficial in explaining factors influencing firms to enter alliances, does not take into account challenges firms can face in determining who to enter alliances with. Another point to consider is that, although ties with entities themselves are important in analysing their behaviour, being part of a whole network can also influence behaviour; as it is not just the attributes of A and B and their history with each other that matter, but also the ties of A to others, and of B to others.

To address the question of with whom firms form alliances, the literature has proposed that firms, based on trust and rich exchange of information (Powell, 1990), tend to create preferential relationships with specific partners; this helps them to decrease search costs as well as reducing the risks of opportunism arising from strategic alliances. These embedded relationships then create a network over time, which provides growing information on the availability, competencies, and reliability of prospective partners (Powell et al., 1996; Gulati, 1995b; Kogut et al., 1992).

If embeddedness influences strategic alliances, the literature on interorganisational relationships also discusses the impact of "proximity". There is consensus around the idea that spatial (geographical) proximity is one of the most important factors affecting interorganisational resource transfers. The main idea underlying this argument is that risks and costs associated with resource transfers make collaboration more likely to occur between physically proximate organizations. The association between spatial proximity and the structure of networks has been observed with various types of relationships, for example knowledge-sharing (Boschma & Ter Wal, 2007; Giuliani & Bell, 2005) and joint R&D projects (Hagedoorn, 2002). Measuring the effects of spatial proximity on emergence of collaboration and eventually, the formation of explicit strategic alliances is all the more important in a study of a globalized industry, where in principle, multinational companies might step in and alliances might be formed between local and foreign entities alike. While geographical factors are still likely to play a role, non-spatial elements (such as embeddedness, as mentioned above, but also similarities, as discussed below) might attenuate their effects. Today, some scholars argue that the importance of place and spatial proximity have been often overemphasized, underestimating the role of networks which are a-spatial entities (Ter Wal & Boschma, 2011).

In addition to embeddedness and proximity, similarities or dissimilarities between partners may also influence formation of new alliances. There is an extensive literature available on how similarities or dissimilarities among actors can encourage tie formation; while some scholars have argued that greater similarity between actors increases the possibility of them establishing a relationship together (for example, Rivera et al., 2010), others have suggested that partners are chosen based on whether they could complement resources and capabilities of an actor in an alliance and hence dissimilarities may be more attractive than similarities (for example, Gulati et al., 2000). Some scholars (Todeva & Knoke, 2005: 141) have also suggested “curvilinear relationships are more plausible” when it comes to partner choice in strategic alliances, discussing the importance of identifying which attributes in the organisation, such as “product, market options, technologies, human resources, managerial styles, or more intangible elements such as reputation and institutional thought patterns”, contributes more to a perfect union and under what conditions.

In this study, I consider that the projects under private participation in water and sewerage sector (see Paper 1 for details on PPI) can be regarded as strategic alliances being formed between governments and companies, as well as companies themselves. This study is focused on alliance formations in the water sector, specifically in cases where private participation is present. Two relational structures are examined in this work: alliance formations between governments and private companies in the form of projects in the water sector and alliance formations between private companies in the form of collaborating on projects in the water sector. The two datasets that are used have dyadic format, the units of analysis being possible pairs of governments and companies (G_i, C_j) in the first case, and of companies with companies (C_j, C_h) in the second case. This is because the dyad is the smallest unit at which the formation of an alliance can be observed. These datasets are described in more details in section 3.

1.1. Alliance Formation in the Water Sector

In this work, I consider the relationship formed between governments and private water companies in fulfilling projects in the water sector, as in private participation in the water sector, as forming alliances.

One of the relational structures examined in this work is alliance formations between governments and private companies. As mentioned in paper 1, the literature on private participation in infrastructure (PPI), especially for studies related to water sector, suggests that as a result of public funding available for infrastructure projects being limited, many governments have invited private companies to carry out such projects. This change of behaviour has happened in the post-war period and has been influenced by the pressure to reduce public sector debt, at the same time being motivated by need to improve public facilities (Grimsey & Lewis, 2002). Participation of private sector saw an increase in Africa, Asia, and Latin America in 1990s (Budds & McGranahan, 2003).

In this work, however, I do not discuss the underlying reasons governments seek private sector involvement, already amply investigated in the literature: I assume that governments have already made decisions on whether or not to have private partners for the water projects and then I investigate how governments choose their private partners from the pool of available candidates around the world. It is evident that the governments' choices are not only restricted to local or national companies; there are major multinational companies which are active in the sector, and there are also global incentives for governments to seek international partners (such as loans and financial supports received by international institutions, for example from World Bank). The choices governments make can have momentous consequences, as the length of projects in the sector could be long; for example, build-rehabilitate-operate-transfer (BROT) projects can be as long as 25 years (for instance, Brazilian company OAS Solucoes Ambientais was awarded a 30-year contract in 2014). It is of imperative importance for governments to know which private company to choose for projects in the water sector, but extant research, as discussed in paper 1, has mostly investigated single cases, without identifying global patterns; this study takes on the challenge to address this gap in the literature. We consider the choice governments make in terms of finding private partners to be similar to the behaviour of organisations when selecting alliance partners.

Another relational structure that is investigated in this work, is the alliances between private companies when fulfilling projects in the water sector. As seen in the data obtained from the World Bank, in some cases, a water-related project is established not just between a government and a single company, but between a government and a consortium of companies, of which one company is usually the leader in terms of having a larger share (for instance, Aguas Argentinas project which started in Argentina in 1993 and in which SUEZ took 47% of shares compared to Aguas de Barcelona having 23% of shares). That companies may partner to do projects together might be due to complementarities between them, for example, a multinational bringing in state-of-the art technical expertise and a small national company bringing in local knowledge, or in some cases a financial company partnering with a company focused on water technologies. In these cases, another question arises: once a company has decided to bid for a government project, and has realized that it needs partners, how does it choose them from all existing companies at a given time period? Again, this question has not been investigated at length in the water literature so far – at least not with the purpose of detecting global behavioural regularities.

Having clarified my objectives, I now hypothesise on the relation between embeddedness and tie formation. The hypotheses are based on literature discussing the impact of embeddedness, in particular relational embeddedness, positional embeddedness, structural embeddedness; proximity, in particular geographical; and similarity, as in geographical, cultural, and economic similarities on tie formation. In the following section, some relevant literature to each of these types of embeddedness is discussed, the hypotheses for this work are outlined, and the measures (variables) built for the purpose of studying these factors are briefly introduced.

2. Hypothesis for this Study

2.1. Embeddedness Hypotheses

2.1.1. Relational Embeddedness

In his widely cited work, Granovetter (1985) argues that embeddedness of organisations in social structures of pre-existing relations enables and constrains their actions over time. In what follows, I follow Gulati and Gargiulo (1999) who distinguish different aspects of embeddedness that can be relevant in an interorganisational context, and examine their individual effects. According to Gulati and Gargiulo (1999: 1446), relational embeddedness "highlights the effects of cohesive ties between social actors on subsequent cooperation between those actors". In forming alliances, there is uncertainty about the true capabilities, the needs, and the potential behaviour (also considering possible opportunism) of potential partners. Compared to having no prior experience in working together, organisations which share an alliance history have gained some understanding of the capabilities, competencies, and reliability of their partners, and they benefit from reduced uncertainty when it comes to choosing a partner. Forming new partnerships undoubtedly requires some monitoring and evaluation, which can be costly for organisations. Hence, forming ties with prior partners, in comparison with forming ties with new and unknown ones, is associated with reduced costs and risks for the organisations. The organisations can also benefit from their prior partners in term of an increased learning speed, since they can readily understand each other. Overall, forming ties based on prior shared experience of collaborating with each other has more benefits when compared with partnerships based only on general experience of collaborating with some entities. Organisations can also learn about new opportunities for cooperation more easily as a result of prior relationships. (Reuer & Lahiri, 2013; Gulati et al., 2009; Gulati & Gargiulo, 1999; Levinthal & Fichman, 1988). The literature on international trade also discusses this point; for example, Chaney (2014) argues that French firms not only search directly to find new trading partners, but they also make use of their existing network of contacts.

Hypothesis 1: The probability of a new alliance formed between two organisations increases as a result of higher levels of prior interaction because of their direct alliances. Hence, in my study I expect tie formation between public and private-sector organizations to be a function of the degree of past interaction and collaboration between them.

In this study, relational embeddedness is considered to be a within-dyad property that depends only on:

- government G_i, company C_j and their history together, if any, which can be thought of as an attribute of their tie, for the case of government-company relationships, and
- Company C_j, company C_h and their history together, if any, which can be thought of as an attribute of their tie, for the case of company-company relationships

Relational embeddedness does not depend on the overall networks originated from the formation of ties; it is an attribute of each individual tie regardless of what other ties the two parties involved might have with the rest of entities in the network.

There can be different measures of past interactions. In this work, I take into account number of projects in the short and long run, whether they were successful – that is, not prematurely ended (cancelled or distressed) –, reinvestments in ongoing projects, recent terminations of projects, and past terminations of projects. Here I take survival of projects as a simplified measure of success in partnerships and I do not look at the outcome of the partnerships in terms of service quality. Each of these measurements are explained in more details in section 3.

2.1.2. Positional Embeddedness

Positional embeddedness looks at the effect of the position that an organisation holds in the overall structure of the alliance network on its decisions to form new ties. This concept – again, borrowed from Gulati and Gargiulo (1999) - is based on the network notions of centrality, which are one way of operationalising the concept of the “roles” of actors in a system without taking into account the specific individuals which are involved in playing these roles (Borgatti & Everett, 1992; Faust, 1988). By investigating the impact of positional embeddedness on formation of new ties, benefits gained from information stemming from particular positions in the network are identified rather than impact of specific ties. By occupying a favourable position in the emerging alliance network, an organisation can not only gain access to information about its potential partners, but could also benefit from an enhanced visibility and attractiveness to other organisations, regardless of whether they have direct or indirect ties with each other.

The information advantages stemming from network centrality have been repeatedly discussed in network analysis literature. The more central an organisation is in a network, the more access it has to a larger "intelligence web" which provides information on collaborative opportunities. By using this information, centrally positioned organisations can lower their level of uncertainty when it comes to forming partnerships, and they are more likely to have better information about a larger number of potential partners (Gulati, 1999; Powell et al., 1996).

In addition to information advantages, organisations that occupy central positions in a network benefit from higher visibility in the network, which consequently improves their attractiveness to potential partners. Network centrality is a clear indication of the involvement of an organisation in strategic alliances; hence it can also represent "willingness, experience, and ability" to enter partnerships (Gulati & Gargiulo, 1999: 1448). Studies of preferential attachment suggest that having high number of partners makes it more likely for organisations to attract prospective partners since they are believed to have higher status and better reputation (Rosenkopf & Padula, 2008).

Hypothesis 2a: The probability of a new alliance formed between two organisations increases as the centrality of the two organisations increases within the alliance network. In this study, I expect that the probability of new projects being carried out between a government and a company, or two specific companies, increases with the respective network centralities of each of the entities involved.

Hypothesis 2b: The probability of a new alliance formed between two organisations increases as the similarity in their network centralities increases. It is expected that the probability of new projects being carried out between a government and a company, or two specific companies, increases when their network centralities are more similar to each other. This hypothesis stems from the network concept of "assortative mixing"; that is "a network is said to show assortative mixing if the nodes in the network that have many connections tend to be connected to other nodes with many connections" (Newman, 2002: p. 1).

This is a property that goes beyond the dyad, unlike the previous relational embeddedness, and takes into account the whole structure of the network:

- for the case of government-company relationships, the centrality of a government G_i (measured as the number of companies with which it has contracts at a given point in time), and of a company C_j (measured as the number of governments with which it has contracts at a given time) in the whole network are taken into account,
- for the case of company-company relationships, the centrality of companies C_j and C_h in the whole network (that is, the number of other companies with which each of them has ties) are taken into account, and
- For both cases of government-company and company-company, the difference between degree centralities of the two entities (G_i and C_j or C_j and C_h) are taken into account.

The measures used for positional embeddedness are two-mode lagged degree centrality [10] for government-company relationships, and one-mode lagged degree centrality for company-company relationships. The idea here is that the position each entity holds in the network (which is usually highly stable over time) can have an impact on the probability of forming new ties. Each of these measurements are explained in more details in section 3.

2.1.3. Structural Embeddedness

In structural embeddedness, contrary to positional embeddedness, the units of interest are triads and not dyads. The focus of analysis becomes indirect communication, rather than direct. Structural embeddedness refers to the extent to which two organisations are connected, indirectly, to each other through one or more common partners. This type of embeddedness encourages formation of new ties in two specific ways, according to Gulati and Gargiulo (1999). Organisations that have ties to a common partner can access reliable information about each other through the common partner and receive referrals about each other (Gulati, 1995b); by having the common partner serving as a channel for information, uncertainties that focal organisations may experience about each other are mitigated. In addition to gain better access to information, having ties to the same partner can indicate being regarded as

[10] Degree centrality refers to the number of ties (relationship) a node has in a network.

trustworthy partners by the same organisation. Common ties to a partner can create reputation lock-in; the organisation shows good behaviour as a result of concern for local reputation, and bad behaviours by either of the partners can be reported to the common partner (Burt & Knez, 1995); because of these reputation effects and joint sanctioning potential, common partners can be used as safeguards against opportunistic behaviour. As a result, compared to any other organisation, those having indirect ties through common partners benefit from lower relational risks, as well as access to better information on partnering about each other.

Hypothesis 3a: The probability of a new alliance being formed between two organisations increases as the number of prior indirect alliances between the two increases. In this study, this hypothesis only applies to the investigation of company-company relationships, and I expect to see more projects carried out by two companies, C_j and C_h, as a result of prior common ties with another company C_k.

Hypothesis 3b: I also look at the effect of partnering with the same government for the company-company dataset. It is expected that the probability of two companies, C_j and C_h, forming an alliance decreases as the number of governments they have both formed ties with, but without a tie between the companies themselves, in the past increases. This hypothesis investigated if the two companies are competitors (they serve the same client), whether they are less likely to form alliances with each other.

Hypothesis 3b is formed with the expectation of finding a negative impact for having common government partners on alliance formations, but one can form two opposite expectations when the common partner is a government: on the one hand, one may have the same as with a company partner (positive effect, as outlined in hypothesis 3a), on the other hand, the common-government-partner may indicate competition (negative effect, as outlined in hypothesis 3b). Therefore, the overall effect is theoretically undecided and needs to be established empirically, on a case-by-case basis.

I have not investigated the effect of structural embeddedness for the government-company relationships, as the organisations involved are different from each other and cannot have common partners strictly speaking. The government-company, as seen in paper 2, is a two-mode [11] network and we cannot define common partners as the two entities of any dyads belong to different modes.

2.2. Proximity Hypotheses

Geographical proximity is the most commonly used dimension of proximity in the literature. Its definition differs slightly in various studies; some define spatial proximity as absolute geographical distance between entities while others use the perceived distance by entities or distance relative to travel times (Knoben & Oerlemans, 2006). To study its effects in the present case, the organizational literature on spatial proximity is the basis of my hypotheses.

2.2.1. Spatial Proximity

When it comes to alliances between companies, it is natural to refer to the literature on interorganisational knowledge transfers, which has highlighted the importance of spatial (geographical) proximity. The main idea underlying this argument is that risks and costs associated with knowledge and, more generally, resource transfers make collaborations more likely to occur between organizations that are close to each other in space (Whittington et al., 2009; Powell et al., 2005; Powell et al., 1996).

The importance of spatial proximity, when discussing interorganisational relationships, goes beyond simple cost and logistics dimensions and involve knowledge transfer and innovation, which smaller geographical distances can facilitate. Short geographical distances are believed to bring organisations together, favour interaction with a high level of information richness, and facilitate the exchange of knowledge, especially tacit knowledge, between firms (Torre & Gilly, 2000). Organisations that are geographically closer to each other can also face fewer barriers to form and maintain partnerships; such firms find it easier to develop inter-firm interactions which are useful in facilitating formation, as well as, execution of alliances (Reuer & Lahiri, 2013). Therefore, it is more likely for firms that are geographically close to each other to form alliances, since local availability of tacit knowledge about potential partners means lower search costs, and also more benefits are expected to be achieved once the alliance is formed because of stronger inter-firm knowledge sharing (Capaldo & Petruzzelli, 2014; Rangan, 2000).

[11] Two-mode networks consist of two groups of entities having ties with each other; ties exist between groups but not within each group. In this work ties between government and companies carrying out projects are considered to create two-mode network, with governments being one mode and companies being the other mode of such networks.

However, spatial proximity is not the only factor: other forms of proximity are also important drivers of network formation in some cases. Boschma (2005) proposed a fivefold classification of geographical, cognitive, social, institutional, and organizational proximity.

After Boschma (2005), empirical studies have found that when controlling for non-spatial forms of proximity, the effect of spatial proximity on the formation of a knowledge network tends to decrease. Geographical proximity does not lose all of its relevance, though: it is worth noting that those studies that included all five forms of proximity still found that spatial proximity positively affects tie formation in knowledge networks (Balland et al., 2013; Balland, 2012; Hardeman et al., 2012).

Hypothesis 4: The probability of a new alliance formed between two organisations increases as the geographical distance between the two decreases. In this study, I expect that the probability of new projects being carried out between a government and a company, or two specific companies, increases as geographical distance between the government (capital city) and the company (capital city of the headquarter's country), or between the two companies (capital cities of the headquarters' countries) decreases.

This is a property of the dyads and:

- for the case of government-company relationships, the geographical distance between the government, G_i, (capital city) and the company C_j (capital city of the headquarter's country) is taken into account, and
- for the case of company-company relationships, the geographical distance between the two companies, C_j and C_h, (capital cities of the headquarters' countries) are taken into account.

The spatial proximities are measured using geodesic [12] distances. Each of these measurements are explained in more details in section 3.

[12] It should be noted here that the term geodesic does not refer to the term commonly used in Social Network Analysis studies; the term is used by geography scholars who have compiled the CEPII database and it is calculated following the great circle formula and using the geographic coordinates of the capital cities of countries, referring to the shortest distance between the capital cities of any pair of countries. (Mayer & Zignago, 2011). In SNA terms however, the geodesic distance refers to the number of relationships in the shortest possible path from one actor to another.

2.3. Similarity Hypotheses

In this work, I broadly frame my hypotheses under similarity concept, but I consider different types of similarity and dissimilarity that governments and companies can face in the sector under investigation.

2.3.1. Geographical Similarity

Entities forming alliances, if in the same geographical region, not only benefit from reduced costs associated to the interaction (which is also captured when discussing spatial proximity), but could also use their local market knowledge to enhance their operations. This notion of advantage in having local knowledge is based on Hymer (1976) work which argued that "National firms have the general advantage of better information about their country: its economy, its languages, its law, and its politics. To a foreigner the cost of acquitting this information may be considerable" (p.34). To some extent, these considerations extend from the national to the regional level: for example, a citizen of Europe is likely to be more knowledgeable of conditions prevailing in another European country, than a citizen of (say) North America. This is because common borders, a shared history, regional trade agreements, and sometimes even monetary or political unions create enhanced opportunities for circulation of knowledge and information across countries within the same geographical region (or sub-region).

Hypothesis 5: The probability of a new alliance formed between two organisations increases as their geographical similarity increases. In this study, I expect that the probability of new projects being carried out between a government and a company, or two specific companies, increases as a result of them being located in the same geographical regions. For companies, regions are defined as the regions of their headquarters' countries.

This is a property of the dyads and:

- for the case of government-company relationships, the extent to which the country (government) and the company (the country where it has its headquarters) are in the same region is considered.
- for the case of company-company relationships, the extent to which the companies (the country where they have their headquarters) are in the same region is considered.

2.3.2. Economic Similarity

The literature on alliance formations argues that complementarities partners bring to their relationship together can impact the creation of such relationships (Lavie & Miller, 2008; Ebers, 1997). I use this notion in my work to investigate the importance of economic similarity (dissimilarity) on partner choice when forming alliances, but I only apply this to the case of government-company relationships. I consider that companies with headquarters in richer countries can have better access to technological and information resources and hence they are attractive partners for governments in lower level income countries for fulfilling projects.

Hypothesis 6: The probability of a new alliance formed between two organisations increases as the similarity between the wealth of their countries of origin decreases. In this study, I expect that the probability of new projects being carried out between a government and a company, increases if the company is from a wealthier country.

This is a property of the dyads and:

- for the case of government-company relationships, I operationalize this idea by looking at the similarity between the global income level of a country (government) and the income level of the country of company's headquarter. To test the direction of the dissimilarity, I specifically look at the extent to which the company comes from a country with a higher level of income than the government.

2.3.3. Cultural Similarity

The literature suggests that collaboration and learning between partners in an alliance can be disrupted by national and organisational cultural differences (Hennart & Zeng ,2002; Pothukuchi et al., 2002; Lyles & Salk, 1996). National culture is related to values deeply incorporated into a society and organisational culture is related to shared beliefs in organisational practices and processes (Hofstede et al., 1990). Hence, it is expected that cultural differences have an impact on the process of alliance formations.

Hypothesis 7: The probability of a new alliance formed between two organisations increases as the cultural differences between them decreases. In this study, I expect that the probability of new projects being carried out between a government and a company, or two specific companies, increases as a result of their cultures being closer to each other.

This is a property of the dyads and:

- for the case of government-company relationships, the similarity between the official languages of the country (government) and the country of a company's headquarter is used as a proxy to illustrate similarity in national culture. I also consider colonial history to be an indicator of cultural similarity; colonial history is defined as whether a government or a company' country of headquarter have ever been colonies/colonisers to each other.
- for the case of company-company relationships, the similarity between the official languages of the countries of companies' headquarters is considered as a representation of similarity of organisational culture. I also consider colonial history to be an indicator of cultural similarity; colonial history is defined as whether the two companies' countries of headquarters have ever been colonies/colonisers to each other.

It should be mentioned that although the above indicators are used in this study, they can have their own limitations; a country might have more than one official language, and colonial history may affect aspects different from culture (such as political structure). But the advantage of these variables is that both can be measured unequivocally for all of the relationships we have. Hence, I take the two indicators together, as they are sufficiently reliable as indicators of similarity in cultural dimension.

In this part, some relevant literature has been discussed, and the hypotheses for this study has been outlined. In the following section, the data used for this study and how different variables were constructed in light of the hypotheses, as well as the estimation method that is used are explained.

3. Data and Model Specification

Two dyadic panel (longitudinal) datasets have been constructed using the original data obtained from the World Bank database, which was described in the previous paper. One dataset is focused on alliances formed between governments and private companies in the form of projects in the water sector. And the second dataset is focused on projects which were/are conducted by two or more private companies in the water sector, hence representing collaboration between such companies. In the following sections, the content of the two datasets, i.e. variables which have been built for the purpose of analysis, are described in detail. It should be noted that the variables are identical to those mentioned in the previous section (section 2), but the aim of this part is to provide more information about the design of the two datasets.

3.1. Datasets

3.1.1. Government-Company dataset

This dataset, as mentioned before, is constructed as a dyadic panel dataset, using the information obtained from World Bank database. Governments of those countries in which the projects take place are considered to be one entity of the dyads, and private companies which carry out the projects are considered to be the other entity of the dyads; hence dyads are defined as pairs of governments and countries. It should be noted here that the Word Bank dataset reports countries and companies as entities involved in carrying out projects, but from here onwards in this work I use the term "governments" instead of countries, since it is assumed that governments (whether at national level or sub-nationally, for example municipalities) are involved in the process of assigning projects to private companies. An alliance tie exists between a government and a private company if the company has carried out or is carrying out a project in the country of that government.

Some projects in the World Bank database are carried out by two or more private companies. For the construction of this dataset, such projects are included more than once, each time with one of the involved private companies as an entity in the dyad. This process has turned 975 projects into 1305 incidences of government and companies forming alliances to carry out projects. As explained before, 65 countries and 453 private companies are present in the original dataset (after cleaning and editing), this results in having 29445 dyads. The starting point of closure dates [13] for projects reported in the World Bank dataset is 1949 and the most recent closure date is 2016; in the dyadic panel data dates are converted into period of 5 years with a total of 14 time periods. The governments are given unique identification numbers (G) ranging from 2000 to 2064, and private companies' identification numbers (C) range from 1000 to 1452. By combining the two, each dyad is also given a unique identification number (dyad_id). Time periods (t), as mentioned before, range from 1 to 14 in the dataset, as depicted in the table below:

[13] Financial closure date is defined as the year in which private sponsors agreed to a legally binding agreement to invest funds or provide services; see Paper 2 (section 2).

Table 3.1, Years, and Corresponding Time Periods.

Note: The period the data captures is from 1949 to 2016. For analysis, 14 time periods of 5 years each have been constructed.

Years	Time Periods	Years	Time Periods	Years	Time Periods
1949-1954	1	1979-1984	7	2009-2014	13
1954-1959	2	1984-1989	8	2014-20016	14
1959-1964	3	1989-1994	9		
1964-1969	4	1994-1999	10		
1969-1974	5	1999-2004	11		
1974-1979	6	2004-2009	12		

A note about missing data

Before describing the construct of variables for this dataset, it is important to bring into attention how missing data has been handled. The information used to build this dataset taken from the original World Bank database includes: Countries where the projects take place and their region and income group, companies involved in the projects and the countries of their headquarters, financial closure dates for the projects, project period, project status, and investment years. Among this information, there is some missing data on countries of companies' headquarters (2 out of 975 projects; it was possible for a number of cases to find this missing information and amend the data), and project periods, which are used to calculate expected termination dates of projects (150 out of 975 projects). This information is regarded as missing in the constructed dataset. It was decided to treat these cases as missing information, since the alternative approach of imputation could affect the results, in particular by artificially reducing variance.

3.1.1.1. Variables and their description

As described in the section 2, in this work I hypothesise on the relation between embeddedness, proximity, and similarity with tie formation (alliance formations). Hence, the dependent variable in this work is defined as the number of projects with a closure year of t between a specific government and a specific company; for each dyad, this variable encompasses all projects which has a closure year of t (period t, five-year interval) and it shows the number of times that a government and a company got together to carry out a project in period t. From here forward, I call this independent variable 'AllianceFormation'. It is a count and varies from 0 to 23.

For clarity, the procedure explained is demonstrated using an example. Assuming three different projects, one between G1, and C1 with a closure date of 1949, another between G1, and C1 and C2 with a closure date of 1950, and a third one between G2, and C2 and C3 with a closure date of 1952, the dataset and dependent variable is built as seen in the table below:

Table 3.2, An Example on Constructing Dataset for Government-Company Relationships.

Note: The variable that is constructed here is the AllianceFormation, between a government (G) and a company (C) in a specific time period.

Time	G	C	AllianceFormation
1	G1	C1	2
1	G1	C2	1
1	G1	C3	0
1	G2	C1	0
1	G2	C2	1
1	G2	C3	1

The independent variables are defined and built based on hypotheses of this study, as explained in section 2. The independent variables are categorised into three groups associated to embeddedness, proximity, and similarity. In the sections below, I describe variables in each of these categories.

3.1.1.1.1. Embeddedness Independent Variables

This category of variables is built around three subcategories of relational, and positional embeddedness.

For relational embeddedness, variables are representation of within-dyad properties which illustrate the history of government G_i, and company C_j, in terms of having alliances. Five independent variables are built for this dataset for relational embeddedness as explained below:

- Lagged AllianceFormation: this variable is the lagged dependent variable (AllianceFormation at time t-1). The idea is that the number of new projects that come into existence at each time period may depend on the number of new projects initiated in the previous time period, that is, there is some form of time dependency.

- ReInvest: how many reinvestments a government (G_i) has made at time t in relation to its project(s) with a company (C_j); this variable may correspond to more than one project, and it is for projects signed at any time before t.
- Terminations: how many projects were terminated at time t between a government (G_i) and a company (C_j). This variable may correspond to more than one project being terminated, and it may be for projects which started at time t or before. This variable takes a value of 0 for all periods of t when a contract is not yet terminated. It should be noted here that the termination dates are expected termination dates calculated using the project periods, and in some cases, they are not the same as actual termination dates. Also, for some projects, given that the project periods are not available termination dates are also unavailable [14].
- PastTerminations: At any time period t, this variable shows how many projects were terminated (in all time periods up until t) in the previous time periods between a government (G_i) and a company (C_j). This variable represents the history of terminated projects between entities of a dyad.
- N_Alliances: how many projects are in existence between a government (G_i) and a company (C_j) for at least part of time span t; there may be more than one project, they have started at any time before t, or they may terminate at any point later than t. In some time periods, there are no contracts. The value of this variable at time t does not count the projects started at time t, and uses terminations which have happened at time t-1. This variable is built to help construct the next two variables and is not used in the analysis itself. The design of this variable is in such a way to represent, at any time period t, the number of alliances initiated between governments and companies in the past which are still ongoing.
- N_SuccessfulAlliances: this variable is calculated using the same logic as N_Alliances, but only those projects which are still active or concluded have been considered. In other words, those reported as cancelled or distressed have not been counted in [15]. This variable is designed so to represent, at any time period t, the number of alliances initiated in the past which are still ongoing and are associated to successful projects; being an active or concluded project is considered a successful alliance compared to distressed or cancelled projects.

[14] See above: A note about missing data.
[15] See Paper 2 (section 2).

- AllianceVsSuccessfulAlliance: this is a binary variable comparing the last two variables, N_Alliances and N_SuccessfulAlliances. It assesses whether these two variables are the same, stated as 1, or they are different, stated as 0. The purpose of creating this variable is to see the impact of those projects which are not active or concluded, i.e. those that cannot be considered cases of successful projects, but their numbers cannot be accurately calculated since it is expected that their termination dates are different from expected termination dates.

For positional embeddedness, three different independent variables are designed. These variables consider the whole structure of networks built from alliance ties between governments and private companies and focus on the position that a government (G_i) and a company (C_j) hold in such networks at any given time t:

- GDegree: This variable counts the total number of projects that a government (G_i) has (with any company) at time period t. In network terms, this variable is the same as degree centrality for each government in each two-mode network (one network for each time period) of alliance ties.
- CDegree: This variable counts the total number of projects that a company (C_j) has (with any government) at time period t. Similar to GDegree, this variable is the same as degree centrality for each company in each two-mode network (one network for each time period) of alliance ties.

Each of these two variables have then been normalised; for every time period, the sum of degree centralities of governments and companies have been calculated, and normalised degree centralities have been obtained by dividing degree centralities by the sum of degree centralities for period:

For t=1 to 14, $Normalised\ G_{(i,t)}Degree = \frac{G_{(i,t)}Degree}{\sum_{i=2000}^{i=2064} G_{(i,t)}Degree}$

where $G_{(i,t)}Degree$ is the degree centrality for a government ($G_{(i)}$) at time t.

And For t=1 to 14, $Normalised\ C_{(j,t)}Degree = \frac{C_{(j,t)}Degree}{\sum_{j=1000}^{j=1452} C_{(j,t)}Degree}$

where $C_{(j,t)}Degree$ is the degree centrality for a company ($C_{(j)}$) at time t.

- DegreeSimilarity: This variable is built to show the extent to which positions of governments and companies are similar to each other in the alliance network at any time t using normalised GDegree and CDegree. The closer this value is to 0, the more similar the positions of the two actors of a dyad, i.e. governments and companies, are; while a value of 1 indicates maximum dissimilarity between the positions of the two actors of a dyad at any time t. The variable is used in the analysis to show how occupying similar (or dissimilar) positions in the network can influence formation of alliance ties (Gulati & Gargiulo 1999).

  For t=1 to 14,

$$DegreeSimilarity_{(t)} = \left|Normalised\ GDegree_{(t)} - Normalised\ CDegree_{(t)}\right|$$

It should be noted here that the lagged values for the normalised variables are used for analysis of the dataset, i.e. the values at time t-1 are used for analysing the impact of positional embeddedness on alliance formation at time t. The use of lagged values essentially translates into how the previous positions of entities in the network affect the current state of the network.

3.1.1.1.2. Spatial Proximity Independent Variables

This variable is built to help investigate the hypothesis that the closer two actors (i.e. government and companies) in a dyad are to each other geographically, the probability of them forming an alliance is higher. For this variable, the geodesic distances between countries obtained from the database of Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) are used. The specific variable taken from this database for the present study is ‘DistCap’, which is calculated following the great circle formula and using the geographic coordinates of the capital cities of countries (Mayer & Zignago, 2011). For companies, the country of their headquarters is considered. It should be noted here that for those companies where the country of headquarter is unknown, DistCap is considered as missing data [16]. For analysis of this dataset, the normalised values of DistCap are taken into account; the normalised DistCap is simply calculated by dividing the DistCap value for each time at any time t by the maximum DistCap value present in the dataset.

[16] See above: A note about missing data.

3.1.1.1.3. Similarity independent variables

These variables are built to help investigate how similarities between governments and companies can facilitate formation of alliances. I consider similarity in terms of geographical similarity, economic similarity, and cultural similarity.

For geographical similarity, a binary variable, RegionSim, is built for each dyad of government/company representing whether the region of a government (country) is similar to the region of the country of a company's headquarter. The variable is set to zero if the regions are different and set to 1 if the regions are the same. Regions of countries are categorised based on the World Bank categorisation and are coded as seen in the table below. For those companies where the countries of headquarters are not known in the data, the regions are coded as missing, and the values for RegionSim are also treated as missing [17]. It should be noted here that this variable is time independent and its value for different dyads does not change in different time periods.

Table 3.3, Region Categories.

Note: Seven regions are present in the data.

Region	**Code**
East Asia and Pacific	1
Europe and Central Asia	2
Latin America and the Caribbean	3
Middle East and North Africa	4
North America	5
South Asia	6
Sub-Saharan Africa	7

For economic similarity, the income level of countries is used to construct a binary variable, IncomeSim, representing whether the income level of a government (country) is similar to income level of the country of a company's headquarter. Although the two entities of dyads

[17] See above: A note about missing data.

are rather different with each other, one being a country (government) and the other being an organisation (company), we can still use the income levels of countries as a proxy to access of companies to better resources; we can expect companies with headquarters in higher level income countries to have better access to technological infrastructure and information resources, which can positively influence their performances. Also, since lower level income countries may benefit more from companies of higher level income countries, another variable, IncomeRelative, is also constructed.

IncomeSim is set to zero if the income levels are different and set to 1 if the income levels are the same. Income levels of countries are categorised based on the World Bank categorisation and are coded as seen in the table below. IncomeRelative is a binary variable and shows whether the company comes from a higher-level income country compared to the income level of the government (country), in which cases the value of the variable is set as 1, and 0 for others. The missing data is treated in the same way as for RegionSim variable. It should be noted here that all governments (countries) present in the original World Bank database have middle and low levels of income.

Table 3.4, Income Level Categories.

Note: Four income groups are present in the data. Although the projects have all been carried out in the middle and low-income countries, some private companies' headquarters are located in high- income countries.

Income Level	**Code**
High income	1
Upper middle income	2
Lower middle income	3
Low income	4

Similar to RegionSim, IncomeSim variable is also time independent and its value does not change for the same dyads of governments/companies in different time periods.

For cultural similarity, two different variables are constructed in this dataset; LangSim, and ColonialHist. The information needed for constructing these two variables are taken from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) database.

LangSim is a binary variable representing whether the first official language of a government and a company's country of headquarter is the same; LangSim is set to 0 if the languages are different and 1 if the languages are the same. It is assumed that similarity of languages between the two entities in an alliance dyad can facilitate working together. Missing data is treated the same way as for RegionSim and IncomeSim variables. This variable is also time independent and its value does not change for a specific dyad in different times.

ColonialHist attempts to capture whether the actors in a dyad have been colonies/colonisers of each other in the past. The idea here is that having some colonial history may have translated into some similarities or enhanced understanding of cultural traits which could facilitate working together in an alliance. For countries where there has been more than one coloniser, the most prominent one is taken into account. The missing data is treated the same way as the previous variables, RegionSim, IncomeSim, and LangSim. This variable is also time independent for any dyad. ColonialHist is coded as two distinct dummy variables:

- The first has value 1 for a dyad, if a government (G_i) has been the coloniser of the country of a company's headquarter (C_j),
- The second has value 1 for a dyad, if the country of a company's headquarter (C_j) has been the coloniser of a government (G_i),

And in both cases:

- 0 for a dyad, if there has been no colonial history between a government (G_i) and a company (C_j)

In the above sections, different categories of independent variables have been defined and the process of calculation and/or construction of each variable is explained. Some control variables have also been constructed for the analysis of this dataset, as outlined below.

3.1.1.1.4. Control Variables

For each entity of a dyad, governments, and companies, two control variables have been constructed, representing:

- Regions (GRegion) and income levels (GIncome) of governments (associated countries), based on codes in tables 3.3 and 3.4

- Regions (CRegion) and income (CIncome) levels of countries of companies' headquarters, based on codes in tables 3.3 and 3.4. There are some missing data for these two control variables [18].

The aim of this part was to introduce the dataset designed and used for testing the hypotheses regarding alliance formations between governments and private companies. The following part focuses on the second dataset studies in this work, namely company-company dataset.

3.1.2. Company-Company dataset

This dataset is constructed with the same logic of the previous one, government-company dataset. It is a dyadic panel dataset, which uses the information obtained from World Bank database; but only those projects are considered in which two or more private companies have been/are involved (230 projects) and hence dyads are defined as pairs of private companies. An alliance tie is considered to exist between two companies if they have carried out or are carrying out a project together. The location (country) where these projects are taking place is of no interest in the analysis of this dataset.

Some projects considered in this dataset involved 3 or more companies. All possible dyads are considered in these cases [19], but dyads are later refined taking into account the shares [20] of companies in projects. The share of each single company in a project can be taken as a clear indicator of its role as leader of the consortium, whether formally or informally, or follower. For example, the company with the highest share is sometimes the official coordinator or initiator of the bid, and sometimes it is the corresponding partner between fellow companies and the government. Companies with lower shares in the project are minority partners, less likely to influence the choices of the consortium as a whole, and less likely to act as intermediaries between the government and the other commercial partners. I look at agency on the side of the leading company, assuming that it must have played a significant role in the creation of the interorganisational ties that constitute the consortium of companies. Therefore, I have coded the original project-based data as dyads based on the three principles below:

[18] See above: A note about missing data.
[19] For example, a project between companies Cj,Ch, and Ck result into having Cj-Ch, Cj-Ck, Ch-Ck, Ch-Cj, Ck-Cj, and Ck-Ch dyads.
[20] See Paper 2 (section 2.3).

- For the case of company C_j and company C_h carrying out a project together, and company C_j having a larger share than company C_h, the dyad is formed as C_j - C_h; the reciprocated tie C_h - C_j is not included.
- For the case of company C_j and company C_h carrying out a project together, and the two companies having an equal share, both C_j - C_h and C_h - C_j dyads are included.
- For the case of company C_j and company C_h carrying out a project together, and where information is missing about either or both companies' shares, both C_j - C_h and C_h - C_j dyads are included.

This procedure has been done so that in the analysis of the data, we can cluster around the first entity of the dyad. This enables recognizing dependencies in the data that are due to the first entity (the 'leader') having initiated multiple projects with several partner companies. In other words, we recognize that the tie created by company C_j to partner with company C_h may not be independent of the tie that C_j also formed with C_k during the same time period (whether as part of the same project or of a different project).

For clarity, an example is given on how the procedure was carried out. Assuming the same example as section 3.1.1, this time we only consider the companies involved (and hence the project with a sole company is dismissed) and they each have different shares in the projects:

- 1950: C1 with 50% share, and C2 with 50% share
- 1952: C2 with 75% share, and C3 with 25% share

Table 3.5, An Example on Constructing Dataset for Company-Company Relationships.

Note: The variable that is constructed here is the AllianceFormation, between two private companies, C_j and C_h, in a specific time period.

Time	C_j	C_h	AllianceFormation
1	C1	C2	1
1	C2	C1	1
1	C2	C3	1
1	C3	C2	0
1	C1	C3	0
1	C3	C1	0

Following the procedure explained above, a dataset with 263 companies and 68906 dyads in each time period (9 to 14, corresponding to 1990 to 2016) is constructed. The companies are given unique identification numbers (C) ranging from 1000 to 1262, and by combining the ids for pairs of companies, each dyad is also given a unique identification number (dyad_id). Time periods (t), as mentioned before, range from 9 to 14 in this dataset, as depicted in the table below:

Table 3.6, Years and Corresponding Time Periods.

Note: Based on table 3.1, the following time periods are taken into consideration in the analysis of data.

Years	Time Periods
1989-1994	9
1994-1999	10
1999-2004	11
2004-2009	12
2009-2014	13
2014-20016	14

Brief note on missing data

There is no missing data on the characteristics of the companies in this dataset, but the contract period used for calculation of expected termination dates of projects are unavailable for 14 projects out of 230. As for the government-company dataset, the unavailable data is treated as missing.

3.1.2.1. Variables and their description

The definitions of variables for this dataset are rather similar to those given in the previous section for government-company dataset. As explained before, I hypothesise on the relation between embeddedness, proximity, and similarity with tie formations (alliance formations). Hence, the dependent variable in this work, for this dataset, is defined as the number of projects with a closure year of t between two companies; for each dyad, this variable encompasses all projects which have a closure year of t (period t) and it shows the number of times that two companies got together to carry out a project in period t. From here forward, I call this independent variable ‘AllianceFormation’. It is a non-negative count and varies from 0 to 7.

The independent variables are defined and built based on hypotheses of this study, as explained in section 2, and following the similar logic of independent variables in government-company dataset. The independent variables are categorised into three groups associated to embeddedness, proximity, and similarity. In the sections below, I describe variables in each of these categories.

3.1.2.1.1. Embeddedness Independent Variables

This category of variables is built around three subcategories of relational, positional, and structural embeddedness.

For relational embeddedness, variables are representation of within-dyad properties which illustrate the history of two companies C_j and C_h, in terms of having alliances. Five independent variables are built for this dataset for relational embeddedness as explained below:

- Lagged AllianceFormation: this variable is the lagged dependent variable (AllianceFormation at time t-1). The idea is that the number of new projects that come into existence at each time period may depend on the number of new projects initiated in the previous time period, that is, there is some form of time dependency.
- ReInvest: how many reinvestments have occurred at time t in relation to projects carried out by two companies (C_j and C_h); this variable may correspond to more than one project, and it is for projects signed at any time before t.
- Terminations: how many of those projects carried out by two companies (C_j and C_h) were terminated at time t. This variable may correspond to more than one project being terminated, and it may be for projects which started at time t or before. This variable takes a value of 0 for all periods of t when a contract is not yet terminated. It should be noted here that the termination dates are expected termination dates calculated using the project periods, and in some cases, they are not the same as actual termination dates. Also, for some projects, given that the project periods are not available termination dates are also unavailable [21].
- PastTerminations: At any time period t, this variable shows how many projects were terminated (in all time periods up until t) in the previous time periods between two

[21] See section Brief note on missing data.

companies, C_j and C_h. This variable represents the history of terminated projects between entities of a dyad.

- N_Alliances: how many projects are in existence between two companies (C_j and C_h) for at least part of time span t; there may be more than one project, they have started at any time before t, or they may terminate at any point later than t. In some time periods, there are no contracts. The value of this variable at time t does not count the projects started at time t, and uses terminations which have happened at time t-1. The design of this variable is in such a way to represent, at any time period t, the number of alliances initiated between companies in the past which are still ongoing. This variable is built to help construct the next two variables and is not used in the analysis itself.
- N_SuccessfulAlliances: this variable is calculated using the same logic as N_Alliances, but only those projects which are still active or concluded have been considered. In other words, those reported as cancelled or distressed have not been counted in [22]. This variable is designed so to represent, at any time period t, the number of alliances initiated in the past which are still ongoing and are associated to successful projects; being an active or concluded project is considered a successful alliance compared to distressed or cancelled projects.
- AllianceVsSuccessfulAlliance: this is a binary variable comparing the last two variables, N_Alliances and N_SuccessfulAlliances. It assesses whether these two variables are the same, stated as 1, or they are different, stated as 0. The purpose of creating this variable is to see the impact of those projects which are not active or concluded, i.e. those that cannot be considered cases of successful projects, but their numbers cannot be accurately calculated since it is expected that their termination dates are different from expected termination dates.
- N_LowShareAlliances: It was noted before that this dataset has been constructed paying specific attention to the shares companies have/have had in projects. But it is still interesting to see whether alliances formed between companies who did not have the largest shares can influence tie formation. N_LowShareAlliances only considers those ties between companies which are not identified as "leaders" in project, and the variable counts the number of such ties formed at each time period t. The lagged value for this variable is used in the model, since we are interested in investigating the impact of such projects initiated previously on the future alliance formations.

[22] See Paper 2 (section 2).

For positional embeddedness, three different independent variables are designed. These variables consider the whole structure of networks built from alliance ties between private companies and focus on the position two companies of a dyad (C_j and C_h) hold in such networks at any given time t:

- C_jDegree: This variable counts the total number of projects that the first entity of any dyad (company C_j) has (with any other company) at time period t. In network terms, this variable is the same as degree centrality for each company in each network (one network for each time period) of alliance ties.
- C_hDegree: This variable counts the total number of projects that the second entity of any dyad (company $C_h$has (with any other company) at time period t. Similar to C_jDegree, this variable is the same as degree centrality for each company in each network (one network for each time period) of alliance ties.

For the purpose of calculating C_jDegree and C_hDegree, I count the total number of ties of each entity in the dyad; that is, the sum of its in-degree and its out-degree, which measures the overall connectedness of each company in the network. This approach is parsimonious as it avoids having different measures of in-degree and out-degree [23]. Relating this point to what has been said about the construction of the dataset using shares of companies in projects, it should be made clear here that in the calculation of C_jDegree and C_hDegree, shares of companies are disregarded; i.e. for calculating company C_j's centrality in any dyad at time t, all its involvement in projects with other companies are taken into account whether its share is larger or smaller than others. Therefore, this measure is a pure relational one, that counts the number of ties of each company involved in the dyad and keeps it separate from its role of leader or follower.

Each of these two variables have then been normalised; for every time period, the sum of degree centralities of companies C_j and C_h have been calculated, and normalised degree centralities have been obtained by dividing degree centralities by the sum of degree centralities for period:

For t=9 to 14, $Normalised\ C_{(j,t)}Degree = \frac{C_{(j,t)}Degree}{\sum_{j=1000}^{j=1253} C_{(j,t)}Degree}$

[23] In-degree centrality is the number of incoming ties of a node in a network, and out-degree centrality is the number of outgoing ties in a network. The two measurements are used for directed network, in which the direction of ties is important. For undirected networks, in which ties are reciprocated and direction of ties is not important, we consider the total number of ties an actor has in a network as its degree centrality.

where $C_{(j,t)}Degree$ is the degree centrality for a company ($C_{(j)}$) at time t.

For t=9 to 14, $Normalised\ C_{(h,t)}Degree = \frac{C_{(h,t)}Degree}{\sum_{h=1000}^{h=1253} C_{(h,t)}Degree}$

where $C_{(h,t)}Degree$ is the degree centrality for a company ($C_{(h)}$) at time t.

- DegreeSimilarity: This variable is built to show the extent to which positions of companies are similar to each other in the alliance network at any time t using normalised C_jDegree and C_hDegree. The closer this value is to 0, the more similar the positions of the two actors of a dyad, i.e. the two companies, are; while a value of 1 indicates maximum dissimilarity between the positions of the two actors of a dyad at any time t. The variable is used in the analysis to show how occupying similar (or dissimilar) positions in the network can influence formation of alliance ties (Gulati & Gargiulo 1999).

  For t=1 to 14,

  $$DegreeSimilarity_{(t)} = \left|Normalised\ CjDegree_{(t)} - Normalised\ ChDegree_{(t)}\right|$$

It should be noted here that the lagged values for the normalised variables are used for analysis of the dataset, i.e. the values at time t-1 are used for analysing the impact of positional embeddedness on alliance formation at time t. The use of lagged values essentially translates into how the previous positions of entities in the network affect the current state of the network.

Structural embeddedness is another point of interest which has only been investigated for the case of company-company dataset. The variable (N_CommonPartners) is constructed to indicate to what extent a pair of companies have shared common partners as a result of their past alliances. The value of this variable for a dyad at time t, is defined as the number of common partners the two companies of the dyad (C_j and C_h) have had up until time period t. The value for this variable is set to 0 if the two companies of a dyad had entered into at least one previous alliance with each other; this is to differentiate between structural and relational embeddedness (Mizruchi 1992). In other words, N_CommonPartners for a dyad at time t, is the number of common partners shared by previously unconnected companies of that dyad up until time t.

Another variable built to investigate structural embeddedness for this dataset is N_GovernmentPartners. For this variable, the information from the government-company dataset is used. The two-mode networks of alliances at each time period are transformed into one-mode networks of only companies, and showing how many governments, a pair of companies have had/have alliances with at time t. This information is then used for the dyadic dataset. In other words, N_GovernmentPartners for a dyad at time t, is the number of governments the two have shared in terms of having projects with up until time t. The idea here is that companies could have obtained information about each other, not only through their mutual ties in the past, but also as a result of having projects with same governments, and that carrying out projects with the same government may results into companies becoming competitors and unwilling to collaborate with each other.

3.1.2.1.2. Spatial Proximity Independent Variables

This variable, similar to the one for government-company dataset, is built to help investigate the hypothesis that the closer two actors (i.e. two companies) in a dyad are to each other geographically, the probability of them forming an alliance is higher. For this variable, the geodesic distances between countries obtained from the database of Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) are used. The specific variable taken from this database for the present study is “DistCap”, which is calculated following the great circle formula and using the geographic coordinates of the capital cities of countries (Mayer & Zignago, 2011). For companies, the country of their headquarters is considered. For analysis of this dataset, the normalised values of DistCap are taken into account; the normalised DistCap is simply calculated by dividing the DistCap value for each time at any time t by the maximum DistCap value present in the dataset.

3.1.2.1.3. Similarity Independent Variables

These variables are built to help investigate how similarities between companies can facilitate formation of alliances. I consider similarity in terms of geographical similarity, economic similarity, and cultural similarity. Given the large number of companies being available in the dataset, and unavailability of information on each specific company, their countries of headquarters are used as proxy to show their financial and cultural characteristics; we can assume that those founded in higher income countries have better access to technological infrastructure and knowledge resources, and that national culture of each country can have an impact on companies’ business culture.

For geographical similarity, one binary variable, RegionSim, is built for each dyad of company/company. RegionSim represents whether the regions of the countries of the two companies' headquarters are the same. The variable is set to 0 if the regions are different and set to 1 if the regions are the same. Regions of countries are categorised based on the World Bank categorisation and are coded as seen in the table below. It should be noted here that this variable is time independent and its value for different dyads does not change in different time periods.

Table 3.7, Region Categories.

Note: Seven regions are present in the data.

Region	**Code**
East Asia and Pacific	1
Europe and Central Asia	2
Latin America and the Caribbean	3
Middle East and North Africa	4
North America	5
South Asia	6
Sub-Saharan Africa	7

For economic similarity, the income level of countries is used to construct a binary variable, IncomeSim, representing whether the income levels of countries of the two companies' headquarters are the same. IncomeSim is set to zero if the income levels are different and set to 1 if the income levels are the same. Income levels of countries are categorised based on the World Bank categorisation and are coded as seen in the table below. Similar to RegionSim, IncomeSim variable is also time independent and its value does not change for the same dyads of company-company in different time periods.

Table 3.8, Income Level Categories.

Note: Four income groups are present in the data. Although the projects have all been carried out in the middle and low-income countries, some private companies' headquarters are located in high- income countries.

Income Level	**Code**
High income	1
Upper middle income	2
Lower middle income	3
Low income	4

For cultural similarity, two different variables are constructed in this dataset; LangSim, and ColonialHist. The information needed for constructing these two variables are taken from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) database.

LangSim is a binary variable representing whether the first official language of the two companies' country of headquarter is the same; LangSim is set to 0 if the languages are different and 1 if the languages are the same. It is assumed that similarity of languages between the two entities in an alliance dyad can facilitate working together. This variable is also time independent and its value does not change for a specific dyad in different times.

ColonialHist attempt to capture whether the actors in a dyad have been colonies/colonisers of each other in the past. The idea here is that having some colonial history may have translated into some similarities or enhanced understanding of cultural traits which could facilitate working together in an alliance. For countries where there has been more than one coloniser, the most prominent one is taken into account. This variable is also time independent for any dyad. ColonialHist is coded aas two distinct dummy variables:

- The first has value 1 for a dyad, if the country of one company's headquarter (C_j) has been the coloniser of the country of the other company's headquarter (C_h),
- The second has value 1 for a dyad, if the country of one company's headquarter (C_h) has been the coloniser of if the country of the other company's headquarter (C_j),

And in both cases:

- 0 for a dyad, if there has been no colonial history between the two companies, C_j and C_h.

In the above sections, different categories of independent variables have been defined and the process of calculation and/or construction of each variable is explained. Some control variables have also been constructed for the analysis of this dataset, as outlined below.

3.1.2.1.4. Control Variables

For each entity of a dyad, the two companies, two control variables have been constructed, representing:

- Regions (C_jRegion) and income levels (C_jIncome) of a company's (C_j) country of headquarter, based on codes in tables 3.7 and 3.8.
- Regions (C_hRegion) and income levels (C_hIncome) of a company's (C_h) country of headquarter, based on codes in tables 3.7 and 3.8.

3.2. Model Specifications

Both datasets, the government-company and the company-company ones, are dyadic because each observation refers to one of the possible pair of entities in the sample – respectively, G_i, C_j and C_j, C_h. The dependent variable is also dyadic, measuring the number of new alliances formed between G_i and C_j (or between C_j and C_h). These datasets are panels because the dyads are repeatedly observed over time. In both cases, then, the dependent variable $Y_{ij,t}$ is a non-negative count that we assume to be Poisson-distributed, with mean that is a function of the lagged dependent variable $Y_{ij,t-1}$ – as a way to allow for time persistence – and of regressors X_t. Following Cameron and Trivedi (2013), we use a Poisson model with exponential feedback that can be estimated by the Generalized Method of Moments (GMM). The advantage of the exponential function is that it ensures that the expected result is non-negative. The model takes the general form:

$$E(Y_{ij,t}) = exp(\rho Y_{ij,t-1} + \beta_i X_{i,t} + \beta_j X_{j,t} + \beta_{ij} X_{ij,t})$$

where $Y_{ij,t}$ is the number of new alliances between entities i and j at time t; $Y_{ij,t-1}$ is the lagged dependent variable, $X_{i,t}$ are the covariates included in the empirical model specification, that refer to entity i (for example, its region or level of income), $X_{i,t}$ are those that refer to entity j (such as its own region), and $X_{ij,t}$ are those that refer to the dyad (for example, geographical distance between i and j); ρ is the effect of the lagged dependent variable, capturing inertia in exchange relations; the β are the coefficients of interest, that we aim to estimate.

For the analysis of the above two datasets, government-company and company-company, General Method of Moments Estimation (GMM) has been used. In this section, GMM approach is briefly introduced, its usefulness for the analysis of the data in this work is discussed, and its limitations are outlined.

3.2.1. General Method of Moments Estimation

The GMM is an estimation procedure, widely discussed by econometricians (Cameron & Trivedy 2010; 2005; Wooldridge, 2010; Hall, 2005) used for specifying economic models, allowing avoidance of unwanted and unnecessary assumptions, for example specifying a particular distribution for the errors. GMM is built on the classical method of moments, which uses the analogy principle stating that a parameter can be estimated by replacing a population moment condition with its sample analogue. Considering a set of T observations, $y_1, \ldots., y_T$, which are i.i.d. Poisson (independent and identically distributed) with intensity parameter of λ, for estimating the unknown parameter sample average can be used, since $E[y_t] = \lambda$:

$$\widehat{\lambda} = T^{-1} \sum_{t=1}^{T} y_t$$

The above equation converges to λ as the sample size increases.

For the case of Poisson data (as in the present case, the dependent variables of interest being counts), there are moments other than mean which depend on λ, and hence other moments can be used to estimate intensity (λ). For instance, $V[y_t] = \lambda$ and $E[y_t^2] = \lambda^2 + \lambda$ both depend on λ. Considering that

$$\lambda + \lambda^2 = E\left[T^{-1} \sum_{t=1}^{T} y_t^2\right]$$

and, considering the quadratic formula, an estimate of λ can be defined as:

$$\widehat{\lambda} = \frac{-1 + \sqrt{1 + 4\overline{y^2}}}{2}$$

where

$$\overline{y^2} = T^{-1} \sum_{t=1}^{T} y_t^2$$

Higher order moments of y_t could also be used to find other estimates for λ.

Such estimators are estimators for method of moments as they use sample moments in order to estimate the parameter of interest. Generalised method of moments (GMM) extends on this classical procedure in two ways: In GMM estimation and interference in a system of Q equations with P unknown parameters ($P \leq Q$) are allowed, and in GMM parameters can be estimated using quantities other than sample moments.

3.2.2. GMM for panel data

In recent years, the Generalised Method of Moments (GMM) has been increasingly used to estimate parameters of models for panel count data. It has been demonstrated that it supports treatment of unobserved individual heterogeneity correlated with the explanatory variables and the presence of explanatory variables that are not strictly exogenous. The Poisson regression model with an integer count dependent variable is an obvious example of application of these new developments (Windmeijer, 2008). Contrary to alternative models (for example, not including the lagged dependent variables) these models have the advantage that they help distinguish between state dependence and unobserved heterogeneity, that is, between cases in which actors i and j form a lot of new alliances with each other today because they already had many in the recent past, or because they have a particular propensity for collaborating with each other.

The rationale behind selecting a GMM estimation of a panel count model can be summarised in three motives. Firstly, the dependent variable is a count, and a discrete one, so that OLS estimation (which is optimal for continuous variables) would be only an imperfect approximation for the results. More seriously, OLS would not guarantee that the expected value (mean conditional on explanatory variables) will be non-negative; neither can it exclude counts outside the range of possible values. Considering the data is panel (repeated observations for several years), one way to estimate this model could be to do Poisson regression, including dummy variables to directly estimate the fixed effects; but this approach would rule out the possibility to check whether the lagged dependent variable also has an effect. GMM method allows for the introduction of the lagged dependent variable, and more generally, it is suitable when there are endogeneity issues. The inclusion of the lagged dependent variable is specifically important for this study, as projects tend to run for long periods of times, and they may be in place at a certain time which would mean no new project being signed again between the entities involved.

3.2.3. Estimation strategy for dyadic data

A major concern with dyad-oriented observation schemes is that observations are not independent, because each actor in the network appears in multiple dyads, creating complex dependencies across observations (Stuart, 1998). Under these conditions, coefficient estimates will still be consistent but the presence of complex dependence structures may lead to under-estimation of the standard errors. In empirical studies of organizational networks this problem is typically alleviated by clustering the standard errors on the sender (the initiator of a tie) and applying the Huber-White correction for heteroskedasticity (Owen-Smith & Powell, 2004; Reagans & McEvily, 2003; White, 1980). This analytical strategy also serves as a control for additional sources of unobserved heterogeneity across actors. Accordingly, we cluster on the first entity in each dyad (government G_i in the government-company study, and leading company C_j in the company-company study). This is in line with the assumptions on agency. In the government-company study, we are particularly interested in choices on the side of governments, whose decision to partner with a particular company is a major public policy operation with potential effects on the health of the population and the economy of the country, and for which in democratic regimes, they will have to respond to their constituencies. In the company-company study, as discussed above, we place emphasis on the choices of the 'leading' company (with the highest share in the consortium) as this is usually the one that started the initiative, communicates with the government awarding the contract, brings together and coordinates partners.

The results of the analysis are discussed in the next section, paying specific attention to hypotheses introduced at the start of this paper.

4. Model Results and Discussion on Findings

In the previous sections, the two datasets that are constructed for the purpose of this study and the different variables built were explained. Also, the specifications of the model and the estimation strategy, with General Method of Moments (GMM) and clustered standard errors, were discussed. In this section, first some descriptive statistics regarding the variables in the two datasets are provided and the predictions regarding the results are outlined, and then the results obtained for each dataset are discussed.

4.1. Summary of Definitions, Descriptive Statistics, and Model Predictions

As described in section 3, various variables in-line with the hypotheses for this work have been constructed. The table below provides a summary of the variables and their definitions, as well as predictions of the signs of variables expected to see after GMM estimation is carried out. It should be noted here that the variables for the two datasets are slightly different, and this has been noted in the explanations below. Also, since the entities in the two datasets are different from each other, i.e. in government-company dataset they are the governments and companies, while in the company-company dataset they are private companies, in the table below they are generally referred to as 'entities of a dyad'.

Table 3.9, Definitions and Predicted Signs of Variables.

Note: All variables that are constructed for analysis by GMM, their definitions, the predicted sign, and the corresponding hypothesis number (see section 2) are included.

Variable	Definition	Prediction	Hypothesis Number
AllianceFormation	Number of times two entities of a dyad formed an alliance (tie) in a given time period	Dependent variable	-
Lagged AllianceFormation	AllianceFormation at time t-1	+	-
Reinvest	Number of reinvestments in projects between two entities of a dyad in any given time period	+	1
Terminations	Number of projects terminated between two entities of a dyad in any given time period	+	1
PastTerminations	The number of terminated projected between two entities of a dyad up until a any time period	+	1

N_SuccessfulAlliances	Number of previous successful alliances between two entities of a dyad up until any given time period	+	1
AllianceVsSuccessfulAlliance	Binary variable; whether the number of past alliances and successful alliances between two entities of a dyad are the same or not at any given time period	NP	1
Lagged LowShareAlliances *Only used for company-company dataset*	Number of times two companies formed an alliance in the previous time period but without having the majority of shares	+	1
For Government-Company dataset only:			
Lagged GDegree	Number of alliances a government has had in the previous time period	+	2a
Lagged Cdegree	Number of alliances a company has had in the previous time period	+	2a
For Company-Company dataset only:			
Lagged C_jDegree	Number of alliances a company (first entity of a dyad (has had in the previous time period	+	2a
Lagged C_hDegree	Number of alliances a company (the second entity in the dyad) has had in the previous time period	+	2a
For both datasets:			
Lagged DegreeSimilarity	Difference between number of alliances the two entities of a dyad have had relative to all alliances in the previous time period	+	2b

N_CommonAlliances *Only used for company-company dataset*	Number of common partners two entities of a dyad have had in their past alliances	+	3
N_GovernmentPartners *Only used for company-company dataset*	Number of shared partners (governments) two entities of a dyad have had ties with in their past alliances	-	3
DistCapt	Time independent variable; The distance between associated countries (capital cities) of two entities in the dyad relative to the largest distance present in the dataset	-	4
RegionSim	Binary and time independent variable; similarity between the associated geographical regions of two entities in the dyad	+	5
IncomeSim	Binary and time independent variable; similarity between the income level of associated countries of two entities in the dyad	-	6
IncomeRelative *Only used for Government-Company dataset*	Binary and time independent variable, whether the income level of the company is higher than the country (government) where the project takes place	+	6
LangSim	Binary and time independent variable; similarity between first official language of associated countries of two entities in the dyad	+	7

ColonialHist_ColoniserColony	Time independent variable; whether the first entity of the dyad has been the coloniser of the second entity.	+	7
ColonialHist_ColonyColoniser	Time independent variable; whether the second entity of the dyad has been the coloniser of the first entity.	+	7
ColonialHist_NoHist	Time independent variable; whether the two entities of the dyad have never had any colonial history.	NP	7
t	Time periods ranging from 1 to14, each consists of 5 calendar years	NP	-
For Government-Company dataset only:			
Gregion	Geographical region of the associated country of a government	Control Variable	-
Gincome	Income level of the associated country of a government	Control Variable	-
Cregion	Geographical region of the associated country of a company	Control Variable	-
Cincome	Income level of the associated country of a company	Control Variable	-
For Company-Company dataset only:			
C_j**Region**	Geographical region of the associated company (first entity of the dyad)	Control Variable	-
C_j**Income**	Income level of the associated company (first entity of the dyad)	Control Variable	-

C_h**Region**	Geographical region of the associated company (second entity of the dyad)	Control Variable	-
C_h**Income**	Income level of the associated company (second entity of the dyad)	Control Variable	-

Note: NP=no prediction

4.2.Descriptive Statistics and Variable Correlations

Before presenting the results of GMM estimations [24] for both Government-Company and Company-Company datasets, it is of interest to show some statistics of variables as well as the correlation matrices.

Table 3.10, Descriptive Statistics for Government-Company Dataset.

Note: The difference between observation numbers for different variables is due to missing data.

Variable	Obs	Mean	Std. Dev.	Min	Max
AllianceFormation	412,230	0.0031657	0.1136968	0	23
Lagged AllianceFormation	412,230	0.0028625	0.1028737	0	21
Reinvest	412,230	0.0004755	0.0335464	0	7
Terminations	412,230	0.0005652	0.0278994	0	5
PastTerminations	412,230	0.0005167	0.025917	0	4
N_SuccessfulAlliances	412,230	0.005936	0.1836176	0	37
AllianceVsSuccessfulAlliance	412,230	0.999345	0.0255841	0	1
Lagged GDegree	412,230	1.296703	10.08688	0	239
Lagged CDegree	412,230	0.1860612	0.949901	0	21
Lagged DegreeSimilarity	412,230	0.0279741	0.1200755	0	1
DistCapt	409,500	0.4541775	0.234502	0	1
RegionSim	409,500	0.1717949	0.3772025	0	1
IncomeSim	409,500	0.3404103	0.4738477	0	1
RelativeIncome	409,500	0.6207179	0.485209	0	1
LangSim	409,500	0.0967521	0.2956203	0	1
ColonialHist_ColoniserColony	409,500	0.0173675	0.1306366	0	1
ColonialHist_ColonyColoniser	409,500	0.0001026	0.0101269	0	1
ColonialHist_NoHist	409,500	0.9825299	0.131015	0	1

[24] For all calculations, and estimations from this point on in this paper, Stats software, version 14.2, is used.

Gov_East Asia and Pacific	412,230	0.1076923	0.3099918	0	1
Gov_Europe and Central Asia	412,230	0.2307692	0.4213256	0	1
Gov_Latin America and the Caribbean	412,230	0.2615385	0.4394731	0	1
Gov_Middle East and North Africa	412,230	0.1076923	0.3099918	0	1
Gov_South Asia	412,230	0.0307692	0.1726921	0	1
Gov_Sub-Saharan Africa	412,230	0.2615385	0.4394731	0	1
Gov_Upper middle income	412,230	0.4769231	0.4994678	0	1
Gov_Lower middle income	412,230	0.4	0.4898985	0	1
Gov_Low income	412,230	0.1230769	0.3285259	0	1
Comp_East Asia and Pacific	409,500	0.4066667	0.4912123	0	1
Comp_Europe and Central Asia	409,500	0.1511111	0.3581576	0	1
Comp_Latin America and the Caribbean	409,500	0.3266667	0.4689948	0	1
Comp_Middle East and North Africa	409,500	0.0333333	0.1795057	0	1
Comp_South Asia	409,500	0.02	0.1400002	0	1
Comp_Sub-Saharan Africa	409,500	0.0133333	0.1146978	0	1
Comp_North America	409,500	0.0488889	0.215636	0	1
Comp_High income	409,500	0.2711111	0.4445339	0	1
Comp_Upper middle income	409,500	0.6511111	0.4766193	0	1
Comp_Lower middle income	409,500	0.0733333	0.2606832	0	1
Comp_Low income	409,500	0.0044444	0.0665184	0	1

Table 3.11, Descriptive Statistics for Company-Company Dataset.

Note: The difference between observation numbers for different variables is due to missing data.

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
AllianceFormation	413,436	0.0014924	0.0520965	0	7
Lagged AllianceFormation	413,436	0.0013327	0.0486435	0	7
Reinvest	413,436	0.0002177	0.0219933	0	5
Terminations	413,436	0.0002854	0.0168918	0	1
PastTerminations	413,436	0.0002612	0.0167484	0	2
N_SuccessfulAlliances	413,436	0.0003749	0.0626925	0	17
AllianceVsSuccessfulAlliance	413,436	0.9975958	0.0489741	0	1
Lagged LowShareAlliances	413,436	0.0002951	0.0195468	0	2
Lagged C_jDegree	413,436	0.6983523	2.169969	0	25
Lagged C_hDegree	413,436	0.6983523	2.169969	0	25
Lagged DegreeSimilarity	413,436	0.0054986	0.013489	0	0.1963989
N_CommonAlliances	413,436	0.0041603	0.0734237	0	5
N_GovernmentPartners	413,436	0.0764762	1.770345	0	177

DistCapt	413,436	0.467486	0.2818411	0	1
RegionSim	413,436	0.274664	0.4463454	0	1
IncomeSim	413,436	0.4526747	0.4977559	0	1
LangSim	413,436	0.1520042	0.3590254	0	1
ColonialHist_ColoniserColony	413,436	0.020332	0.1411336	0	1
ColonialHist_ColonyColoniser	413,436	0.020332	0.1411336	0	1
ColonialHist_NoHist	413,436	0.9593359	0.1975111	0	1
C_j_East Asia and Pacific	413,436	0.3003802	0.4584239	0	1
C_j_Europe and Central Asia	413,436	0.1787072	0.3831074	0	1
C_j_Latin America and the Caribbean	413,436	0.3878327	0.4872567	0	1
C_j_Middle East and North Africa	413,436	0.0494297	0.2167637	0	1
C_j_South Asia	413,436	0.026616	0.1609584	0	1
C_j_Sub-Saharan Africa	413,436	0.0228137	0.1493093	0	1
C_j_North America	413,436	0.0342205	0.1817954	0	1
C_j_High income	413,436	0.2775665	0.4477989	0	1
C_j_Upper middle income	413,436	0.6045627	0.488945	0	1
C_j_Lower middle income	413,436	0.1102662	0.3132216	0	1
C_j_Low income	413,436	0.0076046	0.086872	0	1
C_h_East Asia and Pacific	413,436	0.3003802	0.4584239	0	1
C_h_Europe and Central Asia	413,436	0.1787072	0.3831074	0	1
C_h_Latin America and the Caribbean	413,436	0.3878327	0.4872567	0	1
C_h_Middle East and North Africa	413,436	0.0494297	0.2167637	0	1
C_h_South Asia	413,436	0.026616	0.1609584	0	1
C_h_Sub-Saharan Africa	413,436	0.0228137	0.1493093	0	1
C_h_North America	413,436	0.0342205	0.1817954	0	1
C_h_High income	413,436	0.2775665	0.4477989	0	1
C_h_Upper middle income	413,436	0.6045627	0.488945	0	1
C_h_Lower middle income	413,436	0.1102662	0.3132216	0	1
C_h_Low income	413,436	0.0076046	0.086872	0	1

It should be noted here that since the focus is on factors affecting the creation of new alliance partnership in subsequent periods, we need to be wary of stability of networks over time; the two figures below show the number of new partnerships over the investigated period.

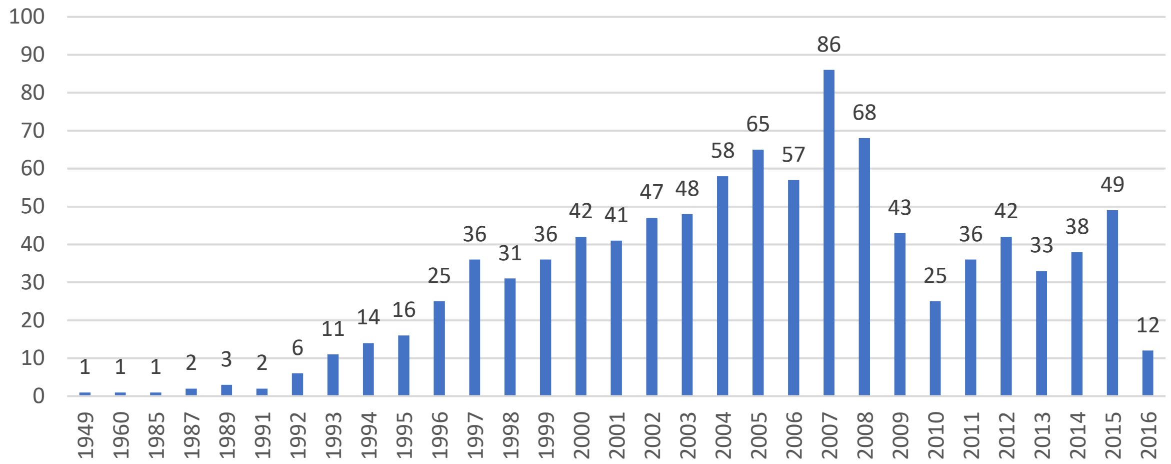

Figure 3.1, Distribution of Projects Based on Closure Dates.

Note: There is a gradual increase in the number of projects until early 2000s. Based on the distribution of projects, only those starting after 1989 are taken into consideration for analysis.

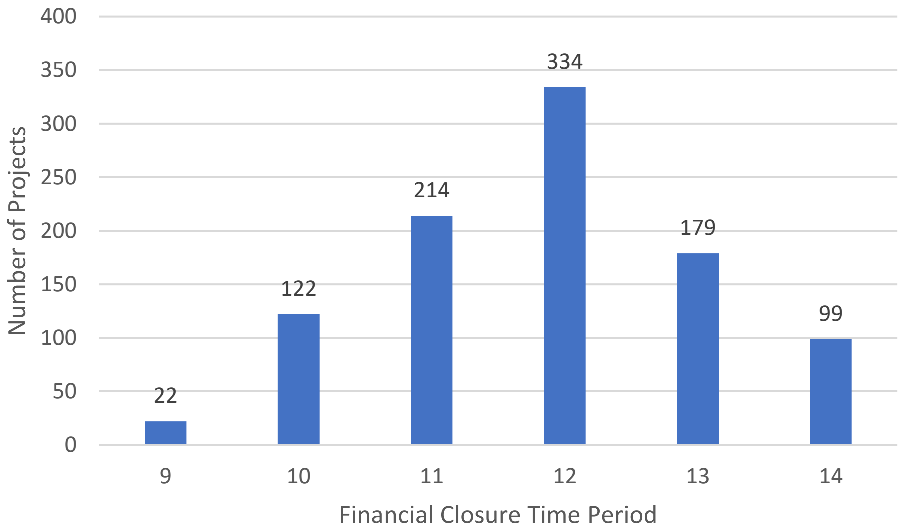

Figure 3.2, Distribution of Projects Based on Closure Time Periods.

Note: Time period 9 starts on 1989, each time period consists of 5 consecutive year.

As it can be noticed in figure 4.1, the number of projects with a financial closure date of 2016 is remarkably low. This might not necessarily mean that private water contracts are becoming unpopular, but it may simply be because of how the World Bank database, which is the source of this data, is updated.

Correlation matrices for the two datasets can be found in Appendix 3.

4.3. Results and Discussion

4.3.1. A Note on China and Time Periods

Before discussing the results of GMM estimation, it is of importance to explain some choices which were made regarding how to perform analysis on the two datasets, government-company, and company-company. Although the aim of this work has been to understand how governments and companies choose their alliance partners, which is a topic commonly investigated in organisational studies, the specific characteristics and history of water sector should not be undermined. Hence, I have not only analysed the two datasets through GMM estimation, but also focused more closely into some cases which are of interest when it comes to investigating the water sector.

As seen in paper 2, the majority of projects have been carried out in China, hence it is evident that analysing the data without paying specific attention to the case of China would not result in holistic discussions. The figure below shows the number of projects initiated in time periods 10 and above.

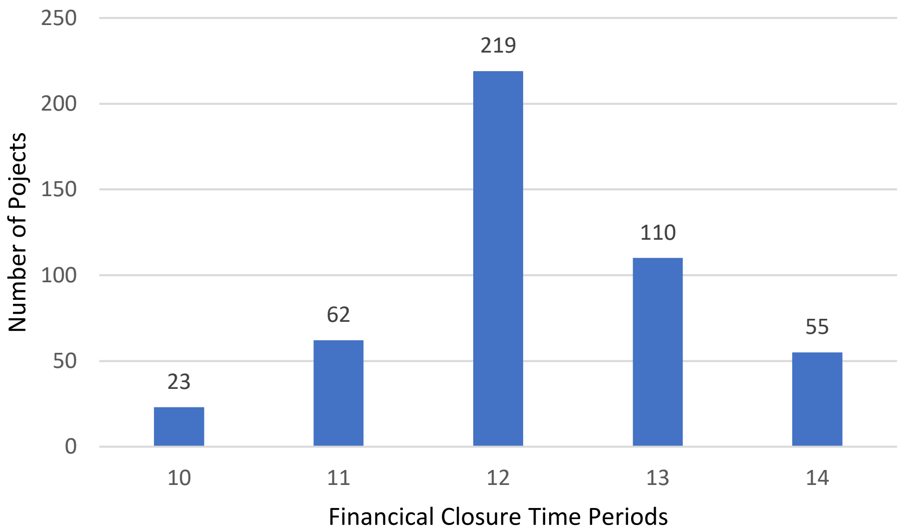

Figure 3.3, Distribution of Projects in China based on Financial Closure Time Periods.

Note: The majority of projects have initiated in China, with different timeline compared to the rest of the world.

Because of the large number of projects in China present in the data and its unique rate of urbanisation which has resulted in increased rate of private participation in water sector, I investigate the government-company dataset both with China being present and being eliminated from the entries. This is to ensure that we can discuss alliance formations in the sector on a global level without the results being affected by cases in China. Looking at the 469 projects in China specifically, it can be seen that 452 projects are still active, only 16 projects have been cancelled over the years, and 1 project is reported to be concluded. The two figures below show the distribution of types and subtype of the projects in China; types and subtypes of projects have been discussed in paper 1 and 2.

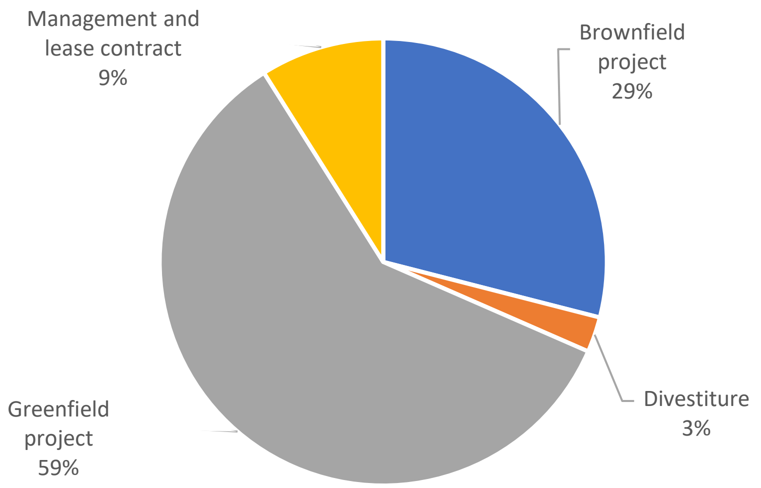

Figure 3.4, Type of PPI Water Projects in China.

Note: Greenfield projects are the most prominent type in China, followed by brownfield ones.

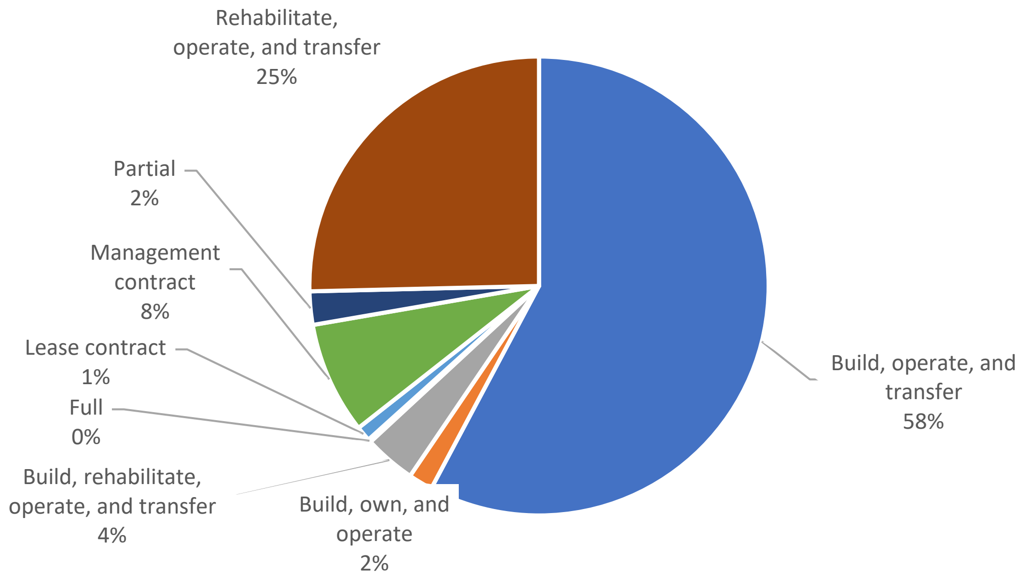

Figure 3.5, Subtype of PPI Water Projects in China.

Note: As well as the prominence of greenfield and brownfield projects in China, build, operate, and transfer, and rehabilitate, operate, and transfer are the most common subtypes of projects.

The average project period is 26 years, not considering 116 cases where the information is not available; the average project period for the rest of the world is 22 years. Out of 159 companies which have been/are involved in these projects, 91 are Chinese companies, 18 are from Hong Kong and 13 are Malaysian companies. In 210 of these projects at least one non-Chinese company has been/is involved while 54 projects have seen cases of two or more companies being involved; among the non-Chinese companies, Suez (France), Veolia Environnement (France) and Golden State Environment (United States) have the largest shares of projects. This information shows that there is some tendency in China to have non-Chinese private companies as partners in projects, However the Chinese private companies are still much more involved in the sector.

The government-company dataset has been analysed with some specific attention being paid to the case of China. But for both datasets, some consideration has been made regarding the time periods based on the original data and the history of private sector. As seen in figure 4.1, only 8 out of 975 projects have a financial closure date before 1990, hence it is decided to use period 9 and above in the analysis of the government-company dataset; these periods correspond to years 1989 to 2016. For the case of company-company dataset, the first project available started in time period 9. This is in-line with the literature on private participation in water sector which states that private involvement in the sector was rare in 1980s, and significantly increased during the 1990s (see Bakker, 2013 for example). But by late 1990s, the private involvement in the sector started to decline, as a result of financial crises which influenced the foreign direct investment flows; from 2000 onward investment was globally significantly lower, excluding in China (Bakker, 2013). Because of how private participation has evolved in the water sector, periods 9 to 11 (corresponding to 1989-2004) and 12 to 14 (corresponding to 2005-2016), have been investigated separately. For the case of government-company dataset, these periods have been also looked at without the presence of China.

4.3.2. Government-Company Dataset Results

4.3.2.1. Results of Projects Initiated from Time Period 9 to 14 (1989-2016)

Table below summarises the results of GMM estimation for government-company ties considering time periods 9 to 14; the first column corresponds to the results for all governments (countries) being included, while in the second column the model has been run without China present among the governments (countries).

As explained in section 3.2, the model to be estimated takes the below general form.

$$E(Y_{ij,t}) = exp(\rho Y_{ij,t-1} + \beta_i X_{i,t} + \beta_j X_{j,t} + \beta_{ij} X_{ij,t})$$

For the period under investigation, time period 9 to 14, and making explicit the dependent and independent variables, the model takes the form of:

$$E(AllianceFormation_{ij,t}) = exp(\rho\ AllianceFormation_{ij,t-1} +$$

$$\beta_i GRegion_i + \beta_i GIncome_i + \beta_j CRegion_j + \beta_j CIncome_j +$$

$$\beta_i GDegree_{i,t-1} + \beta_j CDegree_{j,t-1} +$$

$$\beta_{ij} N\_SuccessfulAlliances_{ij,t} + \beta_{ij} AllianceVsSuccessfulAlliance_{ij,t} + \beta_{ij} Reinvest_{ij,t} +$$
$$\beta_{ij} Terminations_{ij,t} + \beta_{ij} PastTerminations_{ij,t} +$$

$$\beta_{ij} DegreeSimilarity_{ij,t-1} +$$

$$\beta_{ij} DistCapt_{ij} +$$

$$\beta_{ij} RegionSim_{ij} + \beta_{ij} IncomeSim_{ij} + \beta_{ij} RelativeIncome_{ij} + \beta_{ij} LangSim_{ij} + \beta_{ij} ColonialHist_{ij}$$

The independent variables denoted by (ij) are those corresponding to the dyads, whereas variables denoted by (i) correspond to the entity i, i.e. countries and (j) to entity j, i.e. companies. Variables denoted by (t) (or (t – 1) if lagged values are taken) change over time, the others are constant. It should be noted here that for variables associated to degree centrality, lagged values are taken into account. The reason is to overcome possible endogeneity issues; if lagged values are not considered, we would be estimating the probability of new ties between entities i and j at time t based on the number of ties that i and j have at time t, that is in the equation above, we would be considering the same ties in both right and left sides of the equation. Lagged values alleviate this problem, as we would estimate the probability of new ties based on the total number of ties that existed in the previous time period.

Table 3.12, Results for Government-Company Dataset (Time Period 9 to 14).

Note: The GMM analysis has been carried out with and without considering China in the data. The focus should be on the sign and significance of the results for each variable.

Variable	Government-Company Time 9 to 14	Government-Company Time 9 to 14 Without China
AllianceFormation		
L1.	0.1652	-0.0478
N_SuccessfulAlliances	0.1304*	0.1686***
AllianceVsSuccessfulAlliance	0.0426	0.6478
Reinvest	0.6312***	0.6718***
Terminations	-0.5068***	0.5477
PastTerminations	0.6998**	0.5485
Lagged GDegree	0.0026	0.0360***
Lagged CDegree	0.0552**	0.1429***
Lagged DegreeSimilarity	1.9505***	0.1401
DistCapt	-5.2009***	-7.1810***
RegionSim	0.5531	-0.3450
IncomeSim	6.3007***	5.8288***
RelativeIncome	5.6930***	4.7804***
LangSim	1.4105***	1.9066***
ColonialHist		
ColonialHist_ColoniserColony	-0.1556	-0.7115*
ColonialHist_ColonyColoniser	1.8149***	1.8651***
GRegion		
Gov_East Asia and Pacific	Ref.	Ref.
Gov_Europe and Central Asia	-3.1070***	-1.9587***
Gov_Latin America and the Caribbean	-1.1210*	0.1305
Gov_Middle East and North Africa	-2.1293***	-1.6331*
Gov_South Asia	0.3753	0.5138
Gov_Sub-Saharan Africa	-1.6711***	-1.1434*
GIncome		
Gov_Upper middle income	Ref.	Ref.
Gov_Lower middle income	-1.6110***	-0.9650**
Gov_Low income	-2.6192***	-2.0432***
CRegion		
Comp_East Asia and Pacific	Ref.	Ref.
Comp_Europe and Central Asia	1.6485***	2.0715**
Comp_Latin America and the Caribbean	0.9661*	-0.4375

Comp_Middle East and North Africa	1.1759**	1.1944
Comp_South Asia	0.4445	0.3014
Comp_Sub-Saharan Africa	1.5099**	0.8247
Comp_North America	1.2831	0.1873
CIncome		
Comp_High income	Ref.	Ref.
Comp_Upper middle income	-2.1522***	-1.3256*
Comp_Lower middle income	-0.2853	-0.4193
Comp_Low income	1.283	1.6074*
t		
11	0.2468	-0.2564
12	0.3825	-0.6996
13	-0.7936*	-1.2410***
14	-1.2823***	-1.7705***
b0		
_cons	-8.7719***	-8.6321***
Statistics		
N	146250	144000
11		

legend: *p<0.05; **p<0.01; ***p<0.001

For both cases, with China and without China, lagged values of AllianceFormation are insignificant. These results suggest that the number of projects between a government and a company at the previous time period does not influence the probability of the two forming alliances for another project in the following time period.

The next set of variables corresponds to relational embeddedness. While the number of successful past alliances has a significant impact on alliance formations for both cases of global data and data without China, the effect is more pronounced for projects not taking place in China. Also, for both cases, the more number of reinvestment positively influence the formation of alliances. But variables associated to number of terminated projects are only significant for the global dataset; higher rates of terminations at any time period seem to cause less alliance formations, but higher accumulated number of past terminations mean higher chances of forming alliances. Overall, relational embeddedness, which represents a government and a company having a history together in the form of past interaction and collaboration, is found to influence alliance formations. But the impact is much greater for the global dataset compared to the one without China present. Hypothesis 1 is supported for the government-company dataset:

The probability of a new alliance formed between two organisations increases as a result of higher levels of prior interaction because of their direct alliances.

For variables representing positional embeddedness and for the case of global dataset, the results indicate that governments having more central positions in the network of alliances, i.e. governments collaborating with more companies, does not influence the decision of forming new alliances. But the more a company is involved in projects, the higher is probability of it forming new alliances. What is also interesting is the impact of similarity between the positions of governments and companies on formation of new alliances; the more dissimilar are the positions of a government and a company, the higher the probability of them forming a new tie. When China is not considered in the data, positions of both governments and companies have significant impact on new alliance formations, but the similarity of positions does not play a role. Overall, for both cases, positional embeddedness is found to be an important factor in formation of new alliances between governments and companies, and hence hypothesis 2a and 2b are supported, to a very good extent.

The probability of a new alliance formed between two organisations increases as the centrality of the two organisations increases within the alliance network.

The probability of a new alliance formed between two organisations increases as the similarity in their network centralities increases.

Proximity in the form of spatial proximity is seen to have a significant impact on tie formations for both cases; the closer the governments (countries) and companies' countries of headquarters are to each other, the higher the probability of them forming alliances. Hypothesis 4 is supported unanimously:

The probability of a new alliance formed between two organisations increases as the geographical distance between the two decreases.

Being in the same geographical region does not seem to have any impact on new alliance formation, and hence hypothesis 5 is found to be insignificant.

For both cases, having the same level of income has a significant impact on new alliance formations. Also, if the company has a higher level of income (the company's country of headquarter) comparted to a government (country), the two are more likely to form an alliance.

The probability of a new alliance formed between two organisations increases as the similarity between their income level decreases.

Cultural similarity in the form of having the same first official language is found to have a significant impact in both cases. The government being the past colony of the company's country of headquarter is also found to have a significant impact on new tie formations in both cases. Overall, we see that cultural similarities between governments and companies facilitate formations of new alliances, and hence hypothesis 7 is supported:

The probability of a new alliance formed between two organisations increases as the cultural differences between them decreases.

4.3.2.2. Results of Projects Initiated from Time Periods 9 to 11 (1989-2004), and 12 to 14 (2005-2016)

Similar to the above, the model takes the form of:

$$E(AllianceFormation_{ij,t}) = exp(\rho\ AllianceFormation_{ij,t-1} +$$

$$\beta_i GRegion_i + \beta_i GIncome_i + \beta_j CRegion_j + \beta_j CIncome_j +$$

$$\beta_i GDegree_{i,t-1} + \beta_j CDegree_{j,t-1} +$$

$$\beta_{ij} N\_SuccessfulAlliances_{ij,t} + \beta_{ij} AllianceVsSuccessfulAlliance_{ij,t} + \beta_{ij} Reinvest_{ij,t} + \beta_{ij} Terminations_{ij,t} + \beta_{ij} PastTerminations_{ij,t} +$$

$$\beta_{ij} DegreeSimilarity_{ij,t-1} +$$

$$\beta_{ij} DistCapt_{ij} +$$

$$\beta_{ij} RegionSim_{ij} + \beta_{ij} IncomeSim_{ij} + \beta_{ij} RelativeIncome_{ij} + \beta_{ij} LangSim_{ij} + \beta_{ij} ColonialHist_{ij}$$

As explained in section 4.3.1, because of different developments in the private water sector and the special case of China, it has been decided to investigate periods 9 to 11 and 12 to 14 as well, to see whether the patterns of alliance formations are different compared to the period 9 to 14 (as explained in section 4.3.2.1). Table below summarises the results of GMM estimation for government-company data considering time periods 9 to 11 and 12 to 14; the first two columns corresponds to the results for all governments (countries) being included, while in the third and fourth columns the model has been run without China present among the governments (countries).

Between all four cases, lagged values of AllianceFormation seem to be only negatively significant for the period of 12 to 14 without China being included. These results suggest that the number of projects between a government and a company at the previous time period have only affected the formation of alliances after 2005 in countries other than China.

Same as before, the next set of variables investigate the role of relational embeddedness. Between 1989 and 2004, number of successful past alliances did not have an impact on alliance formation, whether on a global level, or without considering China. But, after 2005 and in the more recent projects, successful past alliances have significantly influenced formation of new ties, on both global level, and without considering China. Reinvestments seem to have influenced formation of alliances for all cases, but the impact is more visible for the more recent time periods of 12 to 14. While number of terminated projects at any given period has only had an impact on alliance formation in period 9 to 11, number of past terminations show a very different picture for the two set of periods: from 1989 to 2004 number of past terminations had negatively influenced alliance formations while from 2005 to 2016, the impact is positive. For all cases altogether, hypothesis 1 is supported to a good extent, showing that alliance formations in different periods and with/without the case of China have been influenced by governments and companies having some past interactions, but the impact of relational embeddedness is more significant for the recent time periods of 12 to 14:

The probability of a new alliance formed between two organisations increases as a result of higher levels of prior interaction because of their direct alliances.

The next set of variables look at the impact of positional embeddedness. More central governments, i.e. those with more projects, seem to have more chances of forming new alliances at all time periods, and on a global scale, without presence of China altering the results. But, for the companies, the results are rather different; while in the time periods of 9 to 11, being involved in more projects had an effect on forming new alliances, the impact seems to be insignificant in the more recent time periods of 12 to 14. The similarity in the position of governments and companies has only been important in the time periods of 12 to

14, on a global setting. Overall, for all four cases, positional embeddedness is found to be an important factor in formation of new alliances between governments and companies, and hence hypothesis 2a is supported, while hypothesis 2b does not seem to be true for all cases.

The probability of a new alliance formed between two organisations increases as the centrality of the two organisations increases within the alliance network.

The probability of a new alliance formed between two organisations increases as the similarity in their network centralities increases.

Proximity in the form of spatial proximity, is a very important factor affecting new alliance formations in all cases; the results show that the closer the governments (countries) and companies' countries of headquarters are to each other, the higher the probability of them forming alliances. Hypothesis 4 is supported unanimously, although the impact is less significant for the more recent time periods of 12 to 14 when China is not considered:

The probability of a new alliance formed between two organisations increases as the geographical distance between the two decreases.

For all cases, regional similarity plays no role in formation of new alliances and hypothesis 5 is found to be insignificant.

Governments seem to form alliances with those companies from countries having the same income as them or having a higher income compared to them, in the two sets of time periods. This is what was outlined as hypothesis 6 which is supported for all cases here:

The probability of a new alliance formed between two organisations increases as the similarity between their income level decreases.

Cultural similarity in the form of having the same first official language is found to have a significant impact in all four cases; but the colonial history between governments and companies' countries of headquarters shows a more complex picture. Nevertheless, the impact of cultural similarity on new alliance formations is apparent for all the cases, and hence hypothesis 7 is supported:

The probability of a new alliance formed between two organisations increases as the cultural differences between them decreases.

Table 3.13, Results for Government-Company Dataset (Time Periods 9 to 11 & 12 to 14).

Note: The GMM analysis has been carried out with and without considering China in the data for the two sets of time periods. The focus should be on the sign and significance of the results for each variable.

Variable	Government-Company Time 9 to 11	Government-Company Time 9 to 11 Without China	Government-Company Time 12 to 14	Government-Company Time 12 to 14 Without China
AllianceFormation				
L1.	0.3830	0.5126	0.0729	-0.0829**
N_SuccessfulAlliances	0.0329	-0.1814	0.1800***	0.1636***
AllianceVsSuccessfulAlliance	0.4281	1.4414	1.5479***	0.9073
Reinvest	0.4342*	0.5410*	1.1233***	0.8539***
Terminations	1.2620*	1.3789**	-0.0530	0.1318
PastTerminations	-2.6696**	-3.7177***	0.9203***	0.7453***
Lagged GDegree	0.0282*	0.0241**	0.0137***	0.0738***
Lagged CDegree	0.1232***	0.1424***	0.0236	0.1063
Lagged DegreeSimilarity	0.4495	0.4289	2.9275***	1.1177
DistCapt	-6.3391***	-7.7729***	-4.2232***	-2.9814*
RegionSim	0.3455	-0.4016	-0.1074	0.0894
IncomeSim	5.8058***	5.5184***	4.6247***	4.5015***
RelativeIncome	5.4645***	4.8154***	2.4452*	2.1038*
LangSim	1.4197***	2.0097***	1.7503***	1.7858**
ColonialHist				
ColonialHist_ColoniserColony	-0.3348	-1.0137**	-0.3812	-0.2257
ColonialHist_ColonyColoniser	2.1648**	2.3464***	-2.8712*	-1.0273

GRegion				
Gov_East Asia and Pacific	Ref.	Ref.	Ref.	Ref.
Gov_Europe and Central Asia	-3.6027***	-2.8395***	0.2546	-1.1303
Gov_Latin America and the Caribbean	-1.2031*	-0.3469	3.1120**	0.7589
Gov_Middle East and North Africa	-3.7605***	-3.5858***	2.1503*	0.6670
Gov_South Asia	-1.1325**	-0.9717*	3.0874**	1.0795
Gov_Sub-Saharan Africa	-2.0128***	-1.8306**	0.5198	-1.1247
GIncome				
Gov_Upper middle income	Ref.	Ref.	Ref.	Ref.
Gov_Lower middle income	-1.5384***	-1.1217**	-0.5792	-0.2688
Gov_Low income	-2.0761***	-1.8385**	-1.0949*	-0.4093
CRegion				
Gov_East Asia and Pacific	Ref.	Ref.	Ref.	Ref.
Comp_Europe and Central Asia	2.4395***	2.9380***	0.1381	0.5882
Comp_Latin America and the Caribbean	1.0084	0.2009	-0.1661	0.1592
Comp_Middle East and North Africa	1.5773***	1.7365**	0.6742	0.5456
Comp_South Asia	-0.0669	-0.1193	0.8942	0.8592
Comp_Sub-Saharan Africa	1.3757**	1.1278	-2.4573***	-2.3917**
Comp_North America	1.2879	0.7818	-1.2696	-1.3107
CIncome				
Comp_High income	Ref.	Ref.	Ref.	Ref.
Comp_Upper middle income	-1.8551*	-1.2310	-3.5509***	-3.7071***
Comp_Lower middle income	0.1670	0.0560	-2.8359*	-2.7748*
Comp_Low income	2.2795	2.6642*	-1.3198	-1.6724

t				
11	-0.2166	-0.2228		
12				
13				
14			-0.3540	-0.6996***
b0				
_cons	-8.3239***	-9.3072***	-10.7246***	-9.0667***
Statistics				
N	58500	57600	58500	57600
11				

legend: *p<0.05; **p<0.01; ***p<0.001

4.3.3. Company-Company Dataset Results

4.3.3.1. Results of Projects Initiated from Time Period 9 to 14 (1989-2016)

Table below summarises the results of GMM estimation for company-company data considering time periods 9 to 14; it should be noted here that the first project present in this dataset was initiated in time period 9.

Similar to the model in section 4.3.2, the equation that represents the factors affecting possible alliances between companies takes the form of:

$$E(AllianceFormation_{jh,t}) = exp(\rho\ AllianceFormation_{jh,t-1} +$$

$$B_j C_j Region_j + \beta_j C_j Income_j + \beta_h C_h Region_h + \beta_h C_h Income_h +$$

$$B_j C_j Degree_{j,t-1} + \beta_h C_h Degree_{h,t-1} +$$

$$\beta_{jh} N\_SuccessfulAlliances_{jh,t} + \beta_{jh} AllianceVsSuccessfulAlliance_{jh,t} + \beta_{jh} Reinvest_{jh,t} +$$
$$\beta_{jh} Terminations_{ij,t} + \beta_{jh} PastTerminations_{ij,t} + \beta_{jh} LowShareAlliances_{jh,t-1} +$$

$$\beta_{jh} DegreeSimilarity_{jh,t-1} +$$

$$\beta_{jh} N\_CommonAlliances_{jh,t} + \beta_{jh} N\_GovernmentPartners_{jh,t} +$$

$$\beta_{jh} DistCapt_{jh} +$$

$$\beta_{jh} RegionSim_{jh} + \beta_{jh} IncomeSim_{jh} + \beta_{jh} RelativeIncome_{jh} + \beta_{jh} LangSim_{jh} + \beta_{jh} ColonialHist_{jh}$$

The independent variables denoted by (jh) are those corresponding to the dyads, whereas variables denoted by (j) correspond to the entity j, i.e. companies with the larger shares in a given project and (h) to entity h, i.e. companies with lower shares in a given project.

Table 3.14, Results for Company-Company Dataset (Time Period 9 to 14).

Note: The focus should be on the sign and significance of the results for each variable.

Variable	Company-Company Time 9 to 14
AllianceFormation	
L1.	1.0667***
N_SuccessfulAlliances	0.3084***
AllianceVsSuccessfulAlliance	-2.0211***
Reinvest	0.3126
Terminations	1.3749***
PastTerminations	3.2632***
Lagged LowShareAlliances	0.9653*
Lagged C_jDegree	-0.0066
Lagged C_hDegree	-0.0006
Lagged DegreeSimilarity	16.0209***
N_CommonAlliances	0.2426
N_GovernmentPartners	-0.0494***
DistCapt	-5.5060***
RegionSim	-1.4185**
IncomeSim	0.2372
LangSim	1.5227***
ColonialHist	
ColonialHist_ColoniserColony	-0.7012
ColonialHist_ColonyColoniser	-0.6289
C_j**Region**	
C_j _East Asia and Pacific	Ref.
C_j_Europe and Central Asia	-0.2023
C_j_Latin America and the Caribbean	0.2061
C_j_Middle East and North Africa	-0.6936
C_j_South Asia	-0.4727
C_j_Sub-Saharan Africa	-0.9248
C_j_North America	-0.6621
C_j**Income**	
C_j_High income	Ref.

C_j_Upper middle income	-0.7335**
C_j_Lower middle income	-0.2054
C_j_Low income	0.2174
C_h**Region**	
C_h_East Asia and Pacific	Ref.
C_j_Europe and Central Asia	-0.3222
C_h_Latin America and the Caribbean	0.4042
C_h_Middle East and North Africa	-0.3176
C_h_South Asia	-0.2711
C_h_Sub-Saharan Africa	-0.4195
C_h_North America	-0.1511
C_h**Income**	
C_h_High income	Ref.
C_h_Upper middle income	-0.7094*
C_h_Lower middle income	-0.6329*
C_h_Low income	-0.9382
t	
11	-0.1412
12	-0.3092
13	-0.8756**
14	-1.5043***
b0	
_cons	-1.8346**
Statistics	
N	344530
11	

legend: *p<0.05; **p<0.01; ***p<0.001

The results indicate that lagged values of AllianceFormation can significantly affect new tie formations, that is the number of projects between two companies at the previous time period does influence the probability of the two forming alliances for another project in the following time period.

The next set of variables corresponds to relational embeddedness. The number of successful past alliances between the two companies significantly influences the probability of them entering another, new alliance. The result for the next variable, AllianceVsSuccessfulAlliance, suggests that success of projects is a very important factor in choosing partner. While reinvestment incidences seem to have no impact on new tie formations, number of terminations at any given period and number of past terminations positively influences the number of alliance formations. For this dataset specifically, because of how it was constructed taking into account shares of companies in projects, I had introduced an additional variable representing those ties that do not correspond to majority shares. This variable shows some impact on new tie formations, so we can deduce that the number of alliances in the form of projects within companies taking lower shares than others still influenced the probability of them forming new ties. Overall, relational embeddedness, which represents two companies having a history together in the form of past interaction and collaboration, is found to highly influence new alliance formations. Hypothesis 1 is hence supported for the company-company dataset:

The probability of a new alliance formed between two organisations increases as a result of higher levels of prior interaction because of their direct alliances.

For variables representing positional embeddedness, the results indicate that the number of alliances each of the companies have, does not have an impact on them forming new ties, in other words more central positions of the companies in the overall network of alliance ties does not guarantee them being involved in more projects in the future. But, the more similar their positions are to each other, the higher the possibility of the two to form new ties. Hence, we can conclude that companies tend to collaborate on projects with those which have been involved on the same level as them in the sector. Overall positional embeddedness is found to have some impact on new alliance formations, and hence hypothesis 2b is supported:

The probability of a new alliance formed between two organisations increases as the similarity in their network centralities increases.

For the case of company-company dataset, we are also interested in investigating how indirect ties can impact new ties formations; this is the notion of structural embeddedness. Having ties with common partners seems to have no impact on forming new ties, but the bigger the number of countries (governments) in which they have both been involved but not collaborated in, the less the probability of them entering a new alliance. Hypothesis 3b is supported when it comes to indirect ties between companies only:

It is expected that the probability of two companies, C_j and C_h, forming an alliance decreases as the number of governments they have both formed ties with, but without a tie between the companies themselves, in the past increases.

Hypothesis 4 and the effect of spatial proximity are also supported; the closer the countries of companies' headquarters are to each other, the higher the probability for them to form new ties:

The probability of a new alliance formed between two organisations increases as the geographical distance between the two decreases.

Having headquarters in the same region reduces the probability of companies forming ties, while economic similarity seems to have no impact on alliance formation; both hypotheses 5 and 6 are found to be insignificant. It should be noted here that these results need to be carefully considered as the income levels of companies are not taken into account, but rather the income level of companies' countries of headquarters are used.

Cultural similarity in the form of having the same first official language is found to have a significant impact in this case, but colonial history is an insignificant factor. Hence hypothesis 7 is somewhat supported:

The probability of a new alliance formed between two organisations increases as the cultural differences between them decreases.

4.3.3.2. Results of Projects Initiated from Time Periods 9 to 11 (1989-2004), and 12 to 14 (2005-2016)

Similar to the government-company dataset, two sets of periods have been also investigated to address the specification of sector development. Table below summarises the results of GMM estimation for company-company data considering time periods 9 to 11 and 12 to 14; it should be noted here that the first project present in this dataset was initiated in time period 9.

Similar to the model for period 9 to 14, the equation estimated for these time periods takes the form of:

$$E(AllianceFormation_{jh,t}) = exp(\rho\ AllianceFormation_{jh,t-1} +$$

$$B_jC_jRegion_j + \beta_jC_jIncome_j + \beta_hC_hRegion_h + \beta_hC_hIncome_h +$$

$$B_jC_jDegree_{j,t-1} + \beta_hC_hDegree_{h,t-1} +$$

$$\beta_{jh}N\_SuccessfulAlliances_{jh,t} + \beta_{jh}AllianceVsSuccessfulAlliance_{jh,t} + \beta_{jh}Reinvest_{jh,t}+$$
$$\beta_{jh}Terminations_{ij,t}+ \beta_{jh}PastTerminations_{ij,t}+ \beta_{jh}LowShareAlliances_{jh,t-1}+$$

$$\beta_{jh}DegreeSimilarity_{jh,t-1}+$$

$$\beta_{jh}N\_CommonAlliances_{jh,t}+ \beta_{jh}N\_GovernmentPartners_{jh,t}+$$

$$\beta_{jh}DistCapt_{jh}+$$

$$\beta_{jh}RegionSim_{jh}+ \beta_{jh}IncomeSim_{jh}+ \beta_{jh}RelativeIncome_{jh}+ \beta_{jh}LangSim_{jh}+ \beta_{jh}ColonialHist_{jh}$$

Table 3.15, Results for Company-Company Dataset (Time Periods 9 to 11 & 12 to 14).

Note: The focus should be on the sign and significance of the results for each variable.

Variable	Company-Company Time 9 to 11	Company-Company Time 12 to 14
AllianceFormation		
L1.	3.7040*	0.4037
N_SuccessfulAlliances	2.5747	0.3493***
AllianceVsSuccessfulAlliance	-0.1767	-2.8407***
Reinvest	-0.2243	-10.4253***
Terminations	2.2542	1.6896***
PastTerminations	-2.3376*	2.9491***
Lagged LowShareAlliances	2.4067***	0.3207
Lagged C_jDegree	0.0308	0.1202
Lagged C_hDegree	0.0486	0.0448
Lagged DegreeSimilarity	13.7774***	-4.5358
N_CommonAlliances	1.4975***	-0.6307
N_GovernmentPartners	-0.7970	-0.0103
DistCapt	-8.1370***	-2.1553

RegionSim	-3.1523***	-0.2546
IncomeSim	0.7585*	-1.3710**
LangSim	1.6284***	1.7742***
ColonialHist		
ColonialHist_ColoniserColony	-1.1161	-0.0113
ColonialHist_ColonyColoniser	-1.1160	-0.5707
C_j**Region**		
C_j _East Asia and Pacific	Ref.	Ref.
C_j_Europe and Central Asia	0.3820	-1.5603**
C_j_Latin America and the Caribbean	0.3967	0.1530
C_j_Middle East and North Africa	-3.1738**	-0.4050
C_j_South Asia	-2.6704*	0.9545
C_j_Sub-Saharan Africa	-3.8528	-3.3208***
C_j_North America	-1.0566	-2.2980
C_j**Income**		
C_j_High income	Ref.	Ref.
C_j_Upper middle income	-0.5676	-1.0155
C_j_Lower middle income	0.6627	-2.9414**
C_j_Low income	4.0589	-1.2067
C_h**Region**		
C_h_East Asia and Pacific	Ref.	Ref.
C_j_Europe and Central Asia	0.0938	-1.0368*
C_h_Latin America and the Caribbean	0.5561	0.2905
C_h_Middle East and North Africa	-2.2747**	-0.3071
C_h_South Asia	-2.0066*	0.2624
C_h_Sub-Saharan Africa	-3.4255	-3.5322***
C_h_North America	-0.3191	-1.3420
C_h**Income**		
C_h_High income	Ref.	Ref.
C_h_Upper middle income	-0.5676	-1.0155
C_h_Lower middle income	0.6627	-2.9414**
C_h_Low income	4.0589	-1.2067
t		
11	-0.3398	
12		
13		
14		-0.7865*

b0		
_cons	-3.1283*	-1.6595
Statistics		
N	137812	137812
11		

legend: *p<0.05; **p<0.01; ***p<0.001

The results indicate that lagged values of AllianceFormation could affect new tie formations only for the time period of 9 to 11, for the more recent time period this variable does not have an impact.

For the impact of relational embeddedness on new alliance formation, the results are rather different between the two periods. Between time periods 9 and 11, neither the success of projects, nor the reinvestment incidences have had any impact on new tie formations. But in the more recent time period of 12 to 14, both success of projects and reinvestments have had a significant impact on companies forming alliances; it seems the more the companies have reinvested in projects they have had together, the less they were likely to work together again. Number of terminated projects at any time period is found to be an important factor for those project in time period 12 to 14, so is the terminated projects in the past for both period sets, although the impact on tie formations for the two-time period sets are opposite each other. The more companies have worked together, with having lower shares, the more they were likely to form new alliances in time period 9 to 11 only. We can see that hypothesis 1 is strongly supported for the more recent time period of 12 to 14, while the impact of most variables in time period 9 to 11 is insignificant:

The probability of a new alliance formed between two organisations increases as a result of higher levels of prior interaction because of their direct alliances.

For variables representing positional embeddedness, the results indicate that the number of alliances each of the companies have, does not have an impact on them forming new ties in any of the time periods of 9 to 11 and 12 to 14. But for time period of 9 to 11, the more similar their positions are to each other, the higher the possibility of the two to form new ties. Hence, we can conclude that companies used to collaborate on projects with those which have been involved on the same level as them in the sector, but this tendency has changed at some point. Overall positional embeddedness is found to have some impact on new alliance formations only for time period 9 to 11, and hence hypothesis 2b is supported for this period:

The probability of a new alliance formed between two organisations increases as the similarity in their network centralities increases.

Regarding the impact of structural embeddedness, having ties with common partners seems to have significantly influence forming new ties in the time period of 9 to 11, but for the other period set there is no impact. Also having common government partners seem to not have an impact on forming new ties in any of the time period sets. Therefore, only hypothesis 3a is supported for the time period of 9 to 11, to some extent:

The probability of a new alliance being formed between two organisations increases as the number of prior indirect alliances between the two increases.

Hypothesis 4 and the effect of spatial proximity are also supported for time period of 9 to 11; the closer the countries of companies' headquarters are to each other, the higher the probability for them to form new ties:

The probability of a new alliance formed between two organisations increases as the geographical distance between the two decreases.

Again, only for time period of 9 to 11, having headquarters in the same region reduces the probability of companies forming ties, while economic similarity seems to have an impact on alliance formation in both sets of time period but with opposite effects; hence hypothesis 6 is only supported for the more recent time period of 12 to 14:

The probability of a new alliance formed between two organisations increases as the similarity between the wealth of their countries of origin decreases.

It should be noted here that these results need to be carefully considered as the income levels of companies are not taken into account, but rather the income level of companies' countries of headquarters are used.

Cultural similarity in the form of having the same first official language is found to have a significant impact for both cases, but colonial history is an insignificant factor. Hence hypothesis 7 is somewhat supported for both sets of time periods:

The probability of a new alliance formed between two organisations increases as the cultural differences between them decreases.

4.4. Post Estimation

There is no formal way of checking the goodness of fit for GMM method. However, it is possible to check the validity of instruments, using Hansen's J statistic, which determines the validity of the overidentifying restrictions in a GMM model. In all the models discussed in previous sections, since there are just enough instruments to identify the models, there are none available to test overidentifying restrictions, and the J statistic is by definition zero for all exactly identified models, which is the case of this work.

The GMM method does not calculate the r-squared, but the square of the correlation between observed and predicted values of dependent variable can be used as a pseudo r-squared. The adjusted r-squared can then be calculated by using the formula below:

$$R_{adj}^2 = 1 - (1 - R^2)\frac{n-1}{n-p-1}$$

Where n is the sample size (total number of entries in the data), and p is the number of predictors (total number of independent variables).

The table below shows the calculation for the r-squared and adjusted r-squared for the main models of this work. Both r-squared and adjusted r-squared values are quite low, but it should be emphasised here that considering the method used, the two have limitation in interpreting the results.

Table 3.16, Calculation of R-Squared and Adjusted R-Squared for the Three Main Models.

Model	n (Sample Size)	p (Number of Predictors)	Correlation between "Signatures" and "Predicted Signatures"	R-Squared	Adjusted R- Squared
Government-Company, Time Period 9 to 14	176670	37	0.1098	0.0121	0.0118
Government-Company, Time Period 9 to 14, Without China	173952	37	0.1021	0.0104	0.0102
Company-Company, Time Period 9 to 14	413436	41	0.0717	0.0051	0.0050

5. Discussion

The current study takes its inspiration from studies of interorganisational relationships, and specifically those on alliance formations. Although for some part of this work, entities involved are not strictly "organisations"; in government-company dataset we investigate governments (countries); we can still assume their interactions to result into forming relationships with each other. Similar to other prominent studies in the field (mainly works of Gulati), the main idea of this study is that the formation of a new network structure is dependent on both action and structure which together form some longitudinal dynamics. The underlying structure of alliance networks is considered to be a macro phenomenon which emerges from micro actions of those entities involved, i.e. governments and private companies. Governments and companies make informed decisions on who to partner with in order to have better access to resources and services, as well as attempting to reduce uncertainties of choosing partners. These actions and decisions form network structures over the time which are repositories of information on potential partners; governments and companies then try to use this information to form new alliances.

One argument that needs to be addressed here is how plausible the assumption is that governments and companies can choose alliance partners freely in the sector; considering involvement in the projects for companies require some adherent to government policies as well as the fulfilling bidding requirements, this is an important point which should be discussed. The assumption made in this work was informed by the data used; in paper 2 we clearly see that the network of government-company relationships has evolved into a large component. If the choice of partners was restricted by local policies and requirements, the expectation was to see repetitive patterns of forming relationships between specific governments and companies bases on which company could fulfil requirements imposed by which government. Also, assuming that partner choice is heavily influenced by policies and requirements, we can still expect that being embedded in the alliance network, albeit with restricted choice in the beginning, influence how companies alter themselves to be able to partner with more governments as a result of repository of information being built up in the network on what governments look for in partners and what their policies are. Therefore, either the choice has not really been restricted by requirements or companies have found ways to address them as the years have gone by, and hence the assumption made in this work is appropriate.

The study shows that embeddedness factors can significantly influence new alliance formations; positions of potential partners in the emerging network structures, relative to others and compared to the whole network, are important elements to be considered. I have found that governments and companies which have gained some information about each other through the evolving repository that is the network of alliances, tend to continue working with each other since the embeddedness mechanisms have made it possible for them to identify reliable partners. In such cases, although the risks associated to collaboration become lower, the range of potential partners to be considered is reduced. Studies in economics have suggested that economic pursuit may be hindered by social structure in some situations (Gargiulo & Benassi, 1999; Gulati & Westphal, 1999); the significant impact of embeddedness present for governments and private companies in the water sector could limit the formation of alliance ties to cohesive core of central entities and prevent both governments and companies to form alliances with those not connected to this cohesive cluster. This is of paramount importance for the water sector in which the literature has already confirmed the presence of oligopolistic behaviour (see paper 1, sections 4.2 and 4.3). It can be said that not only have some private companies in the sector had the advantage of dominating the market, but also their influence has increased over the years as a result of their embeddedness in evolving networks of alliances. An interesting perspective to investigate is to focus on the case of Chinese companies and projects in China; given that the alliance networks in China have been more or less dominated by Chinese companies and only a few non-Chinese actors (most of them prominent private companies in the sector), can we expect to see China's private water sector to be controlled by Chinese companies which are already embedded in the alliance structures, and other non-Chinese companies would not enter this market?

The current study shows some interesting differences between how governments and companies can make use of information gained through their past alliances. In particular, a company's experience of being the private partner of some public government makes it significant more likely to bid for more such projects in the future, although this effect is now becoming less pronounced than it used to be. We can think of this result as an indicator of a sort of self-reinforcing effect that over time, may have produced the increasing popularity of some water multinationals: to some extent, the fact that companies such as Veolia Environnement and Suez had a lot of projects around the world has made them more likely than others to be involved in a new partnership with whatever government who might want one.

In this work, investigating proximity and similarity between organisations, namely governments and companies, has shown that although there is a tendency to form alliances with those partners which are geographically close, the choice probably does not go beyond national borders or further than close neighbour countries; there seems to be no link between being in the same geographical regions and having a higher possibility to collaborate on water projects. Further research could be done on this area, making use of network models with Distance Interaction Function (Sohn et al., 2013; Daraganova et al., 2012). This is an interesting result, consistent with the data that suggest that more than 80% of the projects are for Brownfield and Greenfield ones, and more than 75% of them have some element of "transfer" or "build" (see paper 1, section 3.1): hence cost-effective decisions are being made by choosing partners which are closer to where the projects are executed. The type and subtype of projects can also be a contributing factor in choosing alliance partners from richer countries by governments; the projects that constitute the majority of what has been reported for private participation in water sector are capital intensive and having companies which are capable of funding the projects is of importance for governments. I should remind the readers here that the level of income for countries have also been used as a proxy to show how easy it is for a company with its headquarter in a certain country to access resources; although this assumption does not show us the whole picture, it still helps in understanding the dynamics between governments and companies when choosing partners. The results also suggest that none of the parties involved have taken/are taking any chances when it comes to tackling cultural differences while doing business; there is a high tendency to partner with those from culturally similar backgrounds, whether this has manifested through common language or shared history.

Competition has not been analysed in this work, in the classical form. For all, and any set of private companies, they are permanently in collective competition with the alternative of a public-sector service. Hence, the companies visible in this data have either overcome this competition, or have been favoured by the governments as a result of financial inability of public sector to fund projects. For the interaction between companies only, the analysis shows that companies do favour those with whom they have had a common history or they share some similarities. We can think about these results as an indication of how certain companies tend to work together but in competition against others. We also saw in paper 2, while describing the data used, that certain powerful actors such as Veolia and Suez, have formed clusters around them which are connected to each other through only a handful of companies. These sort of behaviour and position in the network of alliances suggest competition between companies involved in the sector.

Although this study has strongly focused on interorganisational relationships, in particular alliance formations, since it investigates an infrastructure sector which has been the topic of extant research (as seen in paper 1), it is important to discuss the results with attention being paid to sector specific characteristics and development. China has been considered a special case in this study, both because of the number of projects occurring in China and since its pattern of involving private companies in the water sector is somewhat an outlier relative to the rest of the world. The trends of private participation in the sector have also been different from decade to decade on a global scale. Although the results show some differences in how alliance formations have been influenced by different factors throughout the years and without China playing a role, the conclusions we can make are more or less similar for the whole period under investigation and for every country in the world. This is an interesting insight into the “minds” of companies and governments; the policies of governments on private participation in the sector have changed throughout the years and the same goes for international strategies of the private companies, but this study shows that irrespective of sector characteristics and industry specifications, the parties involved in these projects and alliances have kept the same criteria for choosing partners. This affirms what the literature on alliance formations suggests that the repository of information built within these alliance networks as years have gone by is what the entities involved are using to make their decisions, which demonstrates the importance to look at the broad picture, beyond the case studies already available in the literature of PPI. Although the policies on private involvement fluctuate in general, it seems that there is less likelihood of changing companies when it comes to choosing partners, hence we can assume there is less competition in the sector than assumed and there are higher entry barriers in a sector where government relationships are key.

6. Conclusions

The idea behind this study was to combine different methods, as well as theoretical knowledge on various subjects, to explain how PPI projects have evolved in the world. This study has used concepts from interorganisational studies, social network analysis methods, and knowledge gained from the literature on private participation in water sector, to construct a holistic approach that is unique and different from previous studies focusing on PPIs. Unlike the majority of the literature, this work does not use case studies, nor does it focus on only micro level factors, but it has combined micro level contributors as well as the interdependencies between them to investigate a macro level outcome, which is the initiation of water related projects with private involvement.

It should be noted here that some governments choose to involve private participation for various reasons, for example due to lending conditionality, while others remain in such relationships because of concerns of multi-million compensation damages that need to be paid upon their exit, and some do not enter such relationships at all. In any case, I did not investigate why governments choose to enter PPIs, but rather assumed they have already chosen whether or not to have such relationships. Furthermore, I have not focused on outcomes of such relationships, for example from the point of view of citizens, but I have looked into the factors shaping partnerships between governments and companies solely.

Given the secondary source of data which has been used for this study, some limitations raised from availability of information. For analysing the impact of some factors, I have made some assumptions and taken some proxies; but an area for future work could be compiling a more complete dataset using other sources which report on PPI projects and overcome some of the issues arising from data availability. I have made some suggestion in Conclusion regarding this point. In fact, this is a project I will be carrying out in the next few months, with the support of William Waters Grant by Association for Social Economics [25].

In conclusion, this work has attempted to shed some light on patterns and contributing factors to alliance formations when considering the private participation in the water sector. To fulfil this purpose, the data used has been investigated from different perspectives and the results are discussed in lieu of some of water sector specifications.

[25] See http://socialeconomics.org/?page=awards_and_grants&side=william_waters_grant

Paper 4- Success Stories: Veolia Environnement and Suez

1. Introduction

The theme of this work has so far been investigation of private participation in the water sector, using the World Bank PPI data. It was shown, among other things, that the private water sector is globalised, dominated by a few multinational enterprises (MNEs) through projects with multiple governments, and a network of alliances with local partners.

I now “zoom in” into the internal organization of these major companies by looking at their network of subsidiaries throughout the world. Since the 1980s, research into multinational corporations has emphasized the importance of subsidiaries as units of analysis, significantly improving our understanding of the strategic roles that they may take (Bartlett & Ghoshal ,1989; 1986). Today, it is widely thought that multinational enterprises function as highly decentralised structures, with national and local subsidiaries that may play differentiated roles and in some cases, enjoy considerable decisional autonomy. In general, subsidiaries are all the more independent as they face specific challenges and need special competences, in their local environment. Subsidiaries may be nested into each other at different levels (for example, company A owning company B owning company C) with multiple ownership relationships (such as, C being co-owned by both A and B) and potential participation of other corporate actors and sometimes even competitors (when a subsidiary such as C is jointly owned by A, B, and yet another corporation D).

The network metaphor is particularly helpful to bring to light not only these complex structures of ownership and the underlying formal alliances between companies, but also the resulting interdependencies and the way access to resources is (formally and informally) negotiated between the parent and each of its subsidiaries, and also between different subsidiaries. The network is a set of channels through which ownership and co-ownership relationships are managed and monitored by the different parties involved. In addition, and perhaps most importantly, the parent-subsidiary network enables the flow of inputs, intermediate products, staff members, and information, thereby facilitating communication and integration of different tasks and activities. In this perspective, mapping ownership ties is a way to reveal the existence of a wider range of relationships between subsidiaries, not limited to contractual engagements but rather involving interactions, exchanges, and information-sharing that are sometimes informal, and would be difficult to observe otherwise.

Inspired by this literature, I apply its main tenets to the globalised water sector to gain insight into the strategies of its main actors. Two multinational environmental services companies, Veolia Environnement and Suez, have been among the most prominent players, and arguably 'the' most prominent ones, in the private water sector. Both companies have been around for over 150 years and they have gone through extensive structural reform since their establishment. Despite the changes of their strategies and structures as well as the range of services they have been providing, they have both been actively involved in providing water and sanitation services around the globe. Their presence and importance could be visibly seen in the World Bank data, as illustrated in figure 2.33. Hence, it was decided to dedicate the last part of this study to these two companies and their worldwide operations in the water sector. This includes not only their operations in low- and middle-income countries that were the focus of paper 3, but any location where they are present, thereby enabling comparisons between potentially different penetration strategies that might be applied to different parts of the world. As explained in the Introduction, the idea for this research initially stemmed from my Master's dissertation on Network Analysis of two French multinational companies, Veolia Environnement and Suez.

In this part, I use Social Network Analysis (SNA) metrics and measures to analyse the data at hand. As mentioned before, the network perspective helps identifying structure of ownerships and alliances between companies, and access to resources between parent and subsidiaries. Apart from the visualisation of these parent-subsidiary networks, and descriptive analysis of them, we can also investigate two aspects of the network, how these subsidiaries are distributed geographically and what activities they do. The blockmodeling method, used in section 4.2, is useful in identifying patterns of ownership in space; this method enables us to aggregate the ownership ties based on a partition, here the geographical location of subsidiaries, and investigate whether subsidiaries in specific regions have closer ownership ties with each other. The SNA metrics that are used, in section 4.3, are helpful in determining whether subsidiaries carrying out certain business activities have closer ties with each other based on relationships recorded in parent-subsidiary networks.

Since both companies are MNEs, and having subsidiaries in foreign markets is one method for foreign direct investment (FDI), we can think about the meaning behind these observations and interpret their results by considering the "Eclectic Paradigm" (Dunning, 1981). Eclectic paradigm, also known as OLI paradigm, unlike older economic theories which attempted to explain determinants of international business activities of MNEs by assets accessed or owned by them, takes into account both tangible and intangible resources available to companies that enhance their competitiveness (Dunning, 2004). OLI paradigm suggests that FDI can provide three types of advantages for companies, compared to other types of business activities; these advantages which are ownership, location, and internalisation ones would then help companies become more competitive in their international production and investment. In what follows, I look at the global parent-subsidiary networks of Veolia and Suez in light of the OLI paradigm, purporting to reveal essential aspects of their foreign penetration strategies within the private water sector. I aim to identify similarities and differences between the two, and as far as possible to draw implications for the sector as a whole.

In this part, the history of the two companies is briefly outlined in order to provide an understanding of the range of their services over time as well as their expansion since their establishment. Also, the source of the data, the steps that have been taken to collect and edit the data, and the description of the final dataset used for the analysis are introduced and explained in detail. Finally, some descriptive Network Analysis and Blockmodeling is performed on the data and results are discussed.

2. Brief Overview of Veolia Environnement and Suez

2.1. Veolia Environnement S.A.

Compagnie Générale des Eaux (CGE) was established in 1853 with two main goals: irrigation of the countryside and supplying water to French towns and cities. Lyon was the first town that CGE supplied water for and within seven years of establishment, CGE was given a 50-year concession for supplying water to Paris. In 1880, CGE started its first venture outside of France by signing an agreement for acquiring water production and distribution rights in Venice, Italy followed by Constantinople (Istanbul), Turkey in 1882 and Porto, Portugal in 1883. CGE expanded its operation to wastewater treatment in 1884 in Reims, France. The company established its first incineration plants in 1967 and later on in 1975 created SARP industries with the main operation of recycling hazardous waste. Omnium de Traitement et de Valorisation (OTV) was formed in 1980 as a result of mergers with a few subsidiaries specialising in design, engineering and construction of water and wastewater treatment facilities. In the same year, CGE acquires substantial interests in Compagnie Générale d'Entreprises Automobiles (CGEA; later known as Connex and Onyx) and Compagnie Générale de Chauffe (CGC; later known as Dalkia). These changes brought together the four main business activities that are now Veolia's specialities. In 1986 the first waste drop-off centres are opened and in 1989 the Onyx brand is established which acquired Groupe Solulier, a leading paper and plastic recycler in Europe, in 1990. The major structural reform took place in 1999; Vivendi Environnement was established to consolidate all the environmental activities that the company was offering; the four major divisions were Vivendi Water (water services), Onyx (waste management), Dalkia (energy), and Connex (transportation). Vivendi Environnement was listed on the Paris Stock Exchange in 2000 and on the New York Stock Exchange in 2001. The company became Veolia Environnement in 2003 following the reduction of Vivendi Universal's holding in Vivendi Environnement from 70% in 2000 to 20.4% in 2002. The four division of the company were given the same name, Veolia, followed by their business activities: Veolia Water, Veolia Environmental Services, Veolia Energy, and Veolia Transport. In 2013, the structure of Veolia was simplified as a result of organising the company's business activities by country rather than along business lines. Veolia's operations were reshaped in 2014, to put more focus on growth regions, pursuing its slogan of "Resourcing the World". In an agreement with EDF over the jointly owned Dalkia, Veolia took over all international activities of Dalkia, except those in France. 100% stake was also acquired in the Latin American Proactiva, the join subsidiary with FCC. Veolia announced its strategic plans for 2016-2018 at the end of 2015, with the aim of gradual resumption of growth in revenue and continuing with operational improvements.

According to recent statistics published by Veolia, on the scale of the company's operations in the water sector specifically: in 2016, 100 million people were supplied with drinking water, 61 million people were connected to wastewater systems, 4052 drinking water production plants were managed, and 2928 wastewater treatment plants were managed. (Veolia, 2017).

2.2. Suez S.A.

The company was originally established in 1858 under the name of Compagnie universelle du canal de Suez with the aim of financing a project for linking the Mediterranean with the Indian Ocean. In 1880, Société Lyonnaise des Eaux and in 1919 Société Industrielle des Transports Automobiles (SITA) were established to provide water and waste collection services respectively. In 1939, Degrémont, a water treatment company, was set up in Paris which built the first drinking water treatment plant in Egypt in 1948. SITA expanded its operations firstly to suburbs of Paris in 1960 and then continued its expansion on an international level to Malaysia and Hong Kong in 1989. In 2003, Suez Group is created by bringing together all the environmental operations of the company: water management, waste management, and energy. In 2008, Suez started selling its stock to the public (date of its IPO) after the merger of Suez with Gaz de France which led to creation of GDF Suez. In 2010, Agbar, which is a prominent player in the water sector in Spain and internationally, is acquired. This has allowed the group to expand its operations in various markets, specifically in Europe.

According to recent statistics published by Suez, on the scale of the company's operations in the water sector specifically: 1130 drinking water production plants are managed, and 2300 wastewater treatment plants are managed (Suez, 2017).

The next section explains the steps taken to collect and edit data for both companies.

3. Data Collection and Edition Process

3.1. Data Source and General Information

From hereafter both companies, Veolia Environnement and Suez are referred to as Veolia and Suez.

ORBIS database of Bureau Van Dijck (BvDEP) is the main source of data used in this chapter. ORBIS provides detailed information about companies' industry and activities, key financial indicators such as operating revenue, cash flow, number of employees, etc., management structure, current shareholders, and current subsidiaries. Since this research focuses on the global operation of Veolia and Suez, the information that is obtained from ORBIS on the current subsidiaries of the two companies is of significant importance.

The data that is originally taken from ORBIS included the names of all subsidiaries for the two companies, and for each subsidiary it includes the subsidiary level, the location (country), ownership details, operating revenue, number of employees, and industrial activity codes. It is essential that at this stage I explain the subsidiary level and industrial activity codes in more details.

For this study, data on all levels of subsidiaries (all levels available on ORBIS) for both companies is collected. Level (1) subsidiaries are those which are directly connected to the parent company; in this work parent companies are Veolia and Suez. Level (2) subsidiaries are those which are linked to level (1) subsidiaries and level (3) ones are linked to level (2) ones and so on. Figure 4.1 illustrates how subsidiaries of different levels are connected to each other and to the parent company.

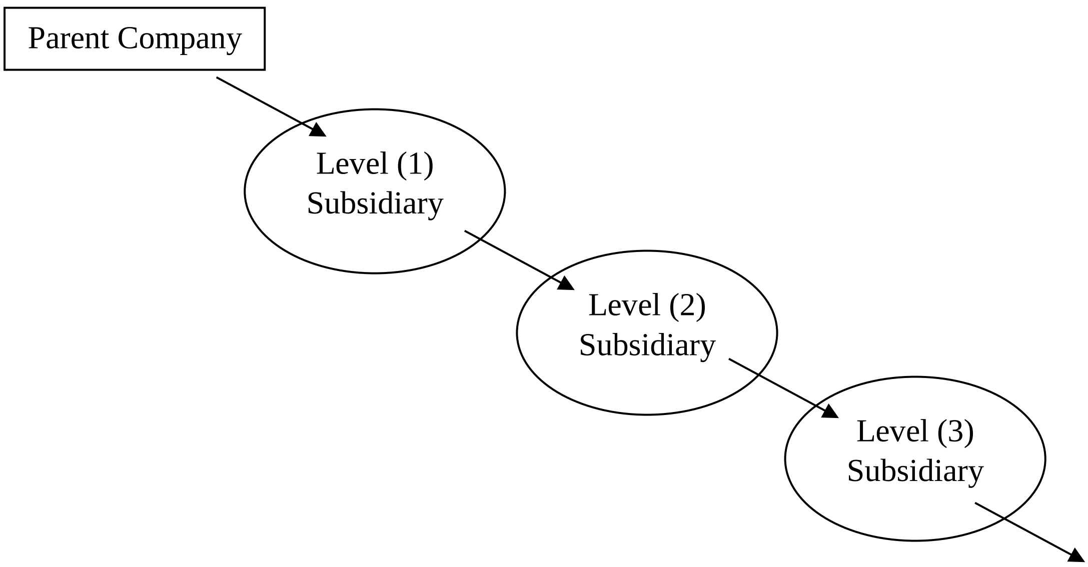

Figure 4.1, Illustration of Connection Between Parent Company and Subsidiaries of Different Levels.

Note: Also see table 4.1.

Three different codes are provided by ORBIS for description of the business activities of each subsidiary: NACE Rev. 2, NAICS 2007, and SIC. This work has used the NACE REV.2 and SIC codes for the purpose of data editing hence these codes are explained here briefly in order to provide some background information which helps in understanding the decisions made for the data editing process.

NACE (Nomenclature générale des Activités économiques dans les Communautés Européennes, translation: Statistical classification of economic activities in the European Communities), "provides the framework for collecting and presenting a large range of statistical data according to economic activity in the fields of economic statistics, e.g. production, employment, national accounts and in other statistical domains" (Eurostat European Commission 2008). NACE Rev. 2 Is the latest revision of the codes which has come into practice in 2008 [26]. SIC (Standard Industrial Classification) is a similar system of categorising industries by using four-digit codes [27]. To summarise, by looking at these codes, the industrial activity of a subsidiary can be easily identified. It should be noted that NACE Rev. 2 code was firstly looked at and ambiguities were resolved by checking the SIC codes.

3.2. Data Editing Process

As mentioned before, Veolia and Suez both provide various environmental services which are categorised into water, waste, energy and transport. As this study discusses and investigates privatisation in the water sector, only those services of the two companies that somehow relate to water sector are of interest. Both companies have subsidiaries, on different levels, whose operations are restricted to water services; to name few among all, for Veolia there are Veolia Water Solutions and Technologies, Affinity Water, and Veolia Eau-Compagnie Generale des Eaux, and for Suez there are Degremont, United Water and Grupo Agbar.

The first challenge in editing the data was encountered when the subsidiaries involved in provision of water services had to be identified. Environmental services are very much linked to each other; if a subsidiary's main industrial activity is water services it is possible that its subsequent subsidiaries are involved in other environmental services, also a subsidiary providing water services might have a parent (a higher-level subsidiary) involved in other

[26] See: http://ec.europa.eu/eurostat/web/nace-rev2
[27] See: https://www.gov.uk/government/publications/standard-industrial-classification-of-economic-activities-sic

environmental activities other than water related ones. This problem was confirmed when the two datasets were analysed and I noticed that the water subsidiaries can be found on different levels and among different groups of industrial activities. Hence, I could not assume that only the level (1) subsidiaries, which are known to provide water related services, and their subsequent subsidiaries are the only operators in the private water sector. This posed a challenging issue as it meant that each and every subsidiary in the two datasets had to be looked at manually in order to make a decision whether to include it in the final dataset that is to be analysed further. The total number of subsidiaries included in the datasets imported from ORBIS is 3703 for Veolia and 7616 for Suez. The issue was addressed by designing a procedure for elimination of those subsidiaries not involved in the water sector based on the NACE Rev.2 and SIC codes.

The steps taken for editing the two datasets are explained here in detail:

- The first step was to identify those subsidiaries which are involved in the water sector; this was done by using three NACE Rev. 2 and SIC codes that include companies with industrial activities in water related services, construction of water projects, and construction of utility projects for fluids. It should be noted that these codes were selected carefully by looking at their descriptions in the relevant NACE and SIC documents. The subsidiaries identified in this stage were the ones with major operations and activities in the water sector.
- In the second step, subsidiaries operating in other businesses related to water sector were identified using the mentioned codes for steam and air conditioning supply and plumbing, heat and air conditioning installation activities.
- There are some subsidiaries in the datasets with general industrial activities based on the two codes; these include activities of holding companies, activities of head offices, professional, scientific and technical activities, technical testing and analysis, engineering activities, and specialised construction activities. The subsidiaries with such codes were also identified.
- The information on the subsidiaries is not always complete; at this stage, the subsidiaries for which the industrial activity is unknown are identified.
- The elimination process began at this stage; a subsidiary was deleted from the dataset if it was not highlighted in the three previous stages, and its name did not include the

word 'water' (in any language), and it did not have any subsequent subsidiary highlighted in the previous three stages linked to it.

- In the final stage, for the remaining subsidiaries, those that have no link with the subsidiaries identified in stages 1 and 2 and those without the word "water" (in any language) in their name are deleted from the datasets.

By completing the above stages, the new datasets are generated and the total number of subsidiaries is now 890 for Veolia and 492 for Suez.

I recognise that during the process of editing the data, some subsidiaries with water related operations might have been deleted from the datasets, but the above procedure is designed to minimize this risk, ensuring that the majority of the subsidiaries that need to be analysed for the purpose of this study are captured and included with the ones with incomplete information and irrelevant industrial activities being deleted. Table 4.1 below shows a summary of some statistics of the compiled datasets.

Table 4.1, Complied Datasets Statistics.

Note: The subsidiaries of the two companies belong to different levels (see figure 4.1), when ownership relationships between parent and subsidiaries and between subsidiaries themselves are considered. The table shows the number of subsidiaries in each level.

Company	**Total number of subsidiaries**	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5 & above**
Veolia	890	53	221	286	156	174
Suez	492	9	25	117	104	237

4. Data Analysis

4.1. Preliminary Analysis: Structure and Geographical Spread of Parent-Subsidiary Networks

For the first stage of data analysis, some preliminary network analysis is carried out which mainly focuses on providing a descriptive overview of the two companies networks of parent-subsidiary ties. As mentioned before, the refined datasets for the two companies include a number of subsidiaries on different levels. Figures[28] 4.2 and 4.3 show the parent-subsidiary networks for Veolia and Suez water services. The names of the companies, and the ownership relationships between them have been used to construct these figures.

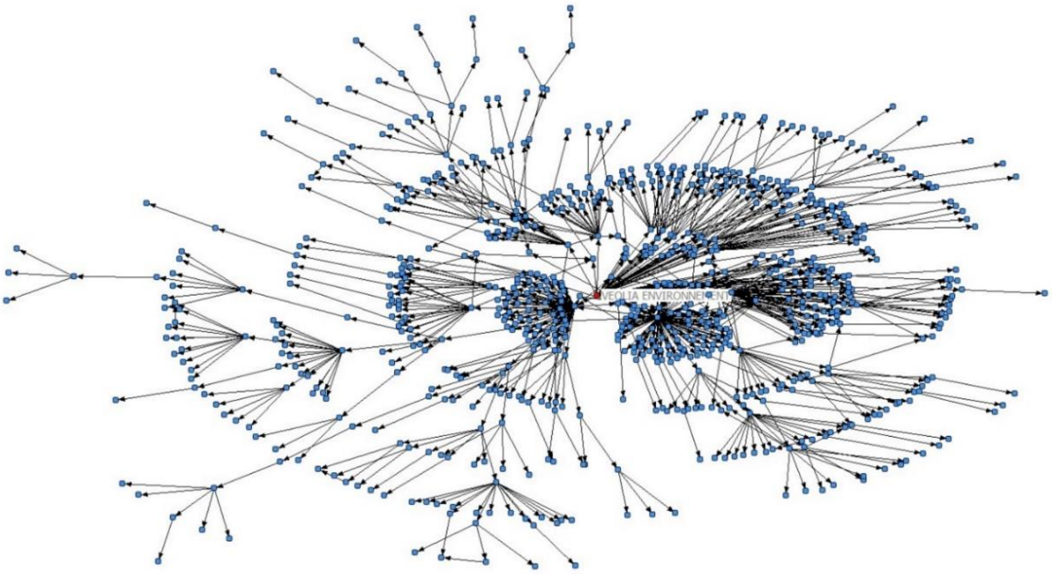

Figure 4.2, Parent-Subsidiary Network for Veolia Water services.

Note: The parent company is identified. Each node represents a subsidiary and the ties show the ownership relationships.

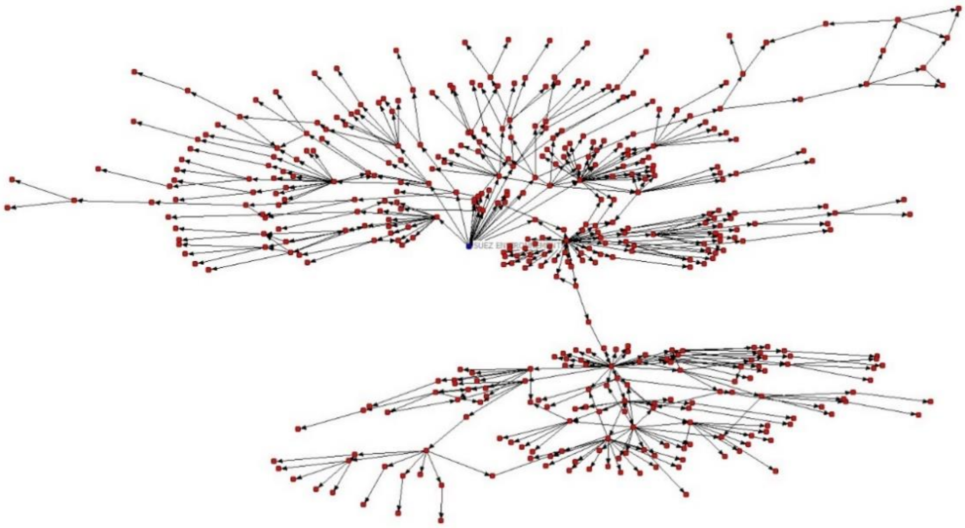

Figure 4.3, Parent-Subsidiary Network for Suez Water Services.

Note: The parent company is identified. Each node represents a subsidiary and the ties show the ownership relationships.

[28] For visualising the parent-subsidiary networks in this section, UCINET (version 6.647) and NetDraw (version 2.161) software have been used.

The names of the subsidiaries are hidden for the sake of clarity of the networks, but the parents, Veolia and Suez are located in the centre of the networks and presented in different colours. From the figures above, we can notice that the structures of the two networks are quite hierarchical with some few links between subsidiaries of non-subsequent levels. However, it is not particularly surprising to see that the networks are tree-shaped (hierarchical), given that ties are representing ownership here. In Veolia network, the majority of subsidiaries seem to belong to levels two and three, as evidenced by table 4.1. above also, hence closer to the parent through their ownership ties, while this pattern is not visible for Suez network. The data in table 4.1 suggests that most of Suez subsidiaries belong to level 5 and above. In both networks, there are some cases of linkages between subsidiaries of different levels; as in subsidiary A owning B, B owing C, while A also owns C. Also, some cases of subsidiaries being owned by two or more subsidiaries of different levels are visible in the networks, for example in the top right corner of Suez network. What is very interesting in the network of Suez is the existence of a "bridging" subsidiary.

What can also be seen is that Suez network consists of two rather separated clusters while this is not the case for Veolia. The four subsidiaries in the Suez network which connect the otherwise separated clusters to each other are consequent subsidiaries of each other with the higher level one being French and the other three being Spanish. The two middles ones are holding companies, while Degremont is involved in construction of water projects and Sociedad General de Aguas de Barcelona SA in water collection, treatment, and supply. This is an interesting insight into Suez network; the ties between these companies act as "bridges" [29] between the clusters; hence they are strategically important subsidiaries in the overall network.

[29] In social network analysis, the tie between A and B is considered a bridge if its removal would place A and B in distinct connected components. Nodes can access parts of the network that are otherwise unreachable through bridges.

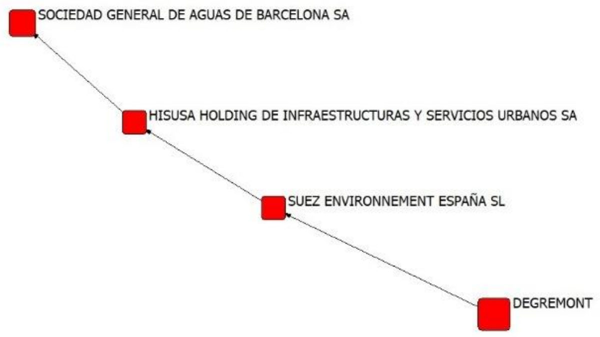

Figure 4.4, Bridging Ties in Suez Network.

Note: Subsidiaries of Suez which bridge the two otherwise unconnected cluster in the network depicted in figure 4.3.

Where are subsidiaries located? By identifying the countries that the two companies have expanded into, I can gain insight into the extent of privatisation in the water sector in various locations around the world. Establishing new subsidiaries onsite, or acquiring local companies, is a means for a multinational company to enter a new market. Figures 4.5 and 4.6 show the locations of subsidiaries represented by the node colours.

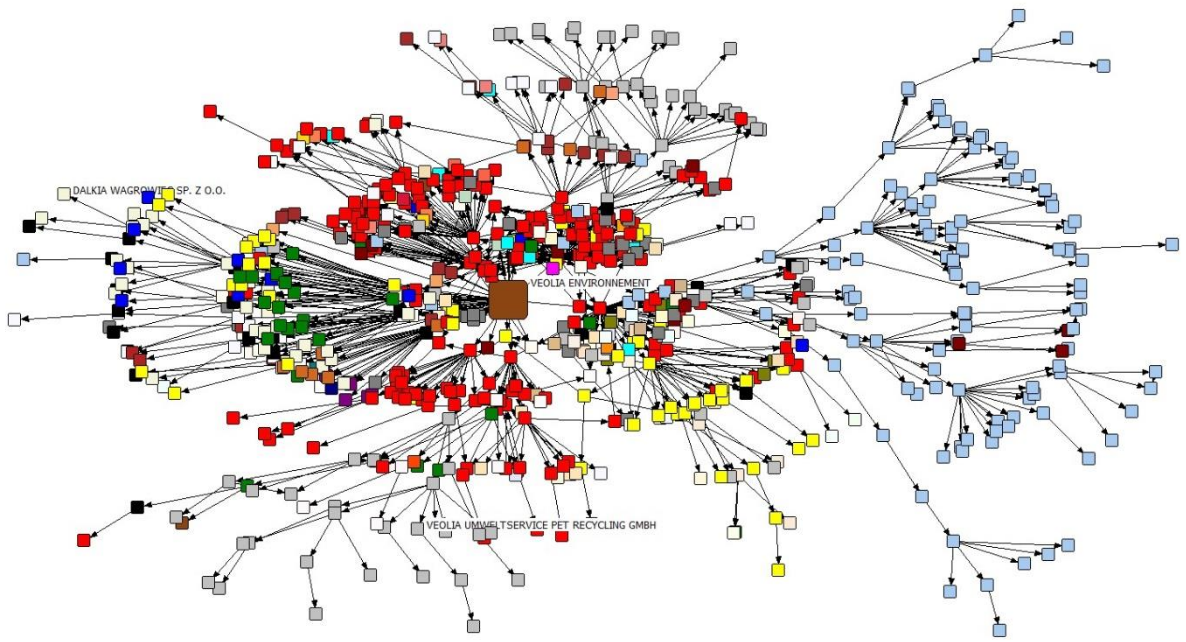

Figure 4.5, Veolia Water Subsidiaries Geographical Locations.

Note: Colours represent countries. The below countries are the locations of most of the subsidiaries:
Red: France, Light Blue: Great Britain, Grey: Germany, Yellow: Italy, Beige: Poland

Further investigation of the Veolia network clarifies that Veolia water subsidiaries are scattered in 68 different countries with the majority of them located in France, Great Britain, Germany, Italy, and Poland. The subsidiaries of Veolia are found to be present in 6 world regions (based on World Bank categorisation): Europe & Central Asia, Middle East & North Africa, Sub-Saharan Africa, Latin America & Caribbean, East Asia & Pacific, and North America. The countries where Veolia's subsidiaries are located fall into 5 income groups (based on World Bank categorisation): low income, lower middle income, upper middle income, high income (OECD), and high income (non-OECD).

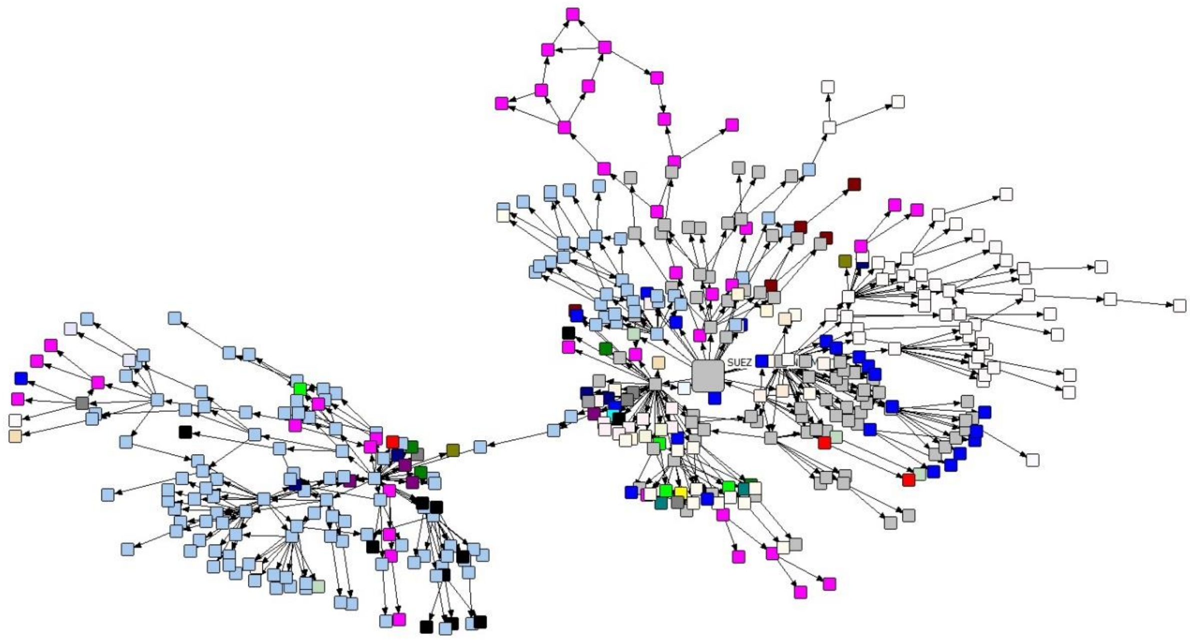

Figure 4.6, Suez Water Subsidiaries Geographical Locations

Note: Colours represent countries. The below countries are the locations of most of the subsidiaries:
Light Blue: Spain, Grey: France, White: Italy, Purple: Great Britain, and Blue: US

Further investigation of the Suez network clarifies that Suez water subsidiaries are scattered in 34 different countries with the majority of them located in Spain, France, Italy, Great Britain, and US. The subsidiaries of Suez are found to be present in 7 world regions (based on World Bank categorisation): Europe & Central Asia, Middle East & North Africa, Sub-Saharan Africa, Latin America & Caribbean, East Asia & Pacific, North America, and South Asia. Suez's subsidiaries are located in countries which fall into 4 income groups (based on World

Bank categorisation): lower middle income, upper middle income, high income (OECD), and high income (non-OECD).

Clearly, the two companies are competitors in some countries where both have large numbers of subsidiaries (France, Great Britain, Italy) while they display some degree of diversification in other countries, where their presence is unbalanced (for example, Suez being relatively more present in Spain, Veolia in Poland). The acquisition/creation of subsidiaries in different locations is a way for these two multinationals to manage their positions in the world-wide competitive structure of the sector. Most frequently, first-level subsidiaries are established overseas as a point of entry to a country, as they are used to create or acquire further (second- and third-level) subsidiaries in that same country; however, especially in the Veolia network, a few subsidiaries own lower-level subsidiaries in a range of different countries, thereby playing important international intermediation roles.

The two figures below are an alternative representation of the distribution of the two companies' subsidiaries, whereby the layout of the network is based on geographical coordinates. In both cases, the centre of the network is Europe and more precisely, France; outward ties spread towards the Americas (left side of each image), Asia and the Pacific (right side), and to a lesser extent, Africa (centre-bottom). The two companies' global approach to diversification is apparent, with Veolia having relatively more subsidiaries in Asia, and Suez in the Americas.

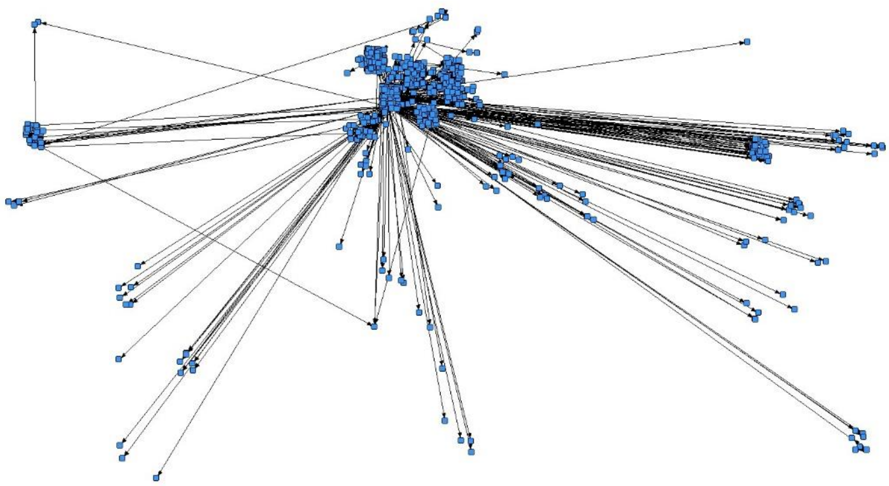

Figure 4.7, Veolia Water Subsidiaries Placed Based on Their Geographical Location.

Note: The concentration of subsidiaries in Europe, in the middle of the graph, is apparent.

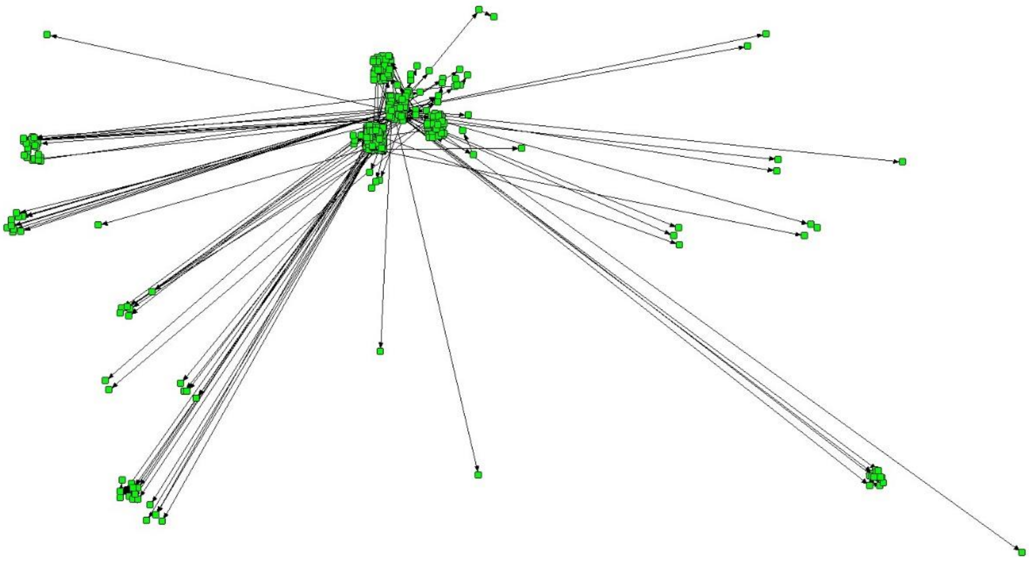

Figure 4.8, Suez Water Subsidiaries Placed Based on Their Geographical Location.

Note: The concentration of subsidiaries in Europe, in the middle of the graph, is apparent.

The above descriptive analysis gives us an overview of how subsidiaries are scattered globally. It is now necessary to look deeper at the linkages across subsidiaries in space to gain more robust understanding of the two companies' geographical expansion strategies

In what follows the two networks are analysed considering the geographical locations of subsidiaries and their activities.

4.2. Ties in Space: BlockModels

The parent-subsidiary data of the two companies are analysed in the next sections using blockmodeling. Before proceeding to discuss how blockmodeling was implemented, I provide a brief explanation of the procedure and associated algorithms. Blockmodeling is an empirical procedure which suggests that units in a network can be grouped together based on the extent to which they are equivalent (Doreian et al., 2005).

If $U = \{X_1,\ X_2, \dots, X_n\}$ is a finite set of units, and the units are related to each other by a relationship, the network is determined as $N = (U, R)$, where $R \subseteq U \times U$, and it is defined by a matrix $R = \left[r_{ij}\right]_{n \times n}$, where

$$r_{ij} = \begin{cases} 1\ (or\ any\ non-negative\ number) & X_i R X_j \\ 0 & otherwise \end{cases}$$

The blockmodeling aims to identify clusters, in other words, groups of units that share some structural characteristics, which are defined in terms of the relationship matrix. The units that are put into the same clusters have the same or similar patterns of connections to the rest of units in those clusters and they form a clustering $C = \{C_1, \ C_2, \dots, C_k\}$. This clustering is a partition of the U:

$$\bigcup_i C_i = U$$

$$i \neq j \ \Rightarrow \ C_i \cap \ C_i \ = \ \emptyset$$

Each of the partitions determines an equivalence relationship, and vice versa, and the clustering partitions the relationship into blocks

$$R\left(C_i, C_j\right) = R \cap \ C_i \ \times C_j$$

A blockmodel then consists of structured which are obtained by identifying all the units that fall into the same cluster of the clustering C. Blockmodeling helps in reducing a larger and incoherent network to smaller structures which are easier to interpret.

Two definitions of the equivalence which are used are structural and regular equivalence (Lorrain & White, 1971; White and Reitz, 1983). Units are said to be structurally equivalent when they are linked to the rest of the network in identical ways; X and Y are structurally equivalent if:

$s1. XRY \ \Leftrightarrow YRX$

$s2. XRX \ \Leftrightarrow YRY$

$s3. \forall Z \in U \setminus \{X, Y\}: \{XRZ \ \Leftrightarrow \ YRZ\}$

$s4. \forall Z \in U \setminus \{X, Y\}: \{ZRX \ \Leftrightarrow \ ZRY\}$

Two units are said to be regularly equivalent if they are equally connected to equivalent others; if for all $X, Y, Z \in U, X \approx Y$ implies that:

$R1. XRZ \ \Leftrightarrow \exists W \in U: (YRW \wedge, W \approx Z)$

$R2. ZRX \Leftrightarrow \exists W \in U: (WRY \wedge, W \approx Z)$

Then the equivalence relationship $\approx$on U is a regular equivalence on network N.

4.2.1. Veolia

As explained in the previous section, the two datasets used for this study are parent-subsidiary data for Veolia Environnement and Suez. In this section, the steps taken for analysis of these two datasets, using blockmodeling[30] are explained and the results are discussed. The information on the ownership relationships between the companies (subsidiaries and their parents) have been used for the blockmodeling.

The parent-subsidiary network for Veolia Environnement, which is built on ownership ties between parent and subsidiaries and subsidiaries and subsidiaries, is presented in figure 4.2. As discussed above, 69 countries are present in the network of Veolia Environnement Company (see Appendix 4).

To identify the patterns between subsidiaries relationships and their location, blockmodeling (Doreian et al., 2005) is used. But first, I discuss whether I have used the original parent-subsidiary data for blockmodeling purposes or I have changed the dataset in a way to better inform the blockmodels.

The parent-subsidiary dataset in a matrix format is presented in the figure below; the names of the companies are written on the edges of the matrix and the grey boxes represent a present tie between corresponding subsidiaries in the associated row and column. Although, from the figure, it seems that diagonal values are present in the matrix, there is no tie between subsidiaries with themselves but the ties in the below matrix are more concentrated around the diagonal.

[30] For blockmodeling, Pajek software (version 4.05) has been used.

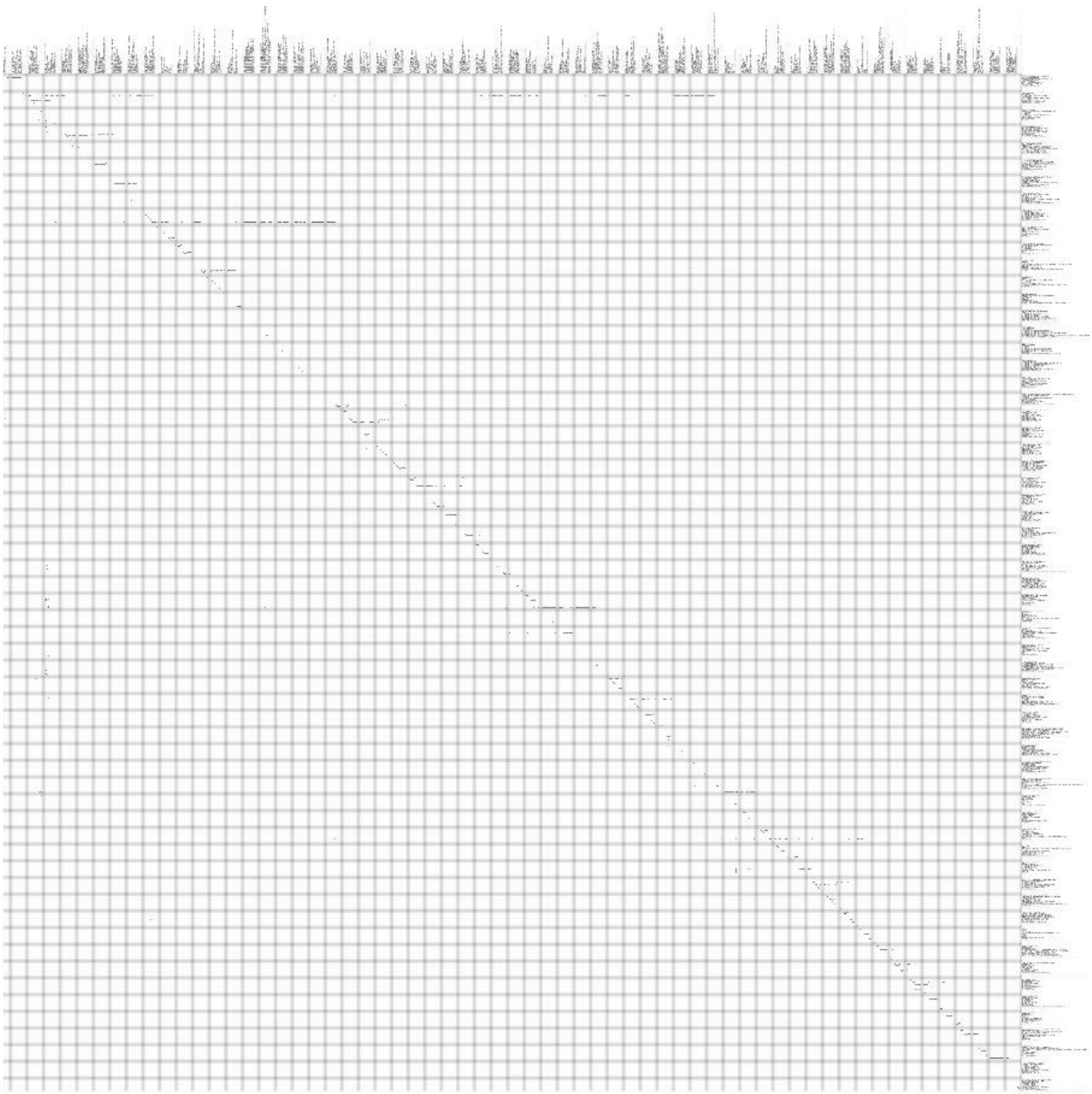

Figure 4.9, Network Matrix Image for Veolia.

Note: Names of subsidiaries are written are on horizontal and vertical axes of the matrix. The matrix is provided to give an insight on the data, the details of the ties is not of interest here.

The matrix is not symmetric; ownership ties which this network is built on are not symmetric ties by definition. But since we are using the ownership information as a proxy for establishing relationships between subsidiaries, we can assume the relationships open the way to channels for interaction, communication and information-sharing that can be assumed to be, by and large, reciprocated. Consider the example of subsidiary B being owned by subsidiary A; the ownership tie is directed from A to B but the two subsidiaries can communicate with each other regardless of this directed tie, hence in this specific sense, their broader set of relationships can be thought of to be reciprocated. The matrix below is the symmetrised version of the parent-subsidiary network.

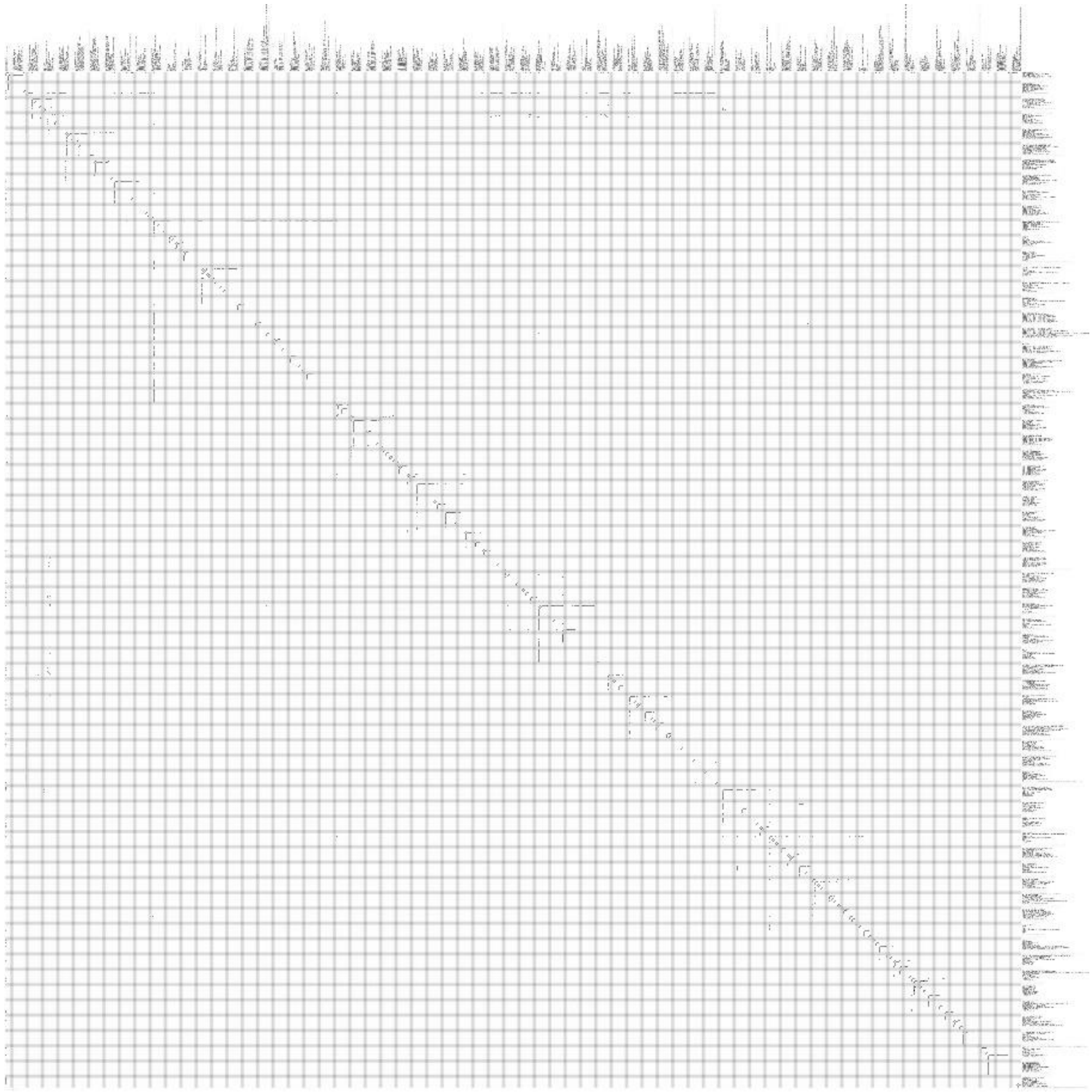

Figure 4.10, Symmetric Network Matrix Image for Veolia.

Note: Names of subsidiaries are written are on horizontal and vertical axes of the matrix. The matrix is provided to give an insight on the data, the details of the ties is not of interest here.

As it is clearly seen from the matrix images above, no clear pattern can be seen for how the subsidiaries have ties to each other. By doing blockmodeling, the subsidaires in the matrix are moved around so different types of blocks can be found; we will discuss the different block types and what they mean in following sections. A blockmodel assigns the vertices of a network, in this case the subsidiaries, to classes and it specifies the permitted types of relation within and between classes.

We can start blockmodeling by using the parent-subsidiary matrix presented above. But, since the patterns of country presence is what we seek to identify, we can alter the matrix so blockmodeling results would provide us with information on such patterns. In the first step, the names of the subsidaires in the matrix are replaced with their location (country); the matrix now represents ties between countries where the subsidiares are located. Clearly, these ties still represent the ownership ties (here, taken as reciprocated) which we originaly had in the matrix.

The matrix is shown in the figure below; the country by country network that is created is a valued network and the strength of the ties are shown by different shades in the matrix below. For example, there are many subsidiaries in France (FR in the matrix) that have ties with subsidiaries in the same country; as a matter of fact the majority of the ties between subsidiaries are France-France ties and hence the cell at the intersection of FR row and FR column is black (the darkest shade visible in the figure). Except the visible symmetry in the figure below and the above mentioned France-France ties, there is not much we can tell about the distribution of subsidiaries in different locations. As mentioned earlier, there are 69 countries in this dataset.

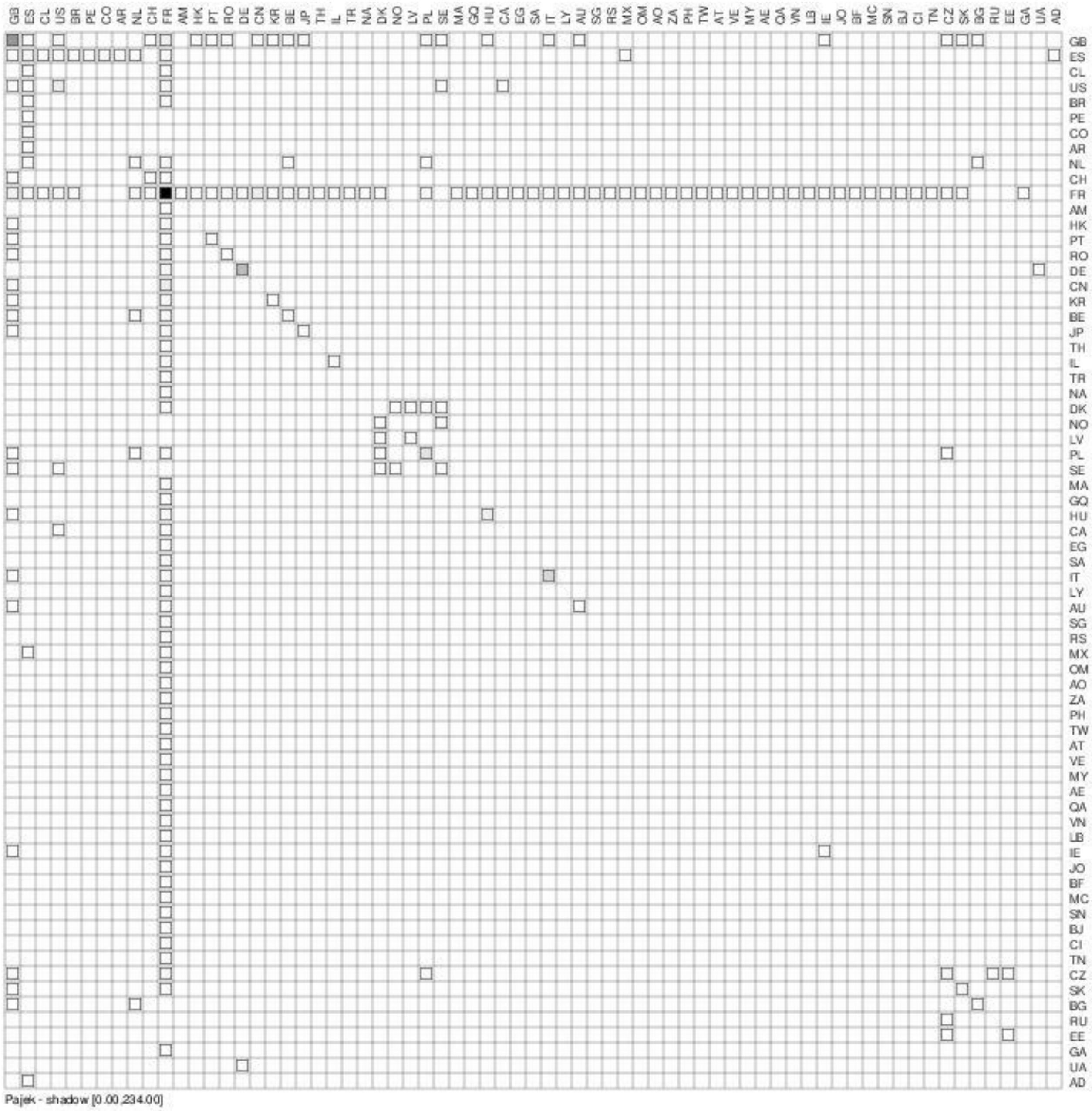

Figure 4.11, Network Matrix Image of Country-Country Associations for Veolia.

Note: Country abbreviations are written are on horizontal and vertical axes of the matrix. The shade of cells' colours represents the number of ties, for example the black cell shows that the most ties exist between subsidiaries in France.

For finding the meaningful number of classes, we consider our thoughts about the distribution of the subsidiaries. The 69 countries can be classified according to their geographical region based on the system World Bank uses in its dataset; the categories are as follows:

- Europe & Central Asia
- Middle East & North Africa
- Sub-Saharan Africa
- Latin America & Caribbean
- East Asia & Pacific
- North America

I specify that the number of these geographical regions is used as the number of classes for blockmodeling, and I hypothesise that ideally, we want to see the same countries belonging to the same region in each class resulting from the blockmodeling. We can then compare the actual results of the blockmodeling to this hypothesis. But as previously said, blockmodeling not only assigns vertices to classes but it also specifies the type of relations we can have within and between classes. For the type of relations, we consider a type of equivalence: regular equivalence. Vertices which are regular equivalent do not have to be connected to the same vertices, but they have to be connected to vertices in the same classes. Hence, a regular block contains at least one arc in each row and in each column.

I start the blockmodeling by trying to optimise the existing partition; in the existing partition, all the countries present in the network are listed in the same order as they appear in the network data and they are allocated to their corresponding region. The results for optimising this partition show that although the initial matrix and the final one (resulting from running blockmodeling) share the same structure, the number of errors have substantially decreased in the final matrix. I have used regular equivalence here; in the final matrix, the vertices in one block are regular equivalent, and the errors show that the rest of the block in the first row and column could be null (empty) by removing one tie.

Table 4.2, Initial Image Matrix for Veolia (Subsidiaries' Countries).

Initial Image Matrix:

	1	2	3	4	5	6
1	reg	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-

Table 4.3, Initial Error Matrix for Veolia (Subsidiaries' Countries).

Initial Error Matrix:

	1	2	3	4	5	6
1	57	18	14	14	14	3
2	18	4	0	0	0	0
3	14	0	1	0	0	0
4	14	0	0	2	1	0
5	14	0	0	1	4	0
6	3	0	0	0	0	0

Initial error = 196.000

Table 4.4, Final Image Matrix for Veolia (Subsidiaries' Countries).

Final Image Matrix:

	1	2	3	4	5	6
1	reg	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-

Table 4.5, Final Error Matrix for Veolia (Subsidiaries' Countries).

Final Error Matrix:

	1	2	3	4	5	6
1	0	1	1	1	1	1
2	1	0	0	0	0	0
3	1	0	0	0	0	0
4	1	0	0	0	0	0
5	1	0	0	0	0	0
6	1	0	0	0	0	0

Final error = 10.000

By trying to optimise the partition, we have restricted the number of solutions we can get. Hence, we try blockmodeling starting from a random partition looking for the best possible solution, but we keep the number of classes and the type of equivalence as before. Several solutions are obtained, from which the below two seem to be the best fit.

Table 4.6, Final Image Matrix (for the first obtained solution) for Veolia (Subsidiaries' Countries).

Final Image Matrix (for the first obtained solution):

	1	2	3	4	5	6
1	reg	-	-	-	-	-
2	-	-	-	com	-	-
3	-	-	-	-	-	-
4	-	com	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-

Table 4.7, Final Error Matrix (for the first obtained solution) for Veolia (Subsidiaries' Countries).

Final Error Matrix (for the first obtained solution):

	1	2	3	4	5	6
1	0	1	1	0	1	1
2	1	0	0	0	0	0
3	1	0	0	0	0	0
4	0	0	0	0	0	0
5	1	0	0	0	0	0
6	1	0	0	0	0	0

Final error = 8.000

Table 4.8, Final Image Matrix (for the second obtained solution) for Veolia (Subsidiaries' Countries).

Final Image Matrix: (for the second obtained solution):

	1	2	3	4	5	6
1	-	-	-	-	-	-
2	-	reg	-	-	-	-
3	-	-	reg	reg	-	reg
4	-	-	reg	reg	-	-
5	-	-	-	-	-	-
6	-	-	reg	-	-	-

Table 4.9, Final Error Matrix (for the second obtained solution) for Veolia (Subsidiaries' Countries).

Final Error Matrix: (for the second obtained solution):

	1	2	3	4	5	6
1	0	0	1	0	0	0
2	0	0	1	0	0	0
3	1	1	0	0	1	0
4	0	0	0	0	0	0
5	0	0	1	0	0	0
6	0	0	0	0	0	1

Final error = 7.000

We discuss the second solution first since more conclusions can be derived from it. In the second solution, vertices in 7 blocks are regular equivalent. Let us look at the relations within classes first; vertices in classes 2, 3, and 4 are regular equivalent hence subsidiaries in these classes have at least one tie with another vertex in the same class. By examining the results which are written as a new partition, we identify the countries which are placed in these 3 classes:

Table 4.10, Second Solution of Blockmodeling for Veolia.

Note: The countries and corresponding regions put into the classes identified by blockmodeling are shown here.

Country Abbreviation	Region	Second Solution Class
DE	Europe & Central Asia	2
UA	Europe & Central Asia	2
GB	Europe & Central Asia	3
ES	Europe & Central Asia	3
FR	Europe & Central Asia	3
SE	Europe & Central Asia	3
CZ	Europe & Central Asia	3
DK	Europe & Central Asia	3
NL	Europe & Central Asia	3
JP	East Asia & Pacific	4
AU	East Asia & Pacific	4
KR	East Asia & Pacific	4
CH	Europe & Central Asia	4
RO	Europe & Central Asia	4
LV	Europe & Central Asia	4
PL	Europe & Central Asia	4
SK	Europe & Central Asia	4
BG	Europe & Central Asia	4
EE	Europe & Central Asia	4
IT	Europe & Central Asia	4
IE	Europe & Central Asia	4
HU	Europe & Central Asia	4
PT	Europe & Central Asia	4
IL	Middle East & North Africa	4
CA	North America	4
US	North America	4

Certain countries in Europe and Central Asia (those placed in class 2 and 3) seem to have more ties among themselves, while others (places in class 4) have ties with subsidiaries in other regions of the world. The other interesting result obtained from blockmodeling is the relations identified between classes 3 and 4, and 3 and 6. I have already presented the countries in classes 3 and 4 above, most of the countries present in the data are actually placed in class 6 which covers all 6 geographical regions except North America. Hence, we can conclude those subsidiaries in class 3 which are all in Europe and Central Asia have ties with subsidiaries in every other region of the world.

By examining the partition created as a result of the first solution, we can see that almost all of the 69 countries, which are in all the 6 geographical regions, are placed in class 1 in which the vertices are regular equivalent. Latvia, China, Benin, Serbia, and Colombia are each placed in one class and Benin and Latvia form a complete block in which all ties are present.

Overall, the blockmodeling of the country by country network reveals that the subsidiaries in following countries in the region of Europe and Central Asia tend to have ties with subsidiaries in the same region; this is an interesting insight into how the subsidiaries of the company could potentially interact with each other:

- DE: Germany
- UA: Ukraine
- GB: Great Britain
- ES: Spain
- FR: France
- SE: Sweden
- CZ: Czech Republic
- DK: Denmark
- NL: Netherlands

We can make the analysis more robust by considering the economic region that the countries belong to; the classification matches the categories used by the World Bank and the regions are as follows:

- Low income

- Lower middle income
- Upper middle income
- High income: OECD
- High income: non-OECD

To make better comparison, we change the number of classes in the blockmodeling to 5; below are the solutions that are found:

Table 4.11, Final Image Matrix for Veolia (Subsidiaries' Countries' Income Groups).

Final Image Matrix:

	1	2	3	4	5
1	reg	-	-	-	-
2	-	-	-	-	-
3	-	-	reg	reg	reg
4	-	-	reg	reg	-
5	-	-	reg	-	-

Table 4.12, Final Error Matrix for Veolia (Subsidiaries' Countries' Income Groups).

Final Error Matrix:

	1	2	3	4	5
1	0	0	1	0	0
2	0	0	1	0	0
3	1	1	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0

Final error = 4.000

Class 1 of the above solution, with vertices being regular equivalent, include Germany and Ukraine which belong to high income (OECD) and lower middle- income regions; the subsidiaries in the two countries were regular equivalent when the blockmodel was done on 6 classes. The class 3 and 4 mostly include countries with high income (OECD). Also, class 3 is very similar to class 3 in the previous blockmodels discussed with regards to geographical regions. But the most interesting insight here is probably the regular equivalence between class 3 and class 5; class 3 subsidiaries all belong to high income (OECD) countries while class 5 subsidiaries belong to all income regions.

The two figures below depict the results for blockmodeling on Veolia in a more visual way. The countries that are grouped together have been put in the same class by blockmodeling over several runs. The purple and dark red lines represent classes which are regular equivalent.

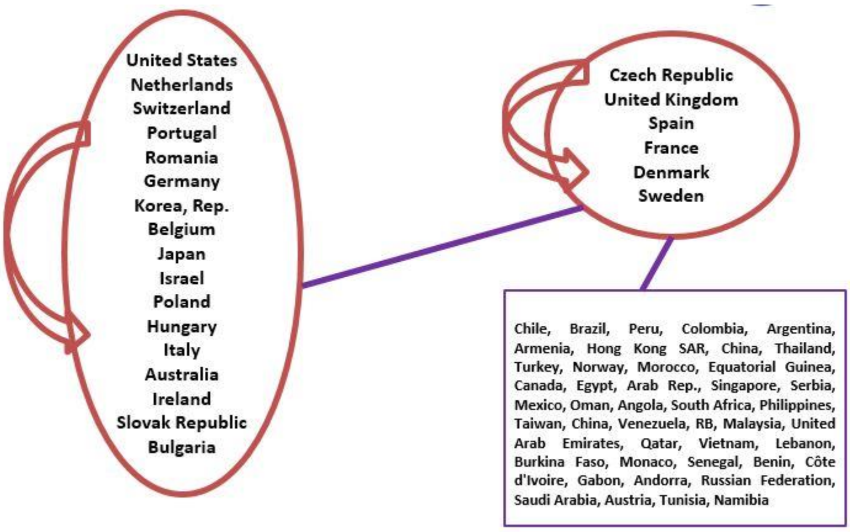

Figure 4.12, Blockmodeling Results for Veolia (Countries).

Note: Countries grouped together have been put in the same class by blockmodeling over several runs. The purple and dark red line represent classes which are regular equivalent.

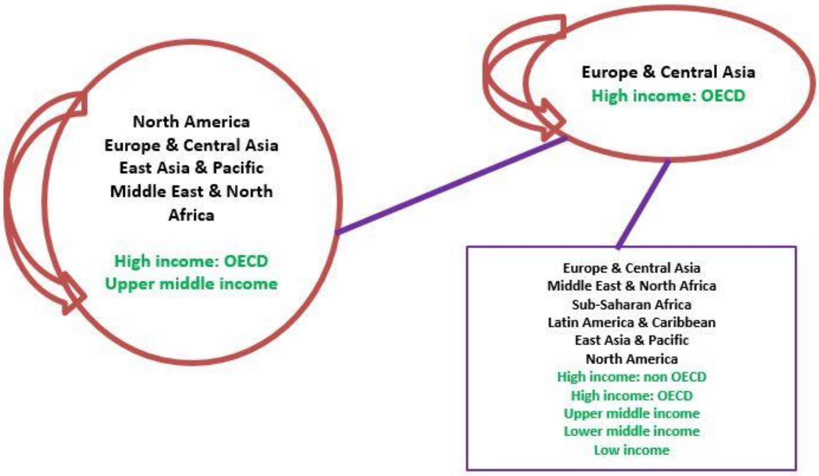

Figure 4.13, Blockmodeling Results for Veolia (Geographical and Economic Regions).

Note: Geographical and economic regions grouped together have been put in the same class by blockmodeling over several runs. The purple and dark red line represent classes which are regular equivalent.

4.2.2. Suez

Similar to the previous section investigating Veolia network, in this section the steps taken for analysis of Suez network and the results are discussed.

The parent-subsidiary network for Suez is also built on ownership ties between parent and subsidiaries and subsidiaries and subsidiaries; the parent-subsidiary network is presented in figure 4.3. Each of the subsidiaries in this network are located in a country and they perform a specific activity; 35 countries are present in the network of Suez Company (see Appendix 4) and the activities are classified in table 4.3, in the following section.

Similar to the previous section, to identify the patterns between subsidiaries relationships, and their location, blockmodeling is used. In this part, I only present the results without going into details of the methods and steps applied, as these were discussed in detail for the case of Veolia. Assuming symmetric ties in the parent-subsidiary network of Suez, the matrix below represents the present relationships.

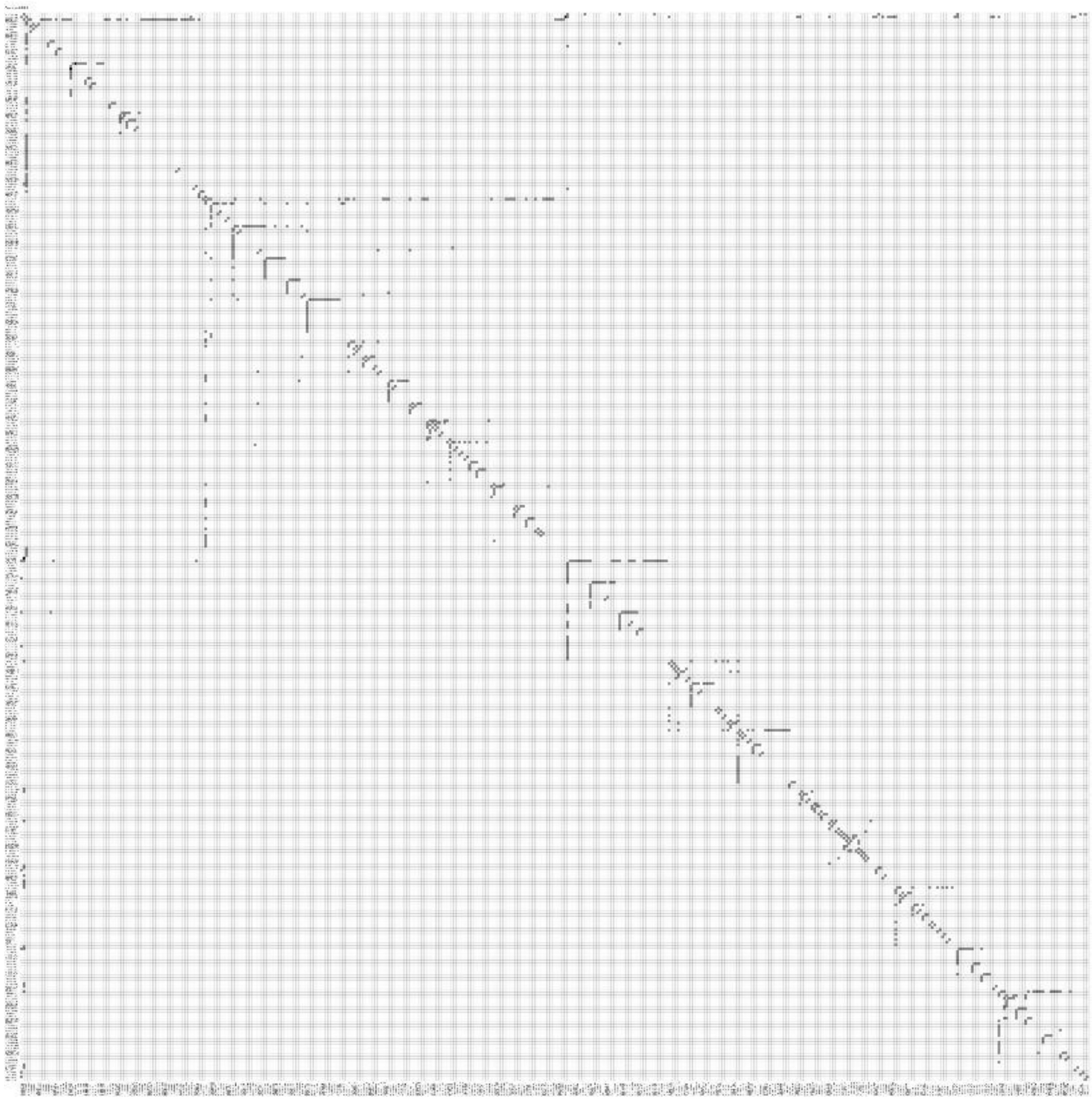

Figure 4.14, Symmetric Network Matrix Image for Suez.

Note: Names of subsidiaries are written are on horizontal and vertical axes of the matrix. The matrix is provided to give an insight on the data, the details of the ties is not of interest here.

The matrix has been altered, by replacing subsidaires' names with their locations (countries), so that blockmodeling results obtained from the altered matrix can shed light on patterns of country presenc for this company's network. The resulting matrix is shown in the figure below, with the strength of the ties presented in darker shades.

As it can be seen in the figure below, there are many subsidiaries in Spain and France (ES and Fr respectively in the matrix) that have ties with subsidiaries in the same country; the majority of the ties between subsidiaries are Spain-Spain ties and hence the cell at the intersection of ES row and ES column is black (the darkest shade visible in the figure).

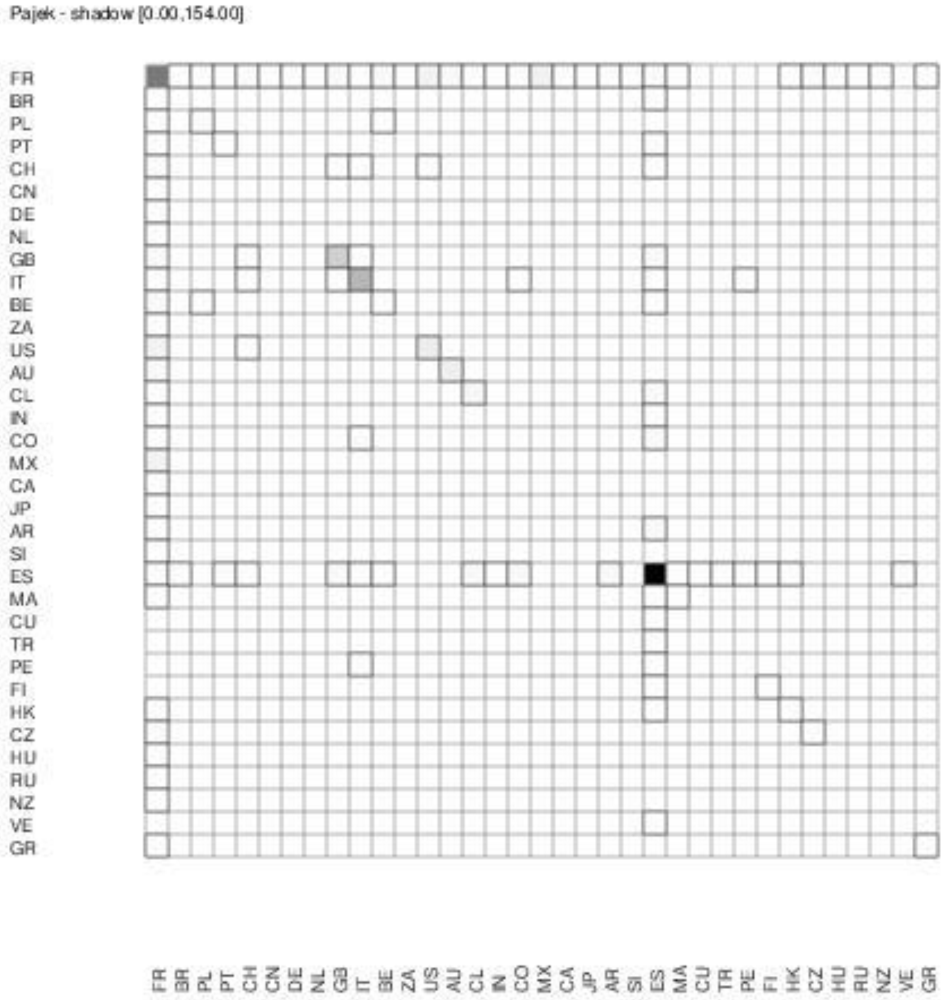

Figure 4.15, Network Matrix Image of Country-Country Associations for Suez.

Note: Country abbreviations are written on horizontal and vertical axes of the matrix.
The shade of cells' colours represents the number of ties, for example the black cell shows that the most ties exist between subsidiaries in Spain.

For finding the meaningful number of classes, we have considered the same classification on countries into geographical regions as before, but in Suez network there is one additional region, South Asia. I specify that the number of these geographical regions is used as the number of classes for blockmodeling, hence for this case we have 7 classes. I also consider the economic regions for better understating of the company's structure. The two figures below summarise the results for blockmodeling on Suez network. The countries that are grouped together have been put in the same class by blockmodeling over several runs. The purple and dark red line represent classes which are regular equivalent and the yellow lines represent classes which are structurally equivalent. Suez results show more variety in terms of groups of subsidiaries which tent to have ties with each other compared to Veolia network. We also see the presence of structurally equivalent classes.

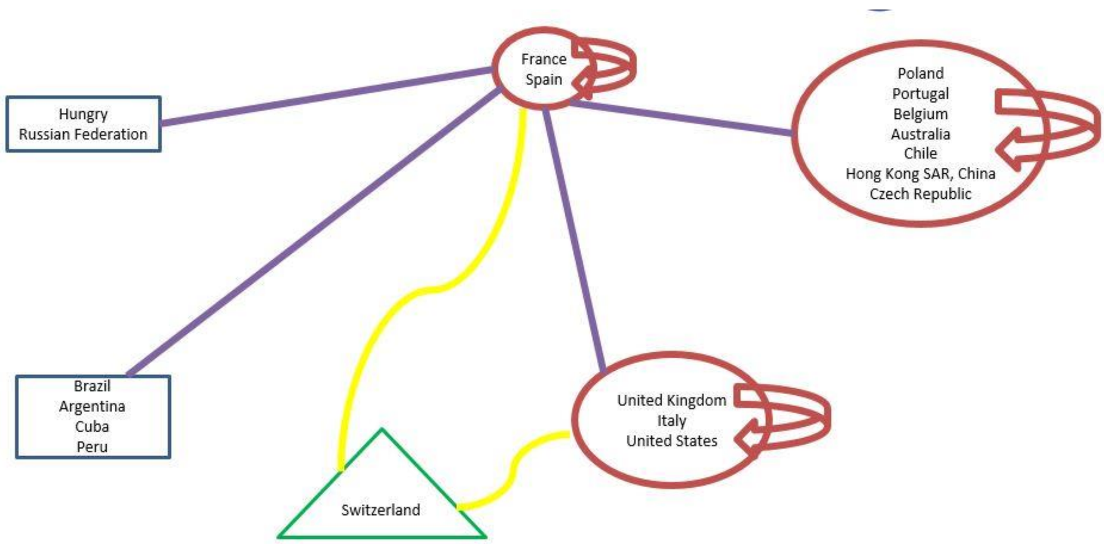

Figure 4.16, Blockmodeling Results for Suez (Countries).

Note: Countries grouped together have been put in the same class by blockmodeling over several runs. The purple and dark red line represent classes which are regular equivalent and the yellow lines represent classes which are structurally equivalent.

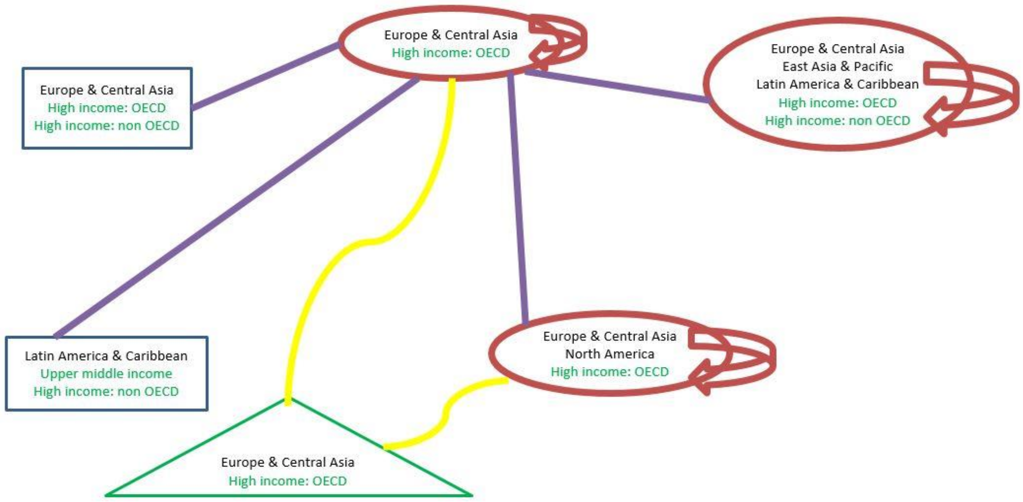

Figure 4.17, Blockmodeling Results for Suez (Geographical and Economic Regions).

Note: Geographical and economic regions grouped together have been put in the same class by blockmodeling over several runs. The purple and dark red line represent classes which are regular equivalent and the yellow lines represent classes which are structurally equivalent

In the two previous sections, 4.2.1 and 4.2.2, the steps taken to do the blockmodeling for both parent-subsidiary networks of Veolia and Suez have been explained. The table below summarises how the procedure was executed; the difference lies between the number of classes defined, as for Suez the subsidiaries are located in 7 different regions. It should be reminded here that the names of subsidiaries have been replaced with the name of countries they are located in for the data used in blockmodeling.

Table 4.13, Blockmodeling Procedure.

Note: Method used, defined classed for two sources of data and type of equivalence considered are stated.

Method Used	Data	Classes	Number of Classes	Type of Equivalence
Generalised Blockmodeling	Veolia Parent-Subsidiary Network	Random	6 (corresponding to number of regions)	Regular Equivalence
			5 (corresponding to number of economic regions)	
	Suez Parent-Subsidiary Network	Random	7 (corresponding to number of regions)	Regular Equivalence
			5 (corresponding to number of economic regions)	Structural Equivalence

4.3. What Do Subsidiaries Do? Analysis of Activities Using E-I Index

4.3.1. Veolia

As explained in section 3 above, the NACE REV.2 and SIC codes, provided by ORBIS, are used for description of the business activities of each subsidiary. Based on these codes, the activities of subsidiaries can be categorised into groups seen in table 4.3 below:

Table 4.14, Business Activity Codes.

Note: Subsidiaries carry out different water and sanitary activities, this information is based on the NACE REV. 2 and SIC codes.

Activity	Activity Code
Water collection, treatment and supply Sewerage Construction of utility projects for fluids	1
Engineering activities and related technical consultancy (in water related service) Activities of head offices Activities of holding companies Other professional, scientific and technical activities	2
Plumbing, heat and air conditioning installation Steam and air conditioning supply Electricity, gas, steam and air conditioning supply	3
Other business support service activities (in water related service)	4
Activities of parent company (restricted to Veolia Environnement only)	5
Unknown activity related to water services	0

As it can be seen from the table above, some of the activities are very much focused on main water and wastewater services, such as water collection, treatment and supply, while others are more auxiliary services which might or might not include water and waste water service; for example, "activities of holding offices" belong to those subsidiaries which have some ties to water and wastewater focused subsidiaries but they do not perform an activity involving providing such services themselves.

The distribution of above listed activities in different countries can be quickly identified (see Appendix 4). Earlier, I endeavoured to understand whether those subsidiaries which have ties to each other are in the same countries; I now look at the extent to which they perform the same or related activities. This can reveal useful information about the strategies of these companies.

For this analysis, “Groups” are defined based on the categories of activities, as shown in table 4.3, and group-external and group-internal ties are analysed using E-I Index[31] (Krackhardt & Stern, 1988); ties represent ownership relationships between companies (subsidiaries and their parents), and E-I Index aims to illustrate whether groups of subsidiaries performing the same activities tend to be owned by each other or by those performing different activates.

The E-I index treats the relationships as binary and ignores any values on them; relationships either exist or they do not. The devised by Krackhard and Stern (1988) as mentioned, is based on a given partition, in this case categories of activities, between internal and external ties. If EL is the number of external ties and IL is the number of internal ties to a predefined group, the formula to calculate the E-I index is as follows:

$$EI_{INDEX} = \frac{EL-IL}{(EL+IL)}$$

E-I index can take values of +1.0 to -1.0, where negative values indicate prevalence of internal ties, while positive values suggest prevalence of external ties.

For Veolia network, prevalent ties with other groups are observed in subsidiaries performing other business support service activities (in water related service) and unknown activities related to water services. The other groups do not show any particular pattern in this network. The table below shows the results for E-I Index analysis on Veolia network.

[31] For calculating the E-I indices in this part, UCINET (version 6.647) software has been used.

Table 4.15, E-I Index for Veolia.

Note: The ties within and between groups are considered, and groups are defined based on the activities of subsidiaries.

Group	E-I Index
Water collection, treatment and supply Sewerage Construction of utility projects for fluids	0.004
Engineering activities and related technical consultancy (in water related service) Activities of head offices Activities of holding companies Other professional, scientific and technical activities	0.330
Plumbing, heat and air conditioning installation Steam and air conditioning supply Electricity, gas, steam and air conditioning supply	-0.006
Other business support service activities (in water related service)	0.518
Activities of parent company (restricted to Veolia Environnement only)	1.000
Unknown activity related to water services	0.714

Since Veolia started as a French company, and considering how subsidiaries in France seem to be significant based on the analysis already done, it is of interest to compare how their French subsidiaries interact with each other compared to their global networks. From the original data, the subsidiaries located in France have been extracted and the network of parent-subsidiary is visualised as below:

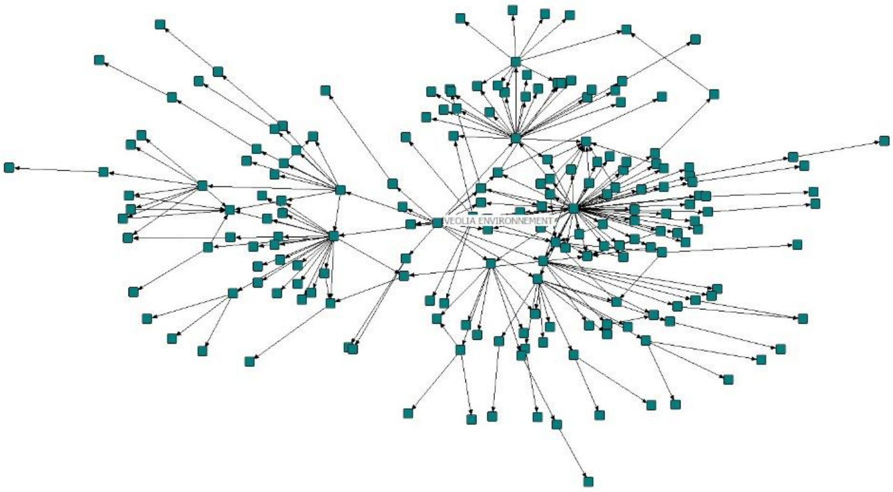

Figure 4.18, Veolia's Parent-Subsidiary Network, restricted to France.

Note: The network represents the ties between Suez and its subsidiaries in France only.

The interaction between French subsidiaries have been analysed using E-I index and compared with the global network results. Prevalent ties with the same group are observed in subsidiaries performing: water collection, treatment, supply, sewerage, and construction of utility projects for fluids, while ties with other groups are found to be among subsidiaries performing plumbing, heat and air conditioning installation, Steam and air conditioning supply, and electricity, gas, steam and air conditioning supply. The table below shows the results for E-I index analysis for Veolia network in France.

Table 4.16, E-I Index for Veolia, restricted to France.

Note: The ties within and between groups are considered, and groups are defined based on the activities of subsidiaries.

Group	E-I Index
Water collection, treatment and supply Sewerage Construction of utility projects for fluids	-0.385
Engineering activities and related technical consultancy (in water related service) Activities of head offices Activities of holding companies Other professional, scientific and technical activities	0.327

Plumbing, heat and air conditioning installation Steam and air conditioning supply Electricity, gas, steam and air conditioning supply	1.000
Other business support service activities (in water related service)	0.392
Activities of parent company (restricted to Veolia Environnement only)	1.000

4.3.2. Suez

Performing E-I index analysis to investigate the business activities of subsidiaries, it has been made clear that in Suez network, prevalent ties with other groups are observed in subsidiaries performing engineering activities and related technical consultancy (in water related service), activities of head offices, activities of holding companies, other professional, scientific and technical activities, and plumbing, heat and air conditioning installation, steam and air conditioning supply, electricity, gas, steam and air conditioning supply. The results are depicted in the table below.

Table 4.17, E-I Index for Suez.

Note: The ties within and between groups are considered, and groups are defined based on the activities of subsidiaries.

Group	E-I Index
Water collection, treatment and supply Sewerage Construction of utility projects for fluids	-0.011
Engineering activities and related technical consultancy (in water related service) Activities of head offices Activities of holding companies Other professional, scientific and technical activities	0.716
Plumbing, heat and air conditioning installation Steam and air conditioning supply Electricity, gas, steam and air conditioning supply	0.892
Other business support service activities (in water related service)	0.558
Activities of parent company (restricted to Veolia Environnement only)	1.000

Unknown activity related to water services	0.550

Similar to Veolia, Suez has also started its activity as a French company, the figure below shows the subsidiaries located in France that have been extracted and the network of parent-subsidiary is visualised:

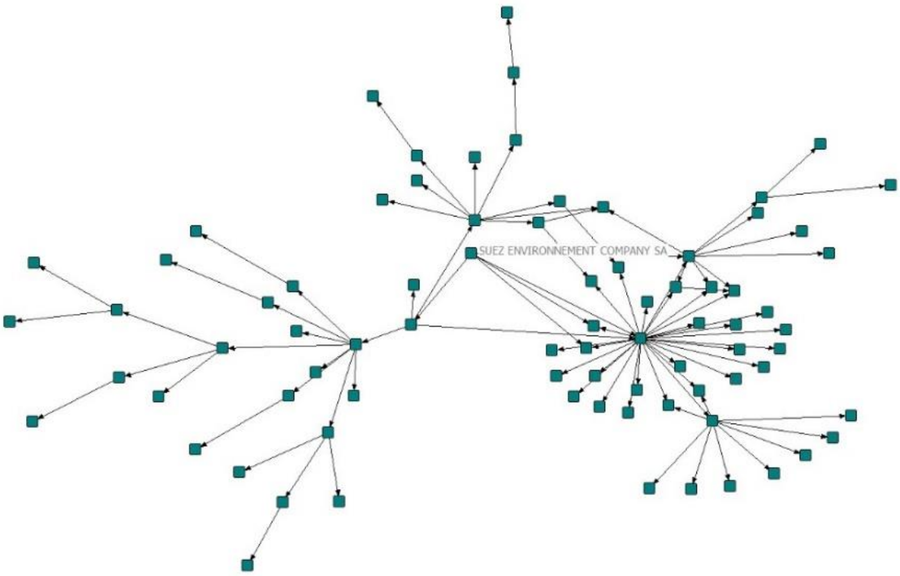

Figure 4.19, Suez's Parent-Subsidiary Network, restricted to France.

Note: The network represents the ties between Suez and its subsidiaries in France only.

Having analysed the ties and specifically business activities of Suez subsidiaries in France using E-I index, it is found that prevalent ties with the same group are present in subsidiaries performing: water collection, treatment, supply, sewerage, and construction of utility projects for fluids, but the tendency is towards having ties with other groups and not within groups. The table below shows the results for E-I index analysis for Suez network in France.

Table 4.18, E-I Index for Suez, restricted to France.

Note: The ties within and between groups are considered, and groups are defined based on the activities of subsidiaries.

Group	E-I Index
Water collection, treatment and supply Sewerage Construction of utility projects for fluids	-0.477

Engineering activities and related technical consultancy (in water related service) Activities of head offices Activities of holding companies Other professional, scientific and technical activities	0.317
Plumbing, heat and air conditioning installation Steam and air conditioning supply Electricity, gas, steam and air conditioning supply	1.000
Other business support service activities (in water related service)	0.789
Activities of parent company (restricted to Veolia Environnement only)	1.000
Unknown activity related to water services	1.000

In this part, the patterns of relationships between subsidiaries in terms of their geographical and economic regions as well as their business activities have been analysed and discussed using blockmodeling and E-I index. The Conclusions below discuss the results in view of international business concepts and theories.

5. Conclusions

The aim of this part of the work was to shed some light on the structure, geographical location and activities of two successful environmental services companies, whose presence has been clearly observed in the previous chapters and within the associated literature. The two companies seem to have followed different foreign penetration strategies. While Suez subsidiaries tend to have ties to those in countries which are geographically close or economically similar, ties between Veolia's subsidiaries show more variations. Suez is also active in a smaller scale compared to Veolia, based on the number of countries its subsidiaries are distributed in. In terms of interaction of subsidiaries based on activity, the global pattern differs from what is observed in France for both companies, but overall subsidiaries seem to be closely working with those carrying out both similar and different activities. It should be noted here that these observations are made on the parent-subsidiary networks of these two companies at one point in time, and the data used does not represent changes in the networks over time.

The parent-subsidiary data for both companies suggest that their presence, through the existence of subsidiaries, is much more visible in European countries. But the data presented in paper 2 clearly shows that both companies have been involved in water projects in low and middle-income countries. If we inspect the World Bank PPI database, we see the names of some subsidiaries of both companies, such as Aguas de Barcelona (Suez) and Vivendi (Veolia Environnement); from this observation, we can deduce that the strong presence of these two companies in PPI project reported in the database has not been strictly through their local subsidiaries, rather through their headquarters. Furthermore, the blockmodeling results suggest that interaction between subsidiaries, in the form of ownership which could be as a proxy to sharing information, is more or less between those in higher income countries.

These results can be explained through the lenses of the above-mentioned OLI paradigm, according to which MNEs' foreign investment choices depend on the combination of three types of competitive advantages related to ownership, location, and internalisation. For both companies, Veolia Environnement and Suez, the ownership advantage can be seen as a powerful driver for FDI in the form of having foreign subsidiaries, and essentially why these two companies have become MNEs. Ownership advantages tend to be generated from monopolistic intangible assets, for example brand names, corporate cultures, and proprietary technologies. Given the history of the two companies, and their strong hold of their local markets (France), we can deduce that they have both been using their ownership advantages which has resulted in their global expansion and increased competitiveness. The literature also suggests that subsidiaries can contribute to ownership or firm specific advantages of a MNE, but to be able to comment on the role of subsidiaries we need to have more information about their internal resources, their leadership and entrepreneurial culture, and their autonomy (Birkinshaw et al., 1998). At the same time, location advantages can explain why the two companies have most of their subsidiaries in European and higher income countries. What drives the decision on where to invest can be dependent on whether the location is institutionally friendly, and offers better regulation systems and investment protection mechanisms, as well as having low entry barriers (Dunning & Lundan, 2008); countries where Veolia and Suez have stronger presence tend to fulfil these characteristics. But one must remember that the location advantages that the two companies seem to be taking advantage of are very much interlinked with the host countries' attitude towards private involvement in water sector, in this specific case. The third advantage, internalisation advantage, explains why some activities have been carried out within a company, while others have been done through arms-length transactions. Considering results seen in paper 2 on shares held by these two companies in PPI projects, we can see that both Veolia and Suez, but more specifically Suez, have found more advantage in carrying out projects in collaboration with other companies, through local or foreign subsidiaries, but their shares seems to make them leader in the projects. Therefore, although the activities are not restricted to internal structures of the two companies, they seem to prefer to have control over their partnerships.

To conclude, through OLI paradigm, it has been tried to discuss some aspects of the two companies which have been observed through the analysis on their parent-subsidiary networks and their involvement in PPI water projects analysed in paper 3. As mentioned previously, the interesting cases of these two companies have inspired this study, therefore it only seems befitting to discuss them, even to a descriptive extent, in this work.

Conclusion

This thesis set out to investigate different aspects of private participation in the water sector, paying specific attention to the interactions of governments and private companies and how such relationships can influence their future interactions.

The different papers presented in this work provide an original contribution to the knowledge of the field, both individually and as a set of interrelated studies. As previously mentioned, the literature on PPIs tend to investigate case studies; these case studies can be country or regional studies; and those that take a more comprehensive approach usually discuss the trends and patterns of private involvement in the sector in a review format or from policy perspective. The originality of this work is that it brings together various disciplines and uses different methods to investigate PPIs on a global level and from different perspective. What this study does differently from the works in the water literature is to consider private involvement around the world to be interlinked with each other, and consider the entities involved, i.e. private companies and governments, to form a network based on the relationship they form for carrying out water projects. The network evolves as the years go by and the relationships between companies and governments change, but nevertheless the interdependencies raised from being part of this network remain for the entities involved. In this work, unlike most of the previous studies, focus is on these interdependencies, and specifically embeddedness of private companies and governments in the network that maps their alliances and collaborations.

The first paper provided a review of the literature on PPIs, by looking at the different types, the history, and the issues that have been discussed by previous studies. It also briefly looked at some works in the area of interorganisational studies; by considering the governments and companies as "organisation", we are evidently investigating relationships between organisations. The aim of this paper was to set out the scene for the rest of this thesis. The water sector has been the subject of a lot of studies, and it possesses unique characteristics because of the nature of services that are involved. Hence it was deemed essential to provide a detailed review of what has already been done on PPIs.

The second paper focused entirely on the data obtained from the world bank on PPIs in the water sector. This paper and the following one formed the major part of this thesis. The data is undoubtedly a rich one, with information being reported on various aspects of the projects. But, although exploring the different variables in the data led to some interesting insights on the trends of PPI in the sector, which were reaffirmations of cases studies in the literature, it became evident that more thorough analysis can unveil more information about what has been going on in the sector since late 1940s. In this paper, I paid some specific attention to the case of China, which has followed a different trend in PPI compared to the rest of the world. I attempted to reduce the dimensionality of the data and find patterns between those variables describing the nature of projects by using multiple correspondence analysis. Although the MCA did not go beyond corroborating existing evidence on differences related to time and space, as well as type of projects and sub-sectors, it confirmed the good quality of the dataset and its usefulness as an instrument of analysis; this exploratory analysis was useful for better understanding the dataset. Furthermore, the data was descriptively looked at from a social network analysis perspective; based on the relationships between governments and private companies involved in projects, a network is formed at each step in time. The visualisation of the networks of both government-company and company-company relationships revealed that the majority of the entities involved have formed a rather large component; this was a further confirmation on the impact the interdependencies can have on their relationships and that we should pay specific attention to the sector as a whole.

The third paper constitutes the bigger part of the analysis of the data described in the second paper. In this paper, the relationship formed between the governments and private companies, as well as those between private companies themselves, are considered as strategic alliances. Hypotheses are set out to answer how governments and private companies form alliances with each other. To analyse the data and address the hypotheses, a dyadic dataset is constructed with different variables associated to each hypothesis and in-line with the literature on alliance formations. General method of moments was then used to estimate a count panel regression model on the data, on a global level, at certain periods in time which have been highlighted by the history of PPIs, and without the presence of China where PPIs have followed a different trend. The results were very interesting and almost all hypotheses were supported. In particular, it was shown that not only do PPI ties depend on the past history of collaboration between the two entities involved (a government and a company, or two companies with each other), but also on the structure of the network in which these ties are embedded. The position of each of these entities in the network, as measured by their centrality, is particularly relevant. This finding confirms the importance of taking a systemic view and take each particular case study as part of a whole. Given the specific characteristics of the sector, the results needed to be discussed in light of the events in the sector and PPI unique features.

The fourth paper looked at two multinational environmental services companies, Veolia Environnement and Suez, which their presence and dominance in the water sector have been highlighted by the literature and in the data used in papers 2 and 3. The parent-subsidiary networks of the two companies were analysed, both descriptively and using some network metrics, as well as using blockmodeling, to understand their geographical penetration and varying business activities on a global level. The results could be discussed using the eclectic paradigm. The purpose of this paper was to zoom in to two cases, which were the reasons this study initiated.

This thesis has attempted to contribute to the knowledge of private participation in the water sector but taking a novel approach of mixing statistical and network analysis methods, to investigate the PPIs in their entirety and from a global perspective. By framing the problem as a dynamic panel data model for a count dependent variable and using a GMM estimator, this study has remained close to the applied econometrics tradition, aiming to detect the factors that shape tie formation while controlling for the interdependencies that arise from the relational structure of the data. Although paper 3 and the results of the GMM estimation comprise the most important analysis of this thesis, in papers 2 and 4 other analytical tools and methods are used as well. The tools used in paper 2 have made it possible to gain a thorough understanding of the data and its different dimensions. Network visualisation tools have illustrated the complex relationships between governments and private companies, and the ‘global’ nature of the network built upon the premises of PPI contracts. The MCA approach revealed the key structuring information from the dataset, not only identifying the dividing lines along spatio-temporal dimensions but also related to technical aspects of water projects. In paper 4, where two environmental services companies are looked into, blockmodeling and network measures and metrics brought into light the specificities of the geographical penetration and activities of these companies. The blockmodeling specifically was a useful tool to determine the interaction of the subsidiaries of these companies on a global level, revealing whether and how these interactions are focused in specific regions.

The data, as mentioned before, is rather rich in details, and provides perfect opportunity for further studies using different methods, specifically statistical approaches that model the structure of the network itself instead of just controlling it. The data on company-company networks can be analysed using Separable Temporal Exponential Random Graph Models (STERGMs), which are an extension of Exponential Random Graphs Models (ERGMs), for modelling dynamic networks in discrete time (Krivitsky & Handcock, 2014). Standard ERGM can also be used which would allow for temporal insights, it yet would have to analyse the government-company and company-company ties separately. However, a problem to solve is how to account for the count nature of the dependent variable and its skewed distribution, aspects that current developments of ERGM take only partly into account. Another option for analysis of the data is using Multilevel ERGM (Wang et al., 2013); this model would allow to simultaneously analyse government-company and company-company ties, and to model the dependencies between government-company ties and company-company alliances. However, this is a cross sectional model, since it is not a temporal model, it would have to run one model for each year, or aggregate, or aggregate into groups of time periods. Obviously, it could only be applied to the cases in which projects were awarded jointly to an alliance or consortium of companies. Longitudinal multilevel network models, such as those proposed by Snijders et al. (2013) and Stadtfeld et al. (2016), could be used to investigate whether a company's choice of government partner co-evolves with its alliance network. But such study should be done with caution as it assumes the company is the one selecting the government partner, and it is in full control of the relationship, which may not be the case given the nature of the sector and PPIs.

The above methods are further analytical ways of investigating the same data used in this study. But, further work can be done by enriching the data or the time frames of investigation. The data used in this study comes from one source; it has already been mentioned that I will be attempting to construct a more comprehensive dataset on various aspects of PPI in the world using different sources [32]. Although the data for papers 2,3, and 4 come from credible databases, there may be cases when the information provided is not fully accurate. For the data on PPIs, the issue of missing information when it comes to the multilateral support dimension meant that this study could not include this aspect in the analysis. Also, the absence of an actual end date for the projects in the data had to be dealt in when building variables for the regression estimated with GMM. Although these limitations of the World Bank data did not prevent useful analyses from being conducted, they also point to the intrinsic interest of a work that would further enrich the dataset. One objective for the near future is to complete the existing data using a wider variety of sources. In paper 4, where Orbis database was used for the two environmental services companies, the main issue was missing information about the activities of the subsidiaries. This was dealt with by considering the relationships between different levels of subsidiaries in an attempt to include every subsidiary involved directly or indirectly in water services. While availability of more details on the nature of the activities of subsidiaries would certainly enrich the analysis, to the best of my knowledge there has been no attempt to collect such data on a systematic basis so far.

The methods used in this study can then be implemented on the new dataset. The literature argues that there is a recent revival in policy support for privatisation, and in particular for PPIs (or PPPs) in infrastructure sectors in general. It has been stated that although this revival is closely linked to previous initiatives, it is different in some ways since the global finance seems to be playing a more central role (Bayliss & Van Waeyenberge, 2017). In water sector specifically, while there was little interest in private investors in 1990s and 2000s, the move for PPP pipelines, which separate water treatment plants from the rest of the utility services, can be seen now; in this way, the investor risk is minimised since bulk water can be produced and sold to the water utility "under a fixed price contract for a specified minimum level of demand for decades" (Bayliss & Van Waeyenberge, 2017: 5). These new developments would undoubtedly alter the data in a few years and can be analysed again to see variations of governments and companies' relationships. Also, since global finance has become a very important factor, further analysis can take relationships between governments, companies, and financing bodies all into consideration. Another area of further research, which has already

[32] The project to construct a comprehensive dataset on PPI in water sector will be done with the aid of William R. Waters Research Grant (The Association for Social Economics) that I have received in January 2017.

attracted much attention is the case of China. PPIs were on the rise in China, while the global trend was on the decline, and there is a still a push in China to attract private companies' involvement. But, it is argued that most of the PPIs in China actually involve state-owned companies (Bloomberg, 2017). Hence, it will be very interesting to focus on the case of China, not only exploring the trends of PPI, but also tracing the companies involved to provide a more thorough understanding of the country's attitude towards private involvement.

These areas and methods are just a number of suggestions for future study. These being said, I believe this thesis and the results obtained can be very beneficial to scholars and policy makers interested in PPIs in general, and in water sector in particular. In terms of scholarly implications, this study not only adds to the body of literature on privatisation in the water sector, but it provides a different perspective, signalling the advantages of using variety of methods, some closer to organisational studies, and considering the setting to be global. For private companies involved in PPIs, including but not restricted to water projects, the study is beneficial in understanding the underlying reasons for the evolving relationships with governments, based on being part of this global web of relationships. Companies can see the advantage of being strategically positioned in these networks and how they could enhance their business profile by altering their views about collaboration. For policy makers, this research could reveal the pattern of interest for PPIs worldwide, and how despite the controversies and debates, there are still PPIs running in most regions, and especially in China. The pattern of involvement of different companies in various regions can help in aligning the policies with how the PPI setting is changing.

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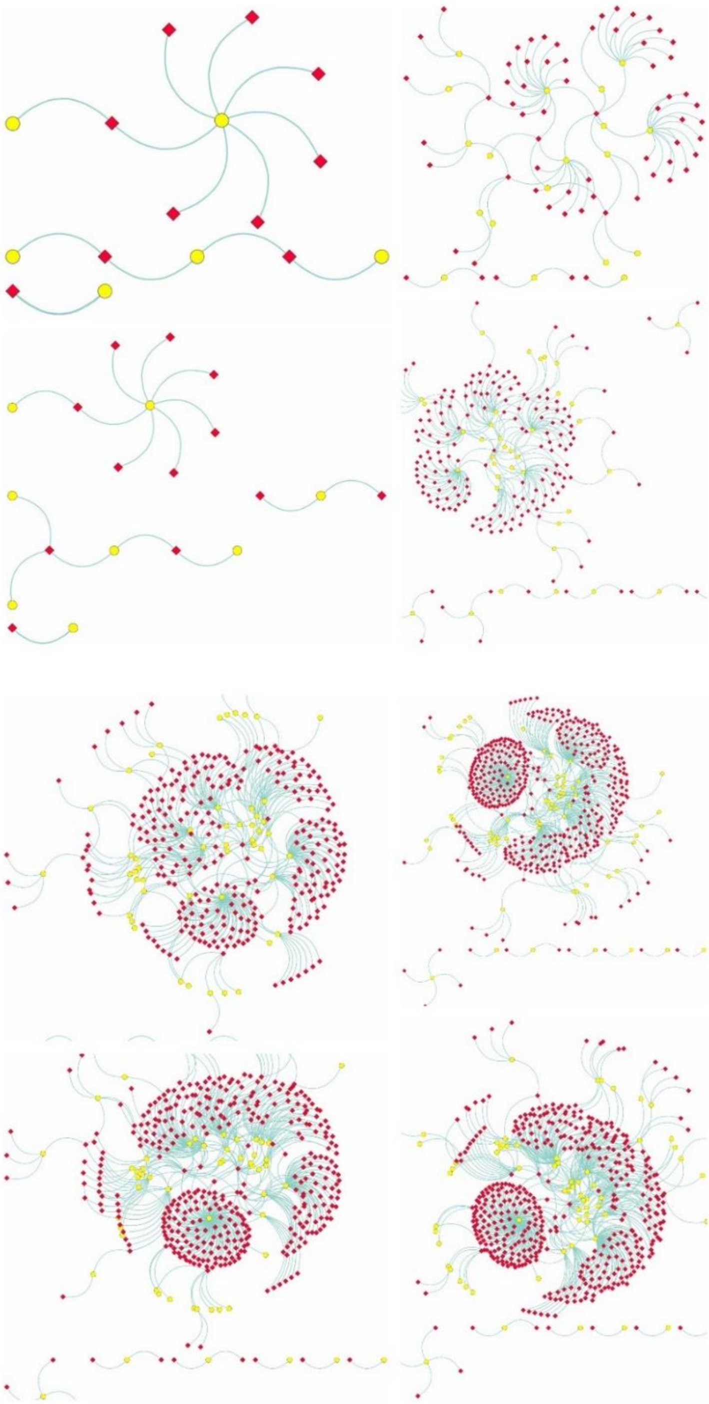
Appendix 1: Government-Company Network Images through Time



Snapshots of Government-Company Network Through Time, Based on Start of Project, Starting from 1989 to 2016.

Appendix 2: MCA Detailed Results

Description of the plane 1:2

The **dimension 1** does not sufficiently discriminate individuals

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The **dimension 2** does not sufficiently discriminate individuals

Description of the plane 3:4

Dimension 3

The group 1 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture* and *Segment=Potable water treatment plant* (factors are sorted from the most common)
- low frequency for the factors *SubtypeofPPI=Rehabilitate, operate, and transfer* and *TypeofPPI=Brownfield* (factors are sorted from the rarest)

The group 2 (characterized by a positive coordinate on the axis) is sharing:

- factors whose frequency does not differ significantly from the mean

The group 3 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the variable *Projectstatus=Cancelled*
- low frequency for the variable *Projectstatus=Active*

The group 4 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Water utility with sewerage* and *Projectstatus=Cancelled* (factors are sorted from the most common)
- low frequency for the variable *Projectstatus=Active*

The group 5 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture*, *Segment=Water utility without sewerage* and *Subsector=Water Utility* (factors are sorted from the most common)
- low frequency for the factors *Subsector=Treatment plant*, *SubtypeofPPI=Rehabilitate, operate, and transfer* and *TypeofPPI=Brownfield* (factors are sorted from the rarest)

The group 6 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Region=Latin America and the Caribbean*, *Segment=Water utility with sewerage*, *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture* and *Subsector=Water Utility* (factors are sorted from the most common)
- low frequency for the factors *Segment=Sewerage treatment plant*, *Segment=Potable water treatment plant*, *Subsector=Treatment plant*, *SubtypeofPPI=Rehabilitate, operate, and transfer*, *TypeofPPI=Brownfield* and *Region=East Asia and Pacific* (factors are sorted from the rarest)

The group 7 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Region=Europe and Central Asia* and *Segment=Water utility with sewerage* (factors are sorted from the most common)
- low frequency for the variable *Region=East Asia and Pacific*

The group 8 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Potable water treatment plant*, *Subsector=Treatment plant*, *SubtypeofPPI=Rehabilitate, operate, and transfer*, *TypeofPPI=Brownfield* and *Region=East Asia and Pacific* (factors are sorted from the most common)
- low frequency for the factors *Region=Latin America and the Caribbean*, *Segment=Water utility with sewerage*, *Segment=Water utility without sewerage*, *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture*, *Segment=Sewerage treatment plant* and *Subsector=Water Utility* (factors are sorted from the rarest)

The group 9 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Sewerage treatment plant*, *Subsector=Treatment plant*, *SubtypeofPPI=Rehabilitate, operate, and transfer*, *TypeofPPI=Brownfield* and *Region=East Asia and Pacific* (factors are sorted from the most common)
- low frequency for the factors *Region=Latin America and the Caribbean*, *Segment=Water utility with sewerage*, *Segment=Water utility without sewerage*, *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture*, *Segment=Potable water treatment plant* and *Subsector=Water Utility* (factors are sorted from the rarest)

The group 10 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Water utility without sewerage*, *Subsector=Water Utility*, *SubtypeofPPI=Rehabilitate, operate, and transfer* and *TypeofPPI=Brownfield* (factors are sorted from the most common)
- low frequency for the factors *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture*, *Segment=Sewerage treatment plant*, *Segment=Potable water treatment plant* and *Subsector=Treatment plant* (factors are sorted from the rarest)

Note that the factor *Divestiture* is highly correlated with the dimension (correlation of 002) This factor could therefore summarize itself the dimension 3

Dimension 4

The group 1 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Potable water treatment plant*, *Subsector=Treatment plant*, *SubtypeofPPI=Rehabilitate, operate, and transfer*, *TypeofPPI=Brownfield* and *Region=East Asia and Pacific* (factors are sorted from the most common)
- low frequency for the factors *Region=Latin America and the Caribbean*, *Segment=Water utility with sewerage*, *Segment=Water utility without sewerage*, *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture*, *Segment=Sewerage treatment plant* and *Subsector=Water Utility* (factors are sorted from the rarest)

The group 2 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Water utility without sewerage*, *Subsector=Water Utility*, *SubtypeofPPI=Rehabilitate, operate, and transfer* and *TypeofPPI=Brownfield* (factors are sorted from the most common)
- low frequency for the factors *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture*, *Segment=Sewerage treatment plant*, *Segment=Potable water treatment plant* and *Subsector=Treatment plant* (factors are sorted from the rarest)

The group 3 (characterized by a negative coordinate on the axis) is sharing:

- factors whose frequency does not differ significantly from the mean

The group 4 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Water utility with sewerage* and *Projectstatus=Cancelled* (factors are sorted from the most common)
- low frequency for the variable *Projectstatus=Active*

The group 5 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *Region=Latin America and the Caribbean*, *Segment=Water utility with sewerage*, *SubtypeofPPI=Partial*, *TypeofPPI=Divestiture* and *Subsector=Water Utility* (factors are sorted from the most common)
- low frequency for the factors *Segment=Sewerage treatment plant*, *Segment=Potable water treatment plant*, *Subsector=Treatment plant*, *SubtypeofPPI=Rehabilitate, operate, and transfer*, *TypeofPPI=Brownfield* and *Region=East Asia and Pacific* (factors are sorted from the rarest)

The group 6 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *Region=Europe and Central Asia* and *Segment=Water utility with sewerage* (factors are sorted from the most common)
- low frequency for the variable *Region=East Asia and Pacific*

Description of the plane 5:6

Dimension 5

The group 1 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Potable water treatment plant*, *Subsector=Treatment plant*, *TypeofPPI=Greenfield project*, *SubtypeofPPI=Build, own, and operate*, *Region=East Asia and Pacific*, *Projectstatus=Cancelled* and *SubtypeofPPI=Build, operate, and transfer* (factors are sorted from the most common)
- low frequency for the factors *Projectstatus=Active*, *Projectstatus=Concluded*, *Region=South Asia*, *Segment=Water utility without sewerage*, *SubtypeofPPI=Management contract*, *Region=Europe and Central Asia*, *SubtypeofPPI=Lease contract*, *Segment=Water utility with sewerage*, *Subsector=Water Utility* and *TypeofPPI=Management and lease contract* (factors are sorted from the rarest)

The group 2 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Management contract*, *Segment=Water utility without sewerage*, *Region=South Asia*, *Subsector=Water Utility*, *Projectstatus=Concluded*, *TypeofPPI=Management and lease contract* and *Region=Middle East and North Africa* (factors are sorted from the most common)
- low frequency for the factors *SubtypeofPPI=Build, operate, and transfer*, *SubtypeofPPI=Build, own, and operate*, *Region=East Asia and Pacific*, *Projectstatus=Cancelled*, *SubtypeofPPI=Lease contract*, *Region=Europe and Central Asia*, *TypeofPPI=Greenfield project*, *Subsector=Treatment plant* and *Segment=Potable water treatment plant* (factors are sorted from the rarest)

The group 3 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Lease contract*, *Region=Europe and Central Asia*, *Segment=Water utility with sewerage*, *TypeofPPI=Management and lease contract*, *Subsector=Water Utility* and *Projectstatus=Active* (factors are sorted from the most common)
- low frequency for the factors *Region=East Asia and Pacific*, *SubtypeofPPI=Build, operate, and transfer*, *Segment=Water utility without sewerage*, *Region=South Asia*, *SubtypeofPPI=Build, own, and operate*, *SubtypeofPPI=Management contract*, *Subsector=Treatment plant*, *Segment=Potable water treatment plant*, *Region=Middle East and North Africa* and *TypeofPPI=Greenfield project* (factors are sorted from the rarest)

Dimension 6

The group 1 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Lease contract*, *Region=Europe and Central Asia*, *Segment=Water utility with sewerage*, *TypeofPPI=Management and lease contract*, *Subsector=Water Utility* and *Projectstatus=Active* (factors are sorted from the most common)
- low frequency for the factors *Region=East Asia and Pacific*, *SubtypeofPPI=Build, operate, and transfer*, *Segment=Water utility without sewerage*, *Region=South Asia*, *SubtypeofPPI=Build, own, and operate*, *SubtypeofPPI=Management contract*, *Subsector=Treatment plant*, *Segment=Potable water treatment plant*, *Region=Middle East and North Africa* and *TypeofPPI=Greenfield project* (factors are sorted from the rarest)

The group 2 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Potable water treatment plant*, *Subsector=Treatment plant*, *TypeofPPI=Greenfield project*, *SubtypeofPPI=Build, own, and operate*, *Region=East Asia and Pacific*, *Projectstatus=Cancelled* and *SubtypeofPPI=Build, operate, and transfer* (factors are sorted from the most common)
- low frequency for the factors *Projectstatus=Active*, *Projectstatus=Concluded*, *Region=South Asia*, *Segment=Water utility without sewerage*, *SubtypeofPPI=Management contract*, *Region=Europe and Central Asia*, *SubtypeofPPI=Lease contract*, *Segment=Water utility with sewerage*, *Subsector=Water Utility* and *TypeofPPI=Management and lease contract* (factors are sorted from the rarest)

The group 3 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Management contract*, *Segment=Water utility without sewerage*, *Region=South Asia*, *Subsector=Water Utility*, *Projectstatus=Concluded*, *TypeofPPI=Management and lease contract* and *Region=Middle East and North Africa* (factors are sorted from the most common)
- low frequency for the factors *SubtypeofPPI=Build, operate, and transfer*, *SubtypeofPPI=Build, own, and operate*, *Region=East Asia and Pacific*, *Projectstatus=Cancelled*, *SubtypeofPPI=Lease contract*, *Region=Europe and Central Asia*, *TypeofPPI=Greenfield project*, *Subsector=Treatment plant* and *Segment=Potable water treatment plant* (factors are sorted from the rarest)

Description of the plane 7:8

Dimension 7

The group 1 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Water utility without sewerage*, *SubtypeofPPI=Lease contract*, *Region=Sub-Saharan Africa*, *Subsector=Water Utility*, *SubtypeofPPI=Build, rehabilitate, operate, and transfer*, *Projectstatus=Cancelled*,

SubtypeofPPI=Build, operate, and transfer and *TypeofPPI=Greenfield project* (factors are sorted from the most common)
- low frequency for the factors *Region=Middle East and North Africa*, *Projectstatus=Active*, *TypeofPPI=Management and lease contract*, *Region=South Asia*, *Segment=Water utility with sewerage*, *Subsector=Treatment plant*, *Segment=Sewerage treatment plant* and *SubtypeofPPI=Management contract* (factors are sorted from the rarest)

The group 2 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Region=South Asia*, *SubtypeofPPI=Rehabilitate, lease or rent, and transfer*, *TypeofPPI=Brownfield*, *TypeofPPI=Greenfield project*, *Segment=Potable water treatment plant* and *SubtypeofPPI=Build, own, and operate* (factors are sorted from the most common)
- low frequency for the factors *Segment=Sewerage treatment plant*, *SubtypeofPPI=Management contract*, *TypeofPPI=Management and lease contract* and *Region=East Asia and Pacific* (factors are sorted from the rarest)

The group 3 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Management contract*, *Segment=Sewerage treatment plant*, *TypeofPPI=Management and lease contract*, *Subsector=Treatment plant*, *Region=East Asia and Pacific* and *Region=Middle East and North Africa* (factors are sorted from the most common)
- low frequency for factors like *Segment=Potable water treatment plant*, *Projectstatus=Cancelled*, *SubtypeofPPI=Rehabilitate, lease or rent, and transfer*, *SubtypeofPPI=Build, rehabilitate, operate, and transfer*, *SubtypeofPPI=Build, operate, and transfer*, *Region=Sub-Saharan Africa*, *SubtypeofPPI=Lease contract*, *TypeofPPI=Brownfield*, *TypeofPPI=Greenfield project* and *Region=South Asia* (factors are sorted from the rarest)

Dimension 8

The group 1 (characterized by a positive coordinate on the axis) is sharing:

- high frequency for the factors *Segment=Water utility without sewerage*, *SubtypeofPPI=Lease contract*, *Region=Sub-Saharan Africa*, *Subsector=Water Utility*, *SubtypeofPPI=Build, rehabilitate, operate, and transfer*, *Projectstatus=Cancelled*, *SubtypeofPPI=Build, operate, and transfer* and *TypeofPPI=Greenfield project* (factors are sorted from the most common)
- low frequency for the factors *Region=Middle East and North Africa*, *Projectstatus=Active*, *TypeofPPI=Management and lease contract*, *Region=South Asia*, *Segment=Water utility with sewerage*, *Subsector=Treatment plant*, *Segment=Sewerage treatment plant* and *SubtypeofPPI=Management contract* (factors are sorted from the rarest)

The group 2 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *SubtypeofPPI=Management contract*, *Segment=Sewerage treatment plant*, *TypeofPPI=Management and lease contract*, *Subsector=Treatment plant*, *Region=East Asia and Pacific* and *Region=Middle East and North Africa* (factors are sorted from the most common)
- low frequency for factors like *Segment=Potable water treatment plant*, *Projectstatus=Cancelled*, *SubtypeofPPI=Rehabilitate, lease or rent, and transfer*, *SubtypeofPPI=Build, rehabilitate, operate, and transfer*, *SubtypeofPPI=Build, operate, and transfer*, *Region=Sub-Saharan Africa*, *SubtypeofPPI=Lease contract*, *TypeofPPI=Brownfield*, *TypeofPPI=Greenfield project* and *Region=South Asia* (factors are sorted from the rarest)

The group 3 (characterized by a negative coordinate on the axis) is sharing:

- high frequency for the factors *Region=South Asia*, *SubtypeofPPI=Rehabilitate, lease or rent, and transfer*, *TypeofPPI=Brownfield*, *TypeofPPI=Greenfield project*, *Segment=Potable water treatment plant* and *SubtypeofPPI=Build, own, and operate* (factors are sorted from the most common)
- low frequency for the factors *Segment=Sewerage treatment plant*, *SubtypeofPPI=Management contract*, *TypeofPPI=Management and lease contract* and *Region=East Asia and Pacific* (factors are sorted from the rarest)

Appendix 3: Correlation Matrices for Government-Company and Company-Company Datasets

Correlation Matrix for Government-Company Dataset.

	AllianceFormation	Lagged AllianceFormation	Reinvest	Terminations	PastTerminations	N_SuccessfulAlliances
AllianceFormation	1.0000					
Lagged AllianceFormation	0.4503	1.0000				
Reinvest	0.1020	0.1135	1.0000			
Terminations	0.1333	0.1854	0.0438	1.0000		
PastTerminations	0.0176	0.0395	0.0053	0.1002	1.0000	
N_SuccessfulAlliances	0.4054	0.7699	0.0988	0.3010	0.0575	1
AllianceVsSuccessfulAlliance	-0.0560	-0.1643	-0.1268	-0.1388	-0.0361	-0.1298
Lagged GDegree	0.1434	0.2164	0.0178	0.0487	0.0101	0.2220
Lagged CDegree	0.0730	0.1421	0.0350	0.0566	0.0399	0.1138
Lagged DegreeSimilarity	0.0980	0.0907	0.0287	0.0377	0.0182	0.1018
DistCapt	-0.0373	-0.0366	-0.0155	-0.0266	-0.0244	-0.0429
RegionSim	0.0407	0.0397	0.0186	0.0233	0.0163	0.0469
IncomeSim	0.0156	0.0142	0.0061	0.0068	0.0009	0.0171
RelativeIncome	-0.0130	-0.0117	-0.0048	-0.0050	0.0008	-0.0141
LangSim	0.0494	0.0472	0.0253	0.0322	0.0311	0.0545
ColonialHist_NoHist	-0.0075	-0.0080	-0.0122	-0.0144	-0.0343	-0.0068
ColonialHist_ColoniserColony	0.0074	0.0079	0.0122	0.0138	0.0344	0.0066
ColonialHist_ColonyColoniser	0.0019	0.0021	-0.0001	0.0087	-0.0002	0.0036

Continued on the next page.

	AllianceVsSuccessfulAlliance	Lagged GDegree	Lagged CDegree	Lagged DegreeSimilarity	DistCapt	RegionSim
AllianceVsSuccessfulAlliance	1.0000					
Lagged GDegree	-0.0581	1.0000				
Lagged CDegree	-0.0775	0.0640	1.0000			
Lagged DegreeSimilarity	-0.0508	0.5532	0.3972	1.0000		
DistCapt	0.0212	0.0045	-0.0125	0.0036	1.0000	
RegionSim	-0.0202	0.0529	0.0016	0.0438	-0.5715	1.0000
IncomeSim	-0.0029	0.0672	-0.0250	0.0408	0.0432	0.1258
RelativeIncome	0.0008	-0.0738	0.0321	-0.0431	-0.0495	-0.1080
LangSim	-0.0400	0.0311	0.0012	0.0205	-0.2300	0.3329
ColonialHist_NoHist	0.0310	0.0057	-0.0290	-0.0143	0.0584	0.0158
ColonialHist_ColoniserColony	-0.0311	-0.0057	0.0292	0.0145	-0.0572	-0.0175
ColonialHist_ColonyColoniser	0.0003	-0.0001	-0.0012	-0.0012	-0.0178	0.0222

	IncomeSim	RelativeIncome	LangSim	ColonialHist_ NoHist	ColonialHist_ColoniserColony	ColonialHist_Colony Coloniser
IncomeSim	1.0000					
RelativeIncome	-0.9190	1.0000				
LangSim	0.0697	-0.0671	1.0000			
ColonialHist_NoHist	0.0815	-0.0897	-0.2662	1.0000		
ColonialHist_ColoniserColony	-0.0811	0.0899	0.2672	-0.9970	1	
ColonialHist_ColonyColoniser	-0.0073	0.0010	-0.0033	-0.0760	-0.0013	1

Correlation Matrix for Company-Company Dataset.

	AllianceFormation	Lagged AllianceFormation	Reinvest	Terminations	PastTerminations	N_SuccessfulAlliances
AllianceFormation	1.0000					
Lagged AllianceFormation	0.3161	1.0000				
Reinvest	0.0504	0.1625	1.0000			
Terminations	0.0490	0.0731	-0.0002	1.0000		
PastTerminations	0.0993	0.0530	-0.0002	0.0596	1.0000	
N_SuccessfulAlliances	0.1798	0.3607	0.0912	0.0227	0.0229	1.0000
AllianceVsSuccessfulAlliance	-0.1484	-0.5408	-0.1500	-0.3208	-0.0523	-0.1053
Lagged LowShareAlliances	0.1183	0.1141	-0.0001	-0.0003	0.0884	0.0078
Lagged CjDegree	0.0350	0.0863	0.0069	0.0146	0.0152	0.0221
Lagged ChDegree	0.0351	0.0840	0.0098	0.0111	0.0147	0.0221
Lagged DegreeSimilarity	0.0226	0.0192	0.0065	0.0086	0.0105	0.0087
N_CommonAlliances	0.0079	0.0079	0.0009	-0.0010	-0.0009	0.0039
N_GovernmentPartners	0.0755	0.1942	0.0209	0.0056	0.0261	0.1661
DistCapt	-0.0316	-0.0302	-0.0092	-0.0180	-0.0152	-0.0012
RegionSim	0.0255	0.0237	0.0082	0.0114	0.0059	-0.0016
IncomeSim	0.0168	0.0156	0.0038	0.0053	0.0009	0.0043
LangSim	0.0380	0.0352	0.0124	0.0176	0.0091	-0.0015
ColonialHist_ColoniserColony	0.0011	0.0017	0.0001	0.0016	0.0059	-0.0009
ColonialHist_ColonyColoniser	-0.0005	-0.0001	-0.0014	0.0006	0.0059	-0.0009
ColonialHist_NoHist	-0.0004	-0.0012	0.0009	-0.0016	-0.0085	0.0012

Continued on the next page.

	AllianceVsSuccessful Alliance	Lagged LowShareAlliances	Lagged CjDegree	Lagged ChDegree	Lagged DegreeSimilarity	N_CommonAlliances
AllianceVsSuccessfulAlliance	1.0000					
Lagged LowShareAlliances	-0.1104	1.0000				
Lagged CjDegree	-0.0625	0.0130	1.0000			
Lagged ChDegree	-0.0596	0.0130	0.0453	1.0000		
Lagged DegreeSimilarity	-0.0230	0.0075	0.5300	0.5300	1.0000	
N_CommonAlliances	-0.0295	0.0125	0.0353	0.0353	0.0211	1.0000
N_GovernmentPartners	-0.0855	0.0142	0.0830	0.0830	0.0523	0.0218
DistCapt	0.0553	-0.0188	-0.0171	-0.0171	-0.0172	-0.0319
RegionSim	-0.0441	0.0143	0.0062	0.0062	0.0003	0.0162
IncomeSim	-0.0245	0.0081	-0.0010	-0.001	0.0001	0.0071
LangSim	-0.0674	0.0209	0.0004	0.0004	-0.0097	0.0331
ColonialHist_ColoniserColony	-0.0048	-0.0013	0.0137	-0.0100	0.0037	0.0056
ColonialHist_ColonyColoniser	0.0015	-0.0013	-0.0100	0.0137	0.0037	0.0056
ColonialHist_NoHist	0.0024	0.0019	-0.0027	-0.0027	-0.0053	-0.0080

	N_GovernmentPartners	DistCapt	RegionSim	IncomeSim	LangSim
N_GovernmentPartners	1				
DistCapt	-0.0378	1.0000			
RegionSim	0.0320	-0.7141	1.0000		
IncomeSim	0.0145	-0.1249	0.4039	1.0000	
LangSim	0.0322	-0.3763	0.3857	0.2104	1.0000
ColonialHist_ColoniserColony	-0.0039	-0.0115	-0.0790	-0.0980	0.2572
ColonialHist_ColonyColoniser	-0.0039	-0.0115	-0.0790	-0.0980	0.2572
ColonialHist_NoHist	0.0056	0.0165	0.1129	0.1400	-0.3676

Continued on the next page.

	ColonialHist_ColoniserColony	ColonialHist_ColonyColoniser	ColonialHist_NoHist
ColonialHist_ColoniserColony	1.0000		
ColonialHist_ColonyColoniser	-0.0208	1.0000	
ColonialHist_NoHist	-0.6997	-0.6997	1.0000

Appendix 4: Location and Activity-Location of Veolia and Suez Subsidiaries

List of Location (Countries) for Veolia Environnement's Subsidiaries

Andorra	Germany	Poland
Angola	Great Britain	Portugal
Argentina	Hong Kong	Qatar
Armenia	Hungry	Romania
Australia	Ireland	Russia
Austria	Israel	Saudi Arabia
Belgium	Italy	Senegal
Benin	Japan	Serbia
Brazil	Jordan	Singapore
Bulgaria	Korea, Republic Of	Slovakia
Burkina Faso	Latvia	South Africa
Canada	Lebanon	Spain
Chile	Libya	Sweden
China	Malaysia	Switzerland
Colombia	Mexico	Taiwan
Cote D'Ivoire	Monaco	Thailand
Czech Republic	Morocco	Tunisia
Denmark	Namibia	Turkey
Egypt	Netherlands	Ukraine
Equatorial Guinea	Norway	United Arab Emirates
Estonia	Oman	USA
France	Peru	Venezuela
Gabon	Philippines	Vietnam

List of Location (Countries) for Suez's Subsidiaries

Argentina	Germany	Peru
Australia	Great Britain	Poland
Belgium	Greece	Portugal
Brazil	Hong Kong	Russia
Canada	Hungry	Slovenia
Chile	India	South Africa
China	Italy	Spain
Colombia	Japan	Switzerland
Cuba	Mexico	Turkey
Czech Republic	Morocco	USA
Finland	Netherlands	Venezuela
France	New Zealand	

Activities in Countries for Veolia Environnement's Subsidiaries

Country	Activity
Andorra	Unknown activity related to water services
Angola	Unknown activity related to water services
Argentina	Unknown activity related to water services
Armenia	Unknown activity related to water services
Australia	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Other business support service activities (in water related service)
	Unknown activity related to water services
Austria	Unknown activity related to water services
Belgium	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Other business support service activities (in water related service)
Benin	Unknown activity related to water services
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
Brazil	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Unknown activity related to water services

Bulgaria	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Burkina Faso	Unknown activity related to water services
Canada	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Chile	Unknown activity related to water services
China	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Colombia	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Cote D'Ivoire	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Czech Republic	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
Denmark	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Egypt	Unknown activity related to water services
Equatorial Guinea	Unknown activity related to water services
Estonia	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
France	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply

	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
Gabon	Unknown activity related to water services
Germany	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Unknown activity related to water services
Great Britain	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
Hong Kong	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Hungry	Unknown activity related to water services
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
Ireland	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids

	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Israel	Other business support service activities (in water related service)
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Unknown activity related to water services
Italy	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Other business support service activities (in water related service)
	Unknown activity related to water services
Japan	Unknown activity related to water services
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Other business support service activities (in water related service)
Jordan	Unknown activity related to water services
Korea, Republic Of	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Latvia	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Lebanon	Unknown activity related to water services
Libya	Unknown activity related to water services
Malaysia	Unknown activity related to water services

Mexico	Unknown activity related to water services
Monaco	Unknown activity related to water services
Morocco	Unknown activity related to water services
Namibia	Unknown activity related to water services
Netherlands	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Unknown activity related to water services
	Other business support service activities (in water related service)
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
Norway	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
Oman	Other business support service activities (in water related service)
	Unknown activity related to water services
Peru	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Philippines	Unknown activity related to water services
Poland	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Unknown activity related to water services
	Other business support service activities (in water related service)
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Portugal	Unknown activity related to water services

	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Qatar	Unknown activity related to water services
Romania	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Russia	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Saudi Arabia	Unknown activity related to water services
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Senegal	Unknown activity related to water services
Serbia	Other business support service activities (in water related service)
Singapore	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Slovakia	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
South Africa	Unknown activity related to water services
Spain	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply

	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Unknown activity related to water services
Sweden	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Switzerland	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
	Unknown activity related to water services
Taiwan	Unknown activity related to water services
Thailand	Unknown activity related to water services
Tunisia	Unknown activity related to water services
Turkey	Unknown activity related to water services
Ukraine	Other business support service activities (in water related service)
United Arab Emirates	Unknown activity related to water services
USA	Unknown activity related to water services
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Other business support service activities (in water related service)
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of

	holding companies; Other professional, scientific, and technical activities
Venezuela	Unknown activity related to water services
Vietnam	Unknown activity related to water services

Activities in Countries for Suez's Subsidiaries

Country	Activity
Argentina	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
Australia	Unknown activity related to water services
	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Belgium	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
	Other business support service activities (in water related service)
Brazil	Unknown activity related to water services
	Other business support service activities (in water related service)
Canada	Other business support service activities (in water related service)
Chile	Unknown activity related to water services
	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
China	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
Colombia	Unknown activity related to water services
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Other business support service activities (in water related service)
Cuba	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Czech Republic	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Finland	Other business support service activities (in water related service)

	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
France	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
	Activities of parent company (restricted to Veolia Environnement only)
Germany	Unknown activity related to water services
Great Britain	Other business support service activities (in water related service)
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Unknown activity related to water services
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Greece	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Hong Kong	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
Hungry	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
India	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Italy	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Other business support service activities (in water related service)
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply

	Unknown activity related to water services
Japan	Other business support service activities (in water related service)
Mexico	Other business support service activities (in water related service)
	Unknown activity related to water services
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Morocco	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Other business support service activities (in water related service)
	Unknown activity related to water services
Netherlands	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
New Zealand	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Peru	Unknown activity related to water services
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Poland	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Other business support service activities (in water related service)
Portugal	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
Russia	Other business support service activities (in water related service)
Slovenia	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
South Africa	Unknown activity related to water services
Spain	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
	Engineering activities and related technical consultancy (in water related service); Activities of head offices; Activities of holding companies; Other professional, scientific, and technical activities

	Other business support service activities (in water related service)
	Plumbing, heat, and air conditioning installation; Steam, and air conditioning supply; Electricity, gas, steam, and air conditioning supply
Switzerland	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Other business support service activities (in water related service)
	Unknown activity related to water services
Turkey	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
USA	Other business support service activities (in water related service)
	Water collection, treatment, and supply; Sewerage; Construction of utility projects for fluids
	Unknown activity related to water services
Venezuela	Unknown activity related to water services