

INTRA- AND INTERCITY NETWORKS OF MULTINATIONAL FIRMS (2010-2019)

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Introduction

Globalization induces common global economic rules that are addressed by numerous various local answers (Castells, 2010; Robinson & Roy, 2016), but across the world, the role of cities is to leverage knowledge and information in the network of globally connected exchanges (Scott, 2001; Roy & Ong, 2011; Neal, 2012; Scott & Storper, 2015). According to Grabher and Stark (1997), *“globalization does not displace the properties of localities but makes them all the more salient”* (p.540). Firms that are organized in networks meet together in different cities in which they extend their access to resources by establishing multiple plants. At stake is the local and global coordination of transfers of value through intra- and interfirm networks, resulting in the concentration of wealth in specific firms in specific cities at the expense of other firms and cities, thereby contributing to the increase in interurban inequalities (Hadjimichalis, 1984; Parnreiter in the present volume). Due to the mutual construction and reinforcement between the intraurban networks and the interurban ones, some intraurban properties are linked to global connectiveness. In addition, between local and global scales, state and regional arrangements, such as free trade zones, are identified scales where the actors' strategies meet institutions facilitating or limiting the organizational complexity of the global value chains of firms (Sassen, 2010; Dickens, 2011; Rozenblat, 2018). Thus, global and local networks are mutually dependent in cities, and different intermediary scales shape the actors' strategies operating at multiple spatial scales in order to ensure their stability and their power.

Many questions remain unanswered in the intra- versus interurban networks' analysis, especially the question of how *“to make explicit an implicit and simplistic equating of spatial scale and power”* (Beauregard, 1995, p.241). This question was examined by seminal papers developing reflections on the networking effects of global economic forces on cities (Amin & Thrift, 1992; Sassen, 2000; Bathelt et al., 2004; Massey, 2007; Bathelt & Glückler, 2011; Castells, 2000, 2010). However, in our opinion, the absence of a distinction between scales and levels of processes avoids a better conceptualization of this intertwining between local and global networks and constituting the dynamics of cities (Pflieger, Rozenblat, 2010; Pumain, 2018; Rozenblat & Neal in this volume).

In fact, in this chapter, we argue that the intertwined two-level processes—the one emerging at the city level from the operations of interdependent actors and the other one emerging from the interaction of these urban processes at the systems of cities' level—are not distinct processes occurring at different geographical scale or scope. Instead, if one considers that cities form systems inside systems of cities (Berry, 1964), cities combine two interacting levels inside the same dynamics: the cities as systems (meso-level) and the systems of cities (macrolevel) (Rozenblat, 2010). The system of cities itself consists of different scales of geographic scopes and institutional organizations that are or are not nested. At stake in the mutual adaptation of these meso- and macrolevels are adaptive cycles permitting or not permitting individuals or firm strategies (microlevel) to blossom within the context of the lining up of local and global forces. We consider cities such as Liverpool or Detroit that flourished in their industrial heyday

but then missed out on the transformational process involving a fundamental transition to the new forms of the economy of the 1990s. The local actors' networks as well as their global linkages are in question in the collapse of these cities' economies. However, later in the 2010s, thanks to strong policies and aided greatly by a local and global network reconfiguration, the two cities rebuilt their economies and their working forces.

This chapter develops further these reflections and the empirical evidence on how global and local networks expand in mutual interdependence inside and between cities, disentangling the processes developed at the city level (meso) and at the system-of-cities level (macro) from the different geographic scales of the system of cities. The multilevel city system is presented as a useful theoretical framework able to connect local to global networks (part 1). The empirical evaluation of these local/global networks is based on the worldwide multinational firms' ownership linkages, which are considered both at their intra- and interurban levels. This evaluation will underline the evolution of the scales of world cities' networking between 2010 and 2019 (part 2) and the uneven role of intraurban linkages in the cities' external linkages development. A focus will be proposed on London's and Beijing's intraurban linkages in order to illustrate how far local and global linkages are similar in nature but develop at these two levels with some mutual adaptations (part 3). Finally, a conclusive discussion on the interpretations and implications of these intra- and intercity networks will be stressed, and a future research path will be suggested (part 4).

1. The local/global cities' systems and the scales of globalization

Numerous reflections have conceptualized the duality of inter- and intraurban networks, stressing the critical balance and flexibility required in the intertwining between the two levels of "local buzz and global pipelines" (Bathelt et al., 2004) for the positioning and the adaptation capacities of each city in the network society (Amin & Thrift, 1992; Sassen, 2000; Castells, 2010). However, the issue of the network dynamics within or between cities is often addressed independently by empirical studies that are conducted either inside cities or between cities. Only few case studies have focused on the interactions between these two levels, showing in details how inter- and intra-level networks mutually reinforce each other and how far these interactions participate in shaping the cities' development (Hall & Pain, 2006; Massey, 2006; Gluckler & Bathelt, 2011).

1.1 The local/global urban processes

We can easily assume that local and global urban processes are closely intertwined. According to Beauregard (1995), *"the local is no longer purely local but has incorporated global (and regional and national) interests and actors. To this extent, any spatial scale exists only temporarily as "purely" local, regional or global"* (Beauregard, 1995, p.241). In fact, some actors have developed local networks in a global perspective or else they have mobilized global networks in a local perspective. Quoting again Beauregard (1995): *"Local actions might have global consequences (...). One might argue that the global is the organization of many local actors on a broader geographical canvas, and without local places the global cannot exist"* (p.242). Specifically, in cities integrated in globalization, local actions may support numerous global perspectives because of the concentration of the important control, innovation and governance of private or public institutions and private firms. Inside these cities, local

connections may provide access for the global actors' connections with other places. Revisiting London that had been built up on global and local processes, Doreen Massey (2006) argued that " *the local is not only the product of the global, but that global itself is produced in local places* " (p.107). To this mutual global/local interwoven framework in London, Amin & Thrift (1992) introduced a temporal dimension, adding top-down or bottom up periods: " *In its old incarnation, the City [of London] was the result of the local going global. In its new incarnation, the City is the result of the global going local* " (p.583). Thus, we wonder which properties of cities burgeon these local/global processes and how the bottom-up and top-down processes occur?

1.1.1 Top-down and bottom-up processes

In a top-down way, the cities' economic advantages are traditionally attached to local agglomeration and, importantly, incorporate the economic base's interactions with other cities inside the regional/national/global cities' networks (Moulaert, Djellal, 1995). Adopting a relational perspective permits the consideration of both local and global relations as parts of the same actors' strategies. Moulaert & Djellal (1995) and later Bathelt & Gluckler (2011) " *extend agglomeration theory by moving beyond the issue of local externalities to examine the positive network externalities for a city as a result of its connectivity with the international city system* " (Bathelt & Gluckler, 2011: 115). International actors can be used as global connectors by other firms located in the same city, and thus the intracity networks integrate global connections as additional trans-local externalities benefiting firms located in that city: " *A city that is highly connected within the city system thus provides accessibility advantages to its firms located in that city* " (Bathelt & Gluckler, 2011: 115).

In a bottom-up process, the trans-local synergies of networks reinforce the capacity of local firms to develop « *economies of overview* » (Johannisson, 1990), which permit the identification and exploitation of different opportunities in various markets. These economies are crucial for the most specialized activities that require a wider catchment market area. Social capital, including the " *know-who* ", is essential in very competitive markets in which innovation, regardless of whether it is industrial or service innovation, is increasingly more related to the relations with clients and consultants and is strongly based on reputation and personal trust (Bathelt & Gluckler, 2011). Economies of overview increase with proximity (Torre & Rallet, 2005) and with the local buzz (Storper, Venable, 2004). They are also supported by institutions that stabilize patterns of interactions based not only on rules, norms, conventions, habits and routines (Bathelt & Gluckler, 2011: chapter 3; Nelson & Winter, 1982) but also on culture (DiMaggio, 1997) and reputation (Uzzi, 1997). The reputational benefits of network transitivity increase trust and the potential economies of overview.

1.1.2 Attractiveness and power of cities

A good reputation promotes the cities' attractiveness for firms and for skilled workers. Firms attract other firms of the same or complementary activities, enabling the local complexity of subcontracting, alliances and " *coopetition* " relationships to thrive. On the other hand, these complex local networking relationships strengthen some firms in the context of global competition, reinforcing their capacity to expand their worldwide power to other cities. To achieve local coordination, firms with linked networks must address the networks' *compatibility* (common standards and norms), *availability* (acceptation of new entrants) and *malleability* (open to revision) (Grewal, 2008). These conditions comprise the aspects about

which firms can communicate and cooperate in order to benefit from their relationships and to increase the capabilities that will reinforce the economies of overview that were evoked previously. Cities constitute the dynamic cognitive context of the functional and symbolic *milieu* (Crevoisier, 2004) where economic agents behave with bounded rationality in an uncertain environment (Camagni, 2001). Saskia Sassen (1991) deeply documented the behavior of producer services in global cities in which local and cosmopolitan businesses and the political elite created some powerful social networks consolidating their updated information on global trends.

Whether controlling other firms or controlled by others, firms insert themselves in local societies, creating their own local embedded networks. Their local interactions with other firms consist in subcontracting, cooperating and competing or forging alliances. In this perspective, they often operate through a deep local labor division that is coordinated with the global one. For management flexibility reasons or to consolidate some cooperative or subcontracting arrangement involving some strategic information that they do not want to outsource, firms also invest locally in other firms in a brownfield way (buying other firms), a greenfield way (creating a new company) or through jointventures. In addition, they participate in local life activities, investing in sports and cultural clubs or social infrastructure. Firms with a group headquarters location specifically deploy a large set of interacting owned firm units with different functions oriented to the control and the coordination of the global activity of the group. Long range international control functions specifically necessitate strong coordination: numerous combined tasks are fragmented into different enterprises operating through a vertical/horizontal disintegration (Scott 2001) that comprises both intra- and intercity regions. Many of these functions remain totally or partly internalized inside the large corporate groups, facilitating the control and the adaptability of the value chain.

1.1.3 Specialization and diversification of cities

Since the 1970s, cities have experienced growing Marshallian effects of specialization thanks to the coupling of the deindustrialization of advanced capitalist countries (Peet, 1987) and the deepening of the worldwide division of labor (Aydalot, 1985; Storper, 1997). Locally, consistent with the Jane Jacobs' intuition of the multiplication of related activities (Jacobs, 1969), numerous complementary functions were developed around specialized ones, stimulating for 15 years increased research on relatedness (Hidalgo et al., 2007; Frenken et al., 2007; Shutters et al., 2015; Content & Frenken, 2016; Farinha et al., 2019). Since the 1990s, authors have remarked on the diversification of activities around some forms of specialization, in particular that for services. For example, the following comment was offered: "*Chicago is the home of the second largest number of corporate headquarters, specialized in manufacturing administration, securities, computing, and data processing (much more than New York), mailing and reproduction services, and management and public relations*" (Markusen & Gwiasda, 1994: 177). Therefore, in cities such as Chicago, the cities' specialization often leads to the apparition of complementary activities sustaining each other locally in a global production network (GPN) perspective (Henderson et al. 2002). In particular, in the knowledge economy based on technology, innovation and communication, numerous specialized services, such as the those provided by information technology consulting (Moulaert & Djellal, 1995), accounting, insurance, banking and finance, management, law, logistics, design and architecture, advertising and media firms (Luthi et al., 2010), contribute to the organization of activities and promote them. These specialized services form industrial or services "clusters" (Porter, 2004)

involving private firms together with education and research institutions, political governance and civil societies and constituting what are called N-Helix systems (Leydersdorff, 2012). Due to their internal local relations, these N-Helix systems are considered local systems, but in their dynamics, their external national or international relations are important as well.

1.1.4 Globalization of polycentric urban regions

Global cities use their whole surrounding region of influence to develop their global scope. This ability allows them to reach a critical size and to use various local resources. City-regions extend much beyond urban cores, forming new business centers, including edge cities where financial and technological centers have expanded outside the real estate pressure of the core and specialized subcenters that are often ancient satellite cities that are now totally incorporated inside the urban dynamic of the central metropolis (Hall, 2014). It is however very difficult to delineate these "city-regions" in a global perspective. In 2006, Hall & Pain coordinated a comparative study of 8 European cities in order to evaluate the cities' polycentricity stage and to what extent one could qualify them as mega-city regions (MCR). They suggested the iterative delineation of these MCR cities by first considering commuters and the advice of specialists and then adjusting these delineations according to the local economic linkages. Following the Globalization and World Cities (GaWC) methodology, they considered the different locations of advanced producer services (APS) firms and assumed that intrafirm linkages between the subsidiaries of the same companies would guarantee some exchanges of information (see also Pain & Shi in this volume). According to this study, they confirmed that the subsidiary companies of APS firms spread their offices in different parts of the city-regions, contributing to their integration inside a single regional-city system. However, they observed that the majority of advanced services remained in the city cores and that due to national policies, some strong national effects affected the way surrounding regions interacted with the main city-core.

In the perspective of situating cities in globalization, we proposed in 2020 the delineation of 1,698 Large Urban Regions (LUR) all over the world, addressing the challenge to study the main large cities of the world in a comparative way (Rozenblat, 2020a). We adopted a triple stage approach consisting of considering first the national definitions of a city and then building upon these uneven delineation-nested definitions by using the following four main concepts:

- *Urban localities*, the term we use for municipalities that are mostly based on political power (MUNI);
- Dense built-up areas, which are evaluated as *Morphological Urban Areas* (MUA);
- *Functional Urban Areas*, which denote areas that are based on the daily flows of commuters or the density of roads (FUA); and
- Polynuclear urban regions, which represent regional systems inserted in globalization and which we term *Large Urban Regions* (LUR).

The Large Urban Regions are built with a third iterative stage, namely, the specific analysis of the location of the multinational firms of our database, their proximity to MUAs or FUAs, and their access to a main national or international airport, which is crucial in the context of multinational firms needing rapid access to their subsidiaries, to markets and to high level services (Rozenblat, 2020a). The detailed municipal composition of these LURs is published in open access (Rozenblat, 2020b), because the LURs delineations must be improved and updated regularly. It is only at the price of this transparency that it will be possible at the international scale to monitor and forecast the comparison of cities' global networks and their local embeddedness in city-regions.

1.2 The scales of global processes

The balance between the local embeddedness of global networks and the global centrality of these local networks lies inside the numerous intermediate nested or non-nested scales (regional, national, free trade zones) that influence the effectiveness and the form of the networks' impacts on city development, regardless of whether the development is in the global North or South (Robinson, 2015). In fact, we do not live in a flat world: countries or groups of countries represent institutional spaces that support firms in very uneven ways in the context of national policies, such as state market demand, taxes or monetary policies (Dicken, 2011). Among numerous scales created by the multiple expansions of actors and which have tendencies to converge partly towards similar ones, these scales hold a certain attraction for network organizations. This can be explained by the facilitation properties of some geographical spaces for free circulation or institutional proximities. This situation results in a discrete set of scales that significantly override global networks.

1.2.1 National scales

Countries represent internal homogeneous spaces where global networks can preferentially expand due to similar rules, language, regulation and control and to the access to physical, human or institutional infrastructures that regroup diverse elements, such as roads, transport, public services, education, social welfare, culture, and administration. States remain a strong regulator of labor markets, wage cost, social welfare and tax systems. In addition, the coordination between states and large domestic corporations gives the former an active role in national policies. Regarding Japanese firms, the involvement of the "Kereitsus" (large consortia of firms) in national economy policies has existed for a long time (Dicken, 2011). Today, Chinese or American firms are becoming powerful economic arms enabling states to dominate international trade and consequently control the global political order. Although this is not always the case because firm groups are not always supported by some national policies, such as those directed against monopolistic positions (and today those protecting the use of personal information), this phenomenon cannot be denied (see Dicken, 2011: chapter 7).

As most of the information on multinational firms is produced at the international level between states, the role of multinationals in the international arena is very well documented through so-called Foreign Direct Investments (FDI) (World Bank, 2017). Because of the lack of information at the lower scales, compared with that in the international space, the amount of information on the magnitude of the multinational firms' expansion inside national spaces is very small.

The concentration of the multinational firms' networks in the different national cities depends also on the inherited hierarchy of cities inside each country, and the primatial model is the most prevalent organization among the states of the world (Moriconi, 1994; Sassen, 2010; Pumain et al., 2015). Primate cities benefit from the initial advantage of being able to dominate their own national urban system, in which the national administration and stock exchanges are often concentrated in order to develop local companies and to attract companies based in other cities. From the firms' network perspective, the strong embeddedness in national institutional functioning (e.g., the level of decentralization and federalism) creates a preferential attractiveness of one or more cities in each country. Thus, the national average development

level and the national cities' hierarchies combine to define the level of the cities' attractiveness and power (Rozenblat & Pumain, 1993).

1.2.2 Supra-regional scales

Regional trade agreements (RTA) regroup national spaces in order to facilitate network deployments and sometimes to reinforce entry barriers towards the outside. They are very numerous in the world, and many of them overlap. The World Trade Organization (WTO) manages all the tariff barriers that are fortunately declining in the world, but nontariff barriers (NTB), such as technical rules and minimal standards, are increasing (Dicken, 2011). Dicken distinguishes the following types of regional trade agreements (Fig. 6.13 p.205):

- *Free trade areas* that remove trade restrictions between member states;
- *Customs Unions* that extend common external trade policies towards nonmembers;
- *Common markets* that enable free movement of factors of production between members; and
- *Economic Unions* in which the harmonization of economic policies are under supra-national control.

In the beginning of 2020, the World Trade Organization (WTO) counted 303 active RTAs (WTO, 2020).

Cities are positioned at these continental scales by the combination of their national average development level and their position in their own country. However, some specific functions in the RTAs (i.e., the European Union headquarters functions, such as those located in Brussels, Luxemburg or Strasbourg in Europe, or the stock exchange operations, such as those in Frankfurt) constitute additional resources that firms gain by being located close to these institutions (Cattan et al., 1994; Rozenblat & Cicille, 2003; Pumain & Rozenblat, 2019). These RTA effects can be visible at the continental scale that often comprises the scope of these regional agreements.

1.2.3 Other scales

Relevant in the expansion of the firms' networks among world cities, other scales based on historical colonial linkages and/or on similar languages also constitute some remaining proximities from the past. The clustering approach of the global ownership networks of firms demonstrated that cities of the Commonwealth countries remain closer to Great Britain than did European cities (Rozenblat et al., 2017); Spanish and Portuguese cities are quite integrated with South American ones; In contrast, the ex-communist countries do not exchange as much within their firms' linkages, but they are rather linked in between Western European cities and Russian cities (Di Lello, Rozenblat, 2015; Zdanowska et al., 2020).

1.3 Disentangling levels and scales of the multinational firms' networks

The balance between the cities' networks at different levels and scales is an important issue for the resilience of cities. The physical properties of the networks' structure reveal that the diversity of the cities' linkages between levels and scales and at each level and scale (in terms of origin/destination and in terms of activities) secure the system's robustness (Garas et al, 2018). In addition, Hu et al. (2013) provided the evidence that the redundancy of linkages between different networks reinforces the robustness of the whole network. These results bring complementary elements to the previous fragmented approaches of linking scales and

levels, allowing the further expansion of evolutionary approaches (Boschma & Martin, 2010) in a multilevel and multiscale perspective (Tab. 1).

Table 1. Processes of the firms' networks in a crossed levels and scales perspective

LEVEL (aggregation of nodes)		GEOGRAPHICAL SCALE (network boundary)		
		The city is considered with different geographical scales		
The city is considered as a level of an organization		1- Intralocalities	2- Intracity-region	3- Interurban
A-Macro	The city as a single LUR interacting with other LURs	Degree of the localities' cohesions	Degree of intracity-region cohesion/specialization/relatedness	National/Global cities' networks' (Pipelines), reputation, economies of overview
B-Meso	The city as a Large Urban Region (LUR)	Localized clusters of industries inside localities; Local institutions	Regional polycentrism inside the LUR; N-Helix of local economic clusters; city-region's governance	LURs compared at the global scale
C-Micro	The city as a set of interacting actors	Interactions of actors within municipalities	Interactions between regional actors (Buzz)	Global interactions of single actors

The consideration of the city as a set of interacting actors permits the identification of actors having simultaneously local multiple interactions and a large scope of global linkages (Table 1: C1, C2, C3). These actors are identified as *"institutional entrepreneurs"*, playing the role of interfaces and facilitators of cascade spill-over processes between heterogeneous social spaces (Padgett & Powell, 2012).

At the meso-level, considering groups of actors in the Large Urban Regions (LURs) enables the determination of how far activities are concentrated in localized localities (B1). At the city-region scale (B2), it is worth evaluating how far these localized clusters are embedded inside local institutions, university, research, and social actors, forming the N-Helix systems that only make sense at the city-region scale. Polycentric relations develop between more or less specialized places inside the city-region, strengthening the whole. Their national to worldwide linkages (A3) constitute another important dimension of the N-Helix, causing clusters to evolve according to the global concurrency, for national and international partners and for national or supra-national regulatory policies (B3). At the global level, the city (LUR) as a whole reaches a cohesion, diversity and relatedness (A1 and A2), causing the emergence of properties of *"economies of overview"* that increase the national and international city reputation (A3), profiting any actors in the LUR by increasing their capacity to develop global networking.

2. Local/global cities networks of multinational firms' ownership linkages

The consequences of attractiveness and power in the local/global interactions could be further documented in a comparative manner for all the cities of the world, filling the gap in scientific literature in which these consequences are either documented in separated ways of global or local or the local/global interactions are addressed for specific cities, such as Chicago (Markusen & Gwiasda, 1994), eight European cities (Hall & Pain, 2006), or the cities in the

Rozenblat C. (2021). Intra and inter cities' networks of multinational firms, in Rozenblat C., Neal Z. (eds.) (2021). *Handbook on cities and networks*, Edward Elgar, in press

Yantze Delta region (Bathelt & Gluckler, 2011). The questions are numerous, and we can only address a few of them here.

The previous multilevel and multiscale framework can expound the empirical study of the firms' networks within and between cities. Adopting a comparative approach for the cities of the world (2.1), we propose to give an overview of the order of magnitude of the importance of each scale, the evolution of their balance over the last 10 years, and the dynamics of the relation between intra- and intercity networks (2.2). We will wonder why cities experience different situations according to their national and continental contexts and how intra- and interurban linkages adopt some specific forms. Deepening some case studies of cities' intraurban networks, we will discuss the importance of the specialized networks and of polycentrism in the cities' scope (2.3).

2.1 Multinational firms' networks' evaluation inside and between cities

The empirical analysis is based on the multinational firms' ownership networks, the information on which we collected and organized for 4 dates during 10 years (BvD ORBIS, 2010, 2013, 2016, 2019). At each date, the sample comprised the first 3,000 firm groups in the world, and the data for all their direct and indirect subsidiaries was collected. Between the different dates, the groups partly changed, and of course, their subsidiaries also changed. Another option would be to consider the same sample of firms from 2010 to 2019. However, this approach would drastically reduce the size of the dataset because many firms decrease or even disappear, and it would avoid considering the new arriving firms.

The strength of the empirical analysis (which is also a limit) is that it enables us to consider intrafirm ownership linkages. The reasons are twofold: first, it permits the use of homogeneous data based on the Bureau van Dijk ORBIS database, certifying that these linkages are real corporate ones and not speculative investments. Second, these linkages are intrafirm ones, representing privileged, tangible institutionalized networks that are measured by the ownership percentage. These linkages do not represent all the firms' networks comprising interactions for trade, collaboration, services, etc., but they reveal a large part of the firms' strategic activities provoking the sharing of participation between firms. Firm activities involving the creation of other new firms and the participation in merger and acquisition (M&A) activities are a large part of the firms' strategies, contributing to capital mobility and technological spillover between firms and thus representing a large issue in the cities' intra- and interurban interactions (Rodrigues-Pose & Zademach, 2003; see also Pain & Shi in this volume). Recent statistics showed that the share of the economy belonging to intrafirm' networks is far from negligible: In 2014, intrafirm trade represented 50% of the U.S. importations (more than 60% for the advanced countries) and 30% of the U.S. exportations, proportions that have remained constant since 2000 (World Bank, 2017). The U.S. intrafirm trade reacted better to the 2008 crisis than the "arm's length trade" (trade between unrelated firms), which decreased very significantly. This better resilience can be explained by the intrafirm network members' different advantages, such as the access to finance, size and productivity, and a wider range of available tools permitting them to hedge against exchange rate movements and to maintain a lower sensitivity to the uncertainty (Bems et al., 2009; Bernard et al., 2009; Carballo, 2015).

In addition, although the ORBIS database comprises the firms' secondary establishments formed since 2016, the exhaustivity of this information is very uneven between countries. Thus, from a worldwide perspective, this information is not usable in a comparative perspective, explaining why we consider only the principal establishments of each firms (firms' official registered headquarters in the country). For our empirical study, all the firms were localized and aggregated by Large Urban Regions (LURs), setting aside some firms that did not have addresses or that were outside any LUR (Tab. 2):

Table 2: Firms' network ownership sample and LURs' representativeness

Year	Principal establishments of direct and indirect subsidiaries			Ownership linkages		
	Total	Localized in LURs	Localized in LURs (in %)	Total linkages	Localized in couples of LURs	Localized in couples of LURs (in %)
2010	657,399	440,333	66.98%	1,015,913	652,811	64%
2013	772,987	551,492	71.35%	1,193,325	800,306	67%
2016	1,118,689	875,610	78.27%	1,619,536	1,158,429	72%
2019	1,303,002	1,067,353	81.91%	1,734,603	1,288,946	74%

Source: Bureau van Dijk (BvD) ORBIS – UNIL, 2010, 2013, 2016, 2019

The Large Urban Regions (LURs) are defined according to the aggregation of localities that are economically dependent to the core cities (Rozenblat, 2020a). The 1,698 LURs defined all over the world comprise a total of 124,806 localities (Rozenblat, 2020b). In total, 1,186 LURs are identified as hosting some multinational firms linked to our sample of firms. In the following text, we will interchangeably use the terms city, urban and LUR.

2.2 Inter- and intracity network construction

The method to aggregate firms and their ownership linkages by LUR and by couples of LURs is explained in detail in Rozenblat (2018). We measured the intensity of a city relationship with another city by adding the total number of ownership relations of the firms located in couples of LURs: LO_{ij} denotes the number of subsidiaries located in the city j having their headquarters (or a minority shareholder) in the city i . Each oriented linkage l_{ij}^e represents an enterprise e having a shareholder or headquarters in city i and a subsidiary located in city j . All l_{ij}^e are summed up to obtain LO_{ij} :

$$LO_{ij} = \sum_{e=1}^p l_{ij}^e \quad (1)$$

Note that in the opposite direction, the city j can also have enterprises e hosting shareholders who invest in subsidiaries of the city i . Then, the nonoriented link LNO_{ij} between cities i and j is expressed as follows:

$$LNO_{ij} = \sum_{e=1}^p l_{ij}^e + \sum_{f=1}^q l_{ji}^f \quad (2)$$

In the empirical following study, we will specify when we will use oriented or nonoriented linkages.

The total weight of each city in the network can be revealed by two different values:

H_i denotes the number of controls from the headquarters of city i to other cities j and is evaluated by the number of outgoing ownership linkages from the city i towards all other cities j ;

S_j denotes the number of links of a subsidiary of city j from all other cities i and is measured by the number of ingoing linkages to the city j from all the other cities i (as these linkages are oriented from the headquarters' LUR i to the subsidiaries of the LUR j , H_i is different from S_i).

H_i and S_j are computed as expressed in equations (3) and (4):

$$H_i = \sum_{j=1}^k LO_{ij} \quad (3)$$

$$S_j = \sum_{i=1}^l LO_{ij} \quad (4)$$

In the network analysis, the value of H_i is the city's "Weighted Out-Degree" (here representing the power of the subsidiaries' control that is concentrated in the city i towards outside the city i), and the value S_j is the city's "Weighted In-Degree" (the attractiveness of the city j for subsidiaries controlled from outside the city j).

The importance of intraurban linkages is measured as follows:

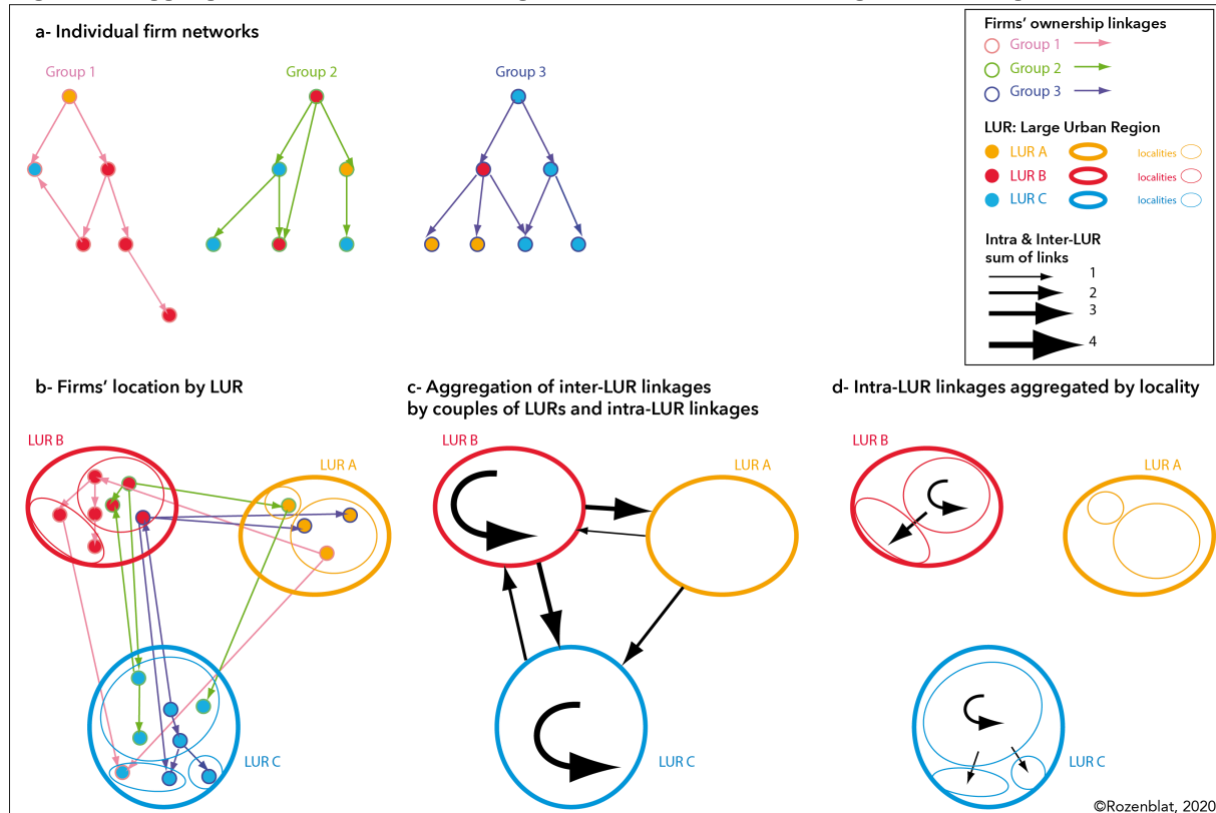
$$I_i = \sum_{j=1}^k LO_{ii} = \sum_{i=1}^l LO_{ii} \quad (5)$$

Note that in this case, the links measured for the headquarters or for the subsidiaries' sums are the same and must be counted only once.

The firms' linkages (Table 1; cells C1 to C3) were aggregated by LUR by using their origin and destination locations, which correspond to the cell A3 of the Table and reveal the weight of the cities at the macro level (Fig. 1). This process yielded a matrix linking the 1,698 LURs of the world. The intercity relationships are oriented, and they are weighted by aggregating the firms' links by pairs of cities, as described in the equations.

For intraurban linkages, the same method is adopted, and we can build intraurban networks linking the different Morphological Urban Areas (MUA) of each LUR and the localities (MUNI) within each MUA, revealing the intralocality linkages ((Table 1; cell B1) or the regional polycentrism (Table 1; cell B2). With this data elaboration, we are able to consider the same networks with different levels of dynamic processes at the global and local scales.

Figure 1. Aggregation of the firms' linkage inside and between Large Urban Regions



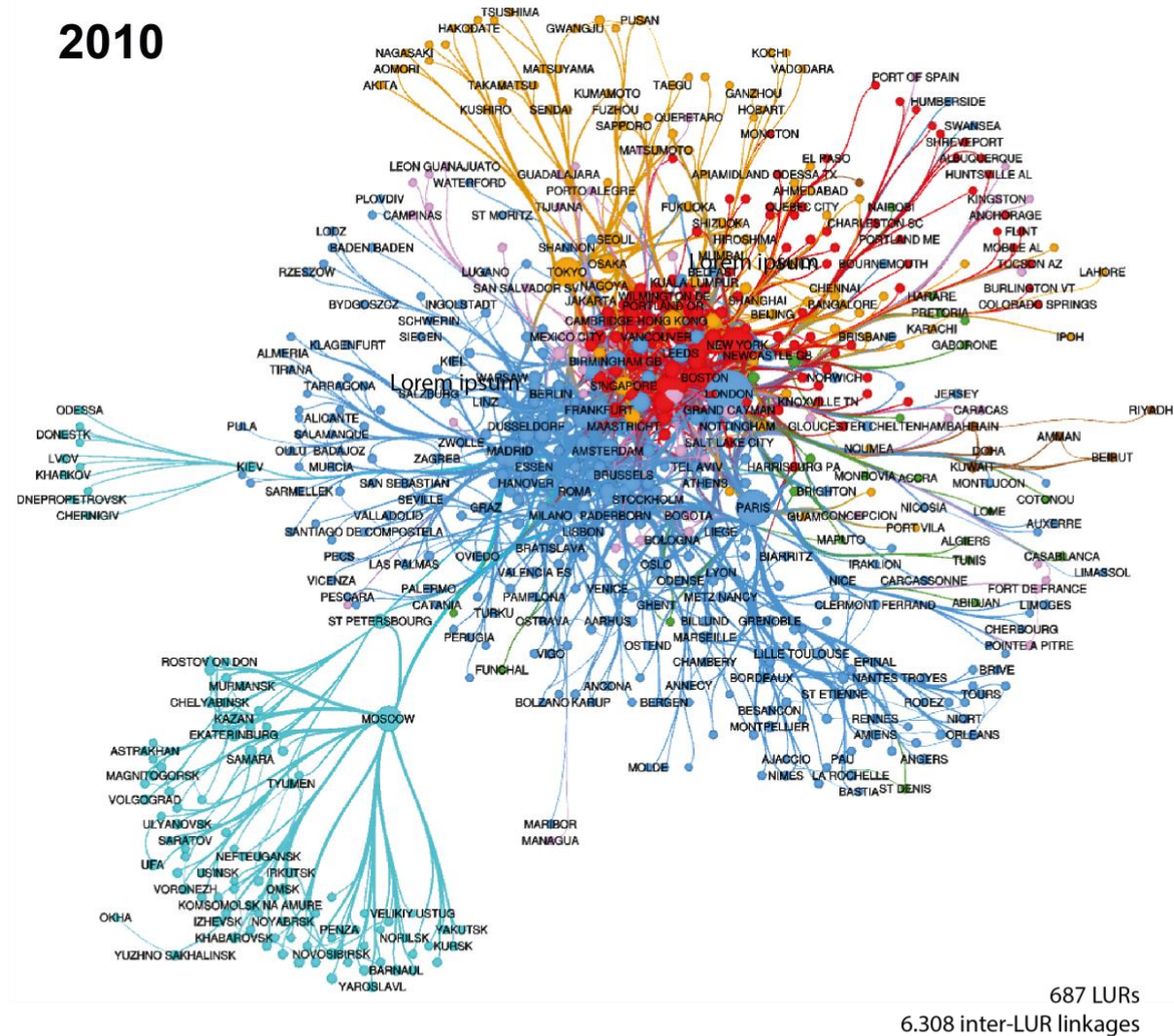
In addition to the attention we paid to the delineation of LURs, we also considered the different geographical territories of 247 countries (UN, 2018) aggregated by 6 large continents (not considering the Arctic where there are no LURs at all and merging Oceania and Asia). This allows us to distinguish the intranational, intracontinental and intercontinental linkages (Table 1: cell A3), considering therefore different scales between the intraurban regional linkages and interurban global ones. In these scales, it is important to be careful not to count the same networks twice (for example, owner or subsidiary firm networks inside cities are the same; likewise, the same holds for national intercity networks inside countries).

2.3 Evolution of multinational firms' networks between cities

Figure 2 displays the graph built by the sum of inter-LUR linkages (Fig. 1 – c). The position of each city-LUR is determined by its networks' proximities with other cities. The continents of the cities are figured by colors, underlying the preponderance of the intracontinental systems of cities. We applied the same thresholds for every year in order to clarify the figure and to avoid too much noise:

- The LURs must have more than 30 total linkages; and
- The linkages between the LURs must be over 10.

Figure 2-A: Cities in the globalization of firms in 2010

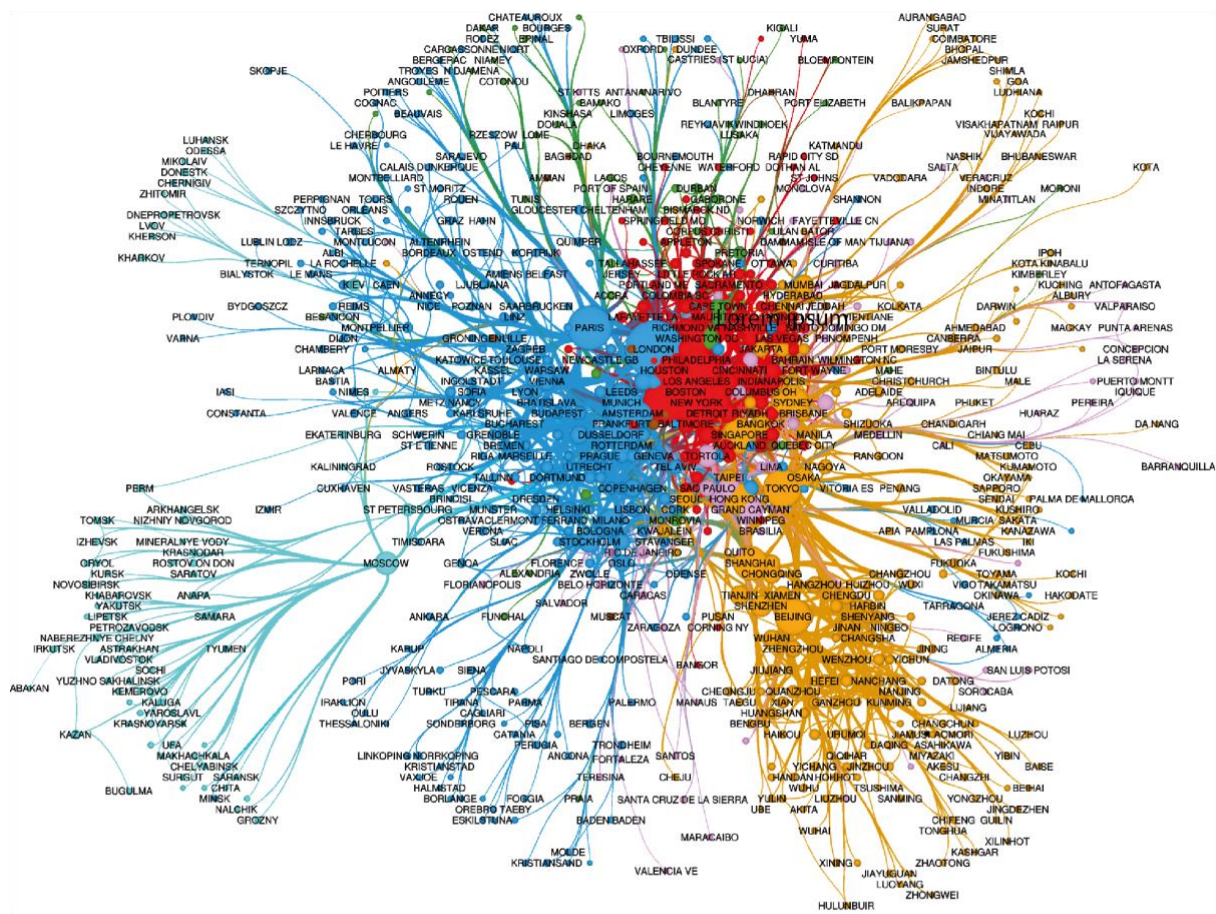


Number of firms' linkages by LUR (Large Urban Region):	Continent or Geographical zone:	Firms' linkages* between LURs
<ul style="list-style-type: none"> ● 125,000 ● 70,000 ● 15,000 ● 30 	<ul style="list-style-type: none"> ■ Middle East ■ North America ■ South America ■ Europe ■ Asia ■ Africa ■ Russia and Ukraine 	<p>— Proportional to nodes' size</p> <p>Firms' linkages are based on ownership relations between firms</p> <p>Thresholds:</p> <ul style="list-style-type: none"> - Weighted inter-LUR linkages > 10 - LURS in which the sum of the weighted linkages is greater than 30

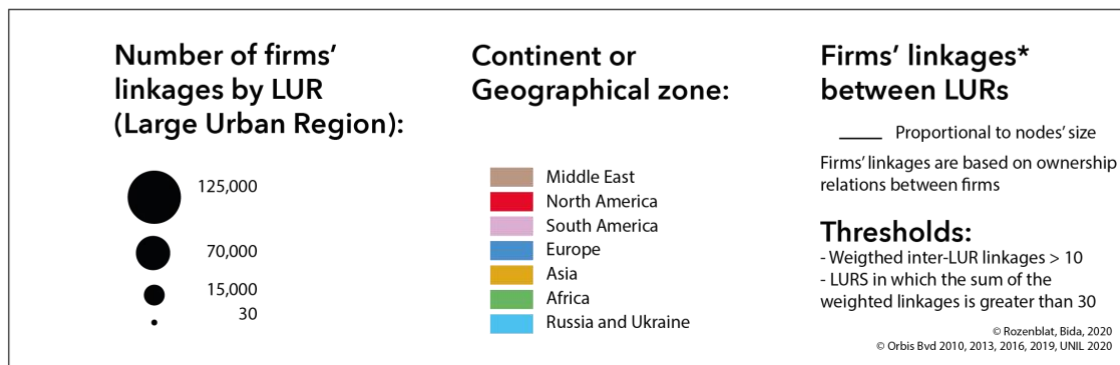
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Figure 2-b: Cities in the globalization of firms in 2019

2019



902 LURs
12,870 inter-LUR linkages

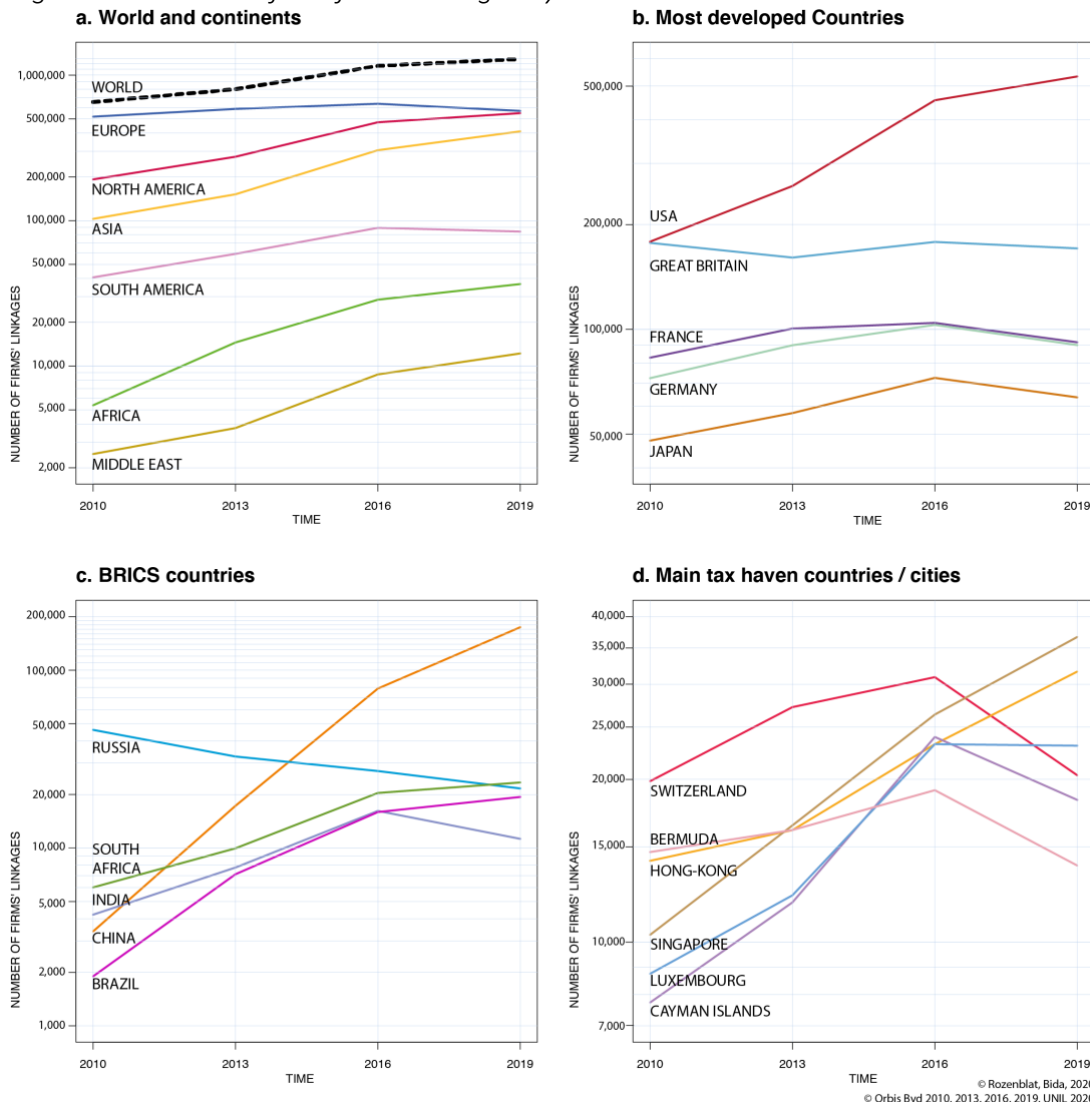


In 2010, European and North American cities constituted the core of the worldwide system dominated by London, then Paris and New York (each regrouping half of London's linkages), and Tokyo was lower (with also half of Paris' linkages). Other cities surrounded them. The ex-USSR and Ukrainian cities remain quite isolated, and this isolation existed over the period 2010-2019. The Middle East cities, such as Kuwait, Bahrain, Doha, Amman, Beirut and Riyadh, also form a quite isolated system. The Asian cities clustered around the domination of Tokyo, and other Japanese cities, such as Osaka, Nagoya, and Seoul formed a distinct subsystem as well.

Asian or Oceanian cities, such as Hong Kong, Kuala Lumpur, Taipei, Singapore, Bangkok, Sydney, Beijing and Shanghai, have multiple linkages with core cities and thus are positioned in between them in the core area. African and South American cities are either linked to the core system through European cities or through North American ones. This attachment mostly depends on their colonial period legacy, from which remains a special bond often reinforced by language (a good example of this kind of legacy is the still strong ties between Spain and Portugal and South American cities [Rozenblat et al., 2017]).

The evolution between 2010 and 2019 is principally characterized by the expansion of the cities' network. The number of cities above the threshold of 30 firm external linkages grew notably between 2010 and 2013, and the network of intercity linkages grew faster between 2013 and 2016, demonstrating a complexification of the cities' networks. In Figure 3, this expansion is more visible by geographical areas for all LURs.

Figure 3: Evolution of the firms' linkages by areas



While most developed countries remained stable during the period 2010-2019 and even decreased from 2016 to 2019, the United States' linkages continuously increased. Middle Eastern, Asian and North American firms' linkages (intra- or interurban) grew the most from 2010 to 2019. The U.S.A. (Fig. 3.b) and China (Fig. 3.c) had the most impressive total increase

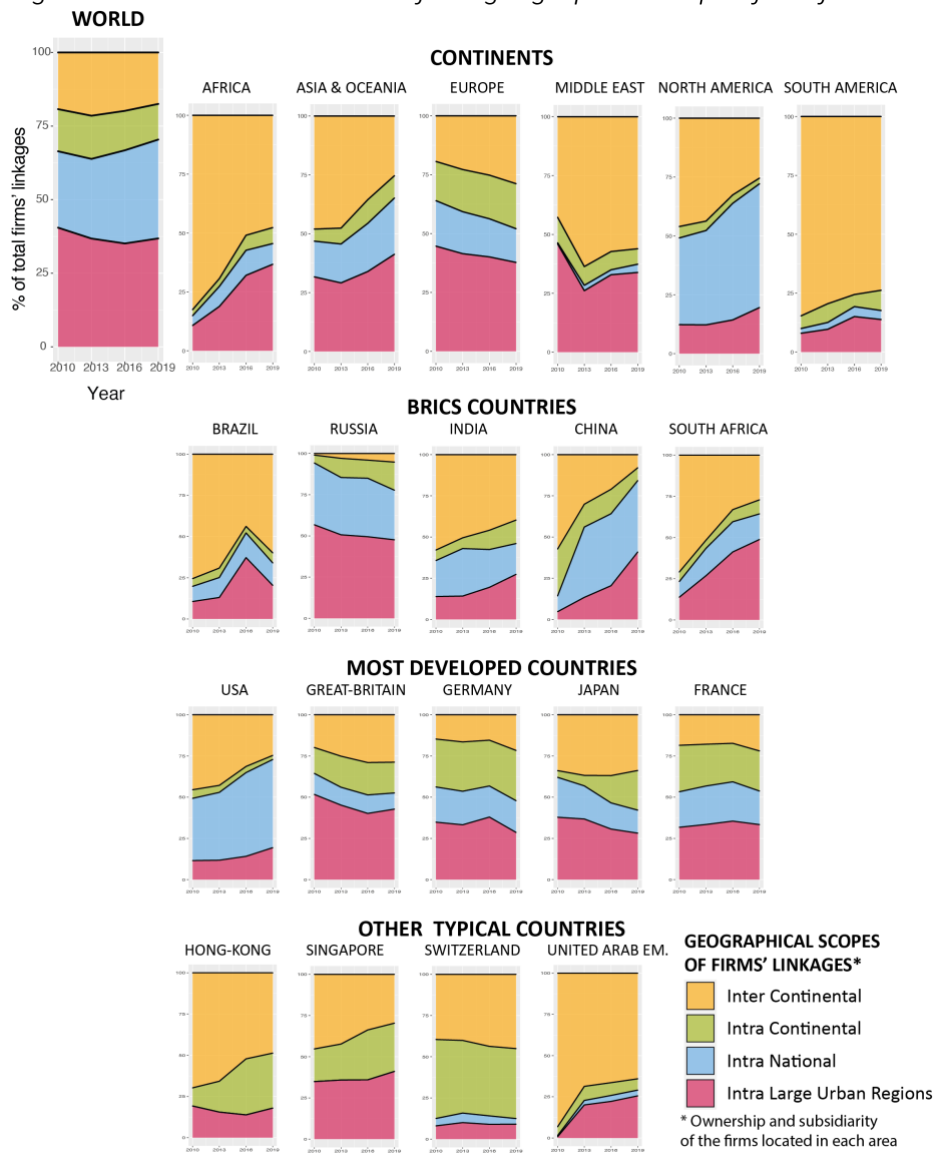
of their firms' networks in cities. Specifically, Chinese cities' firm networks expanded very fast. In Figure 2, Chinese cities began to constitute a distinct national Chinese system around Beijing in 2013, and this system was reinforced until 2019. In parallel, Shanghai and Hong Kong remained closer to the international core of the network.

Other BRICS countries in general gained importance in the worldwide city firms' system, except Russia, which regularly decreased from 36,000 total linkages in 2010 to 22,000 in 2019 (Fig. 3.c). For the tax haven countries, Singapore grew at the same speed as China, supplanting Hong Kong, which grew slower. After large increases until 2016, Switzerland, Luxembourg, Bermuda and the Cayman Islands decreased from 2016 to 2019.

2.4 Evolution of the cities' networks' scopes

To better understand these different national trajectories, the geographical scope of the cities' networks can thus be summed by intraurban, national, intracontinental and intercontinental scales (Fig. 4).

Figure 4: Evolution 2010-2019 of the geographical scope of the firms' linkages by areas



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Source: BvD ORBIS - UNIL-IGD, 2010, 2013, 2016, 2019

The geographical scope of the firms' linkages at the world scale during the period 2010-2019 shows a decreasing proportion of international linkages (intra- and intercontinental) coupled with an intraurban linkages' decrease for the benefit of intranational ones. On average, at the world scale, intraurban linkages represented 40% of the total firms' linkages in 2010 and still represented 36% in 2019.

Of course, this worldwide average hides some very uneven evolutions according to the initial level of each country, as a dependence on statistics based only on categories of countries may not show evidence of very diverse country situations. Inside BRICS member countries, countries, such as China, Brazil, India and South Africa, whose firms' networks increased a great deal during the period, decreased their intercontinental share of flows to the benefit of intraurban and intranational flows. However, India increased more its intracontinental linkages with other Asian cities. The U.S.A. also experienced a large increase in firm networks at the national scale. One of the U.S. cities that benefited more from this national consolidation was Wilmington (Delaware), which offers very low taxes to firms operating in its jurisdiction, reducing their tax burden. Russia is the country with a lower level of intercontinental linkages; however, during the period, its links with Europe increased not only proportionally, from 4% to 17% but also in absolute value, increasing from 2,200 to 3,600, despite the Russian multinational linkages' general decrease when considering all scales combined.

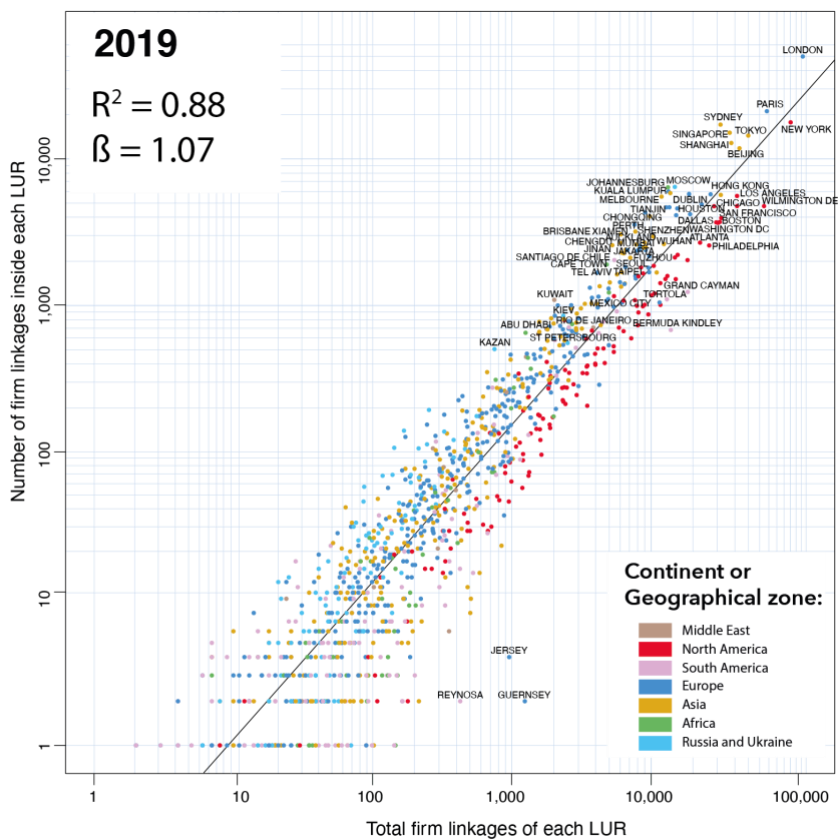
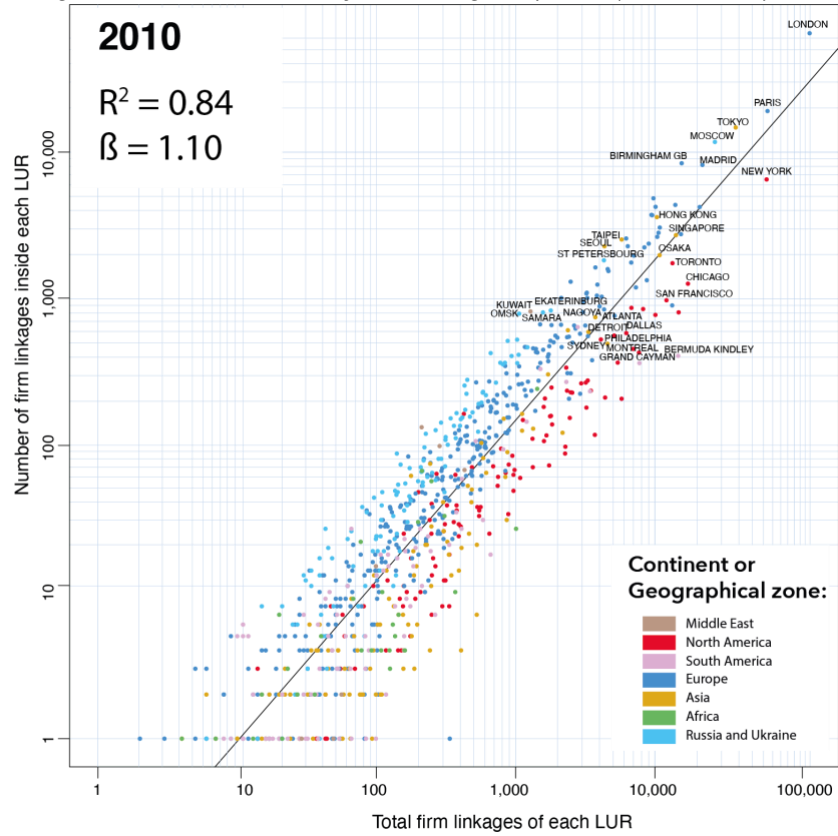
2.5 Interrelations between intraurban and interurban linkages

The role of cities in the global interurban system is based on a very stable proportion of intraurban linkages, and there is a log-linear relation between the two numbers (Fig. 5).

The urban "scaling" analysis in general "*reveals the general non-linear properties of how cities work, manifested as economies of scale, when certain quantities grow more slowly than city size ("sub-linearly") or as increasing returns to scale, when quantities grow faster than city size ("super-linearly")*" (Bettencourt et al., 2019: 2). The scaling properties can be interpreted as elasticity by economists but also as network effects reflecting the way the agglomerated individuals may produce different quantities through a better and more complex coordination of their social networks, their institutional organization or their innovative level (Pumain et al., 2006; Batty, 2006; Bettencourt et al., 2007; West, 2017; Lobo et al., 2020).

In this case, the scaling approach directly addresses two network quantities: the total firms' linkages that mostly comprise national and global networks and the local ones remaining inside the LURs. Thus, it presents a vision of the complexity of the local networks, while the total networks at every scale are varying. A stable β parameter over the period 2010-2019 means that the intraurban linkages remain, on average, at the same proportion in relation to the total linkages. A β value that is always significantly over 1 means that local linkages are more than proportional to the total linkages and that therefore they are relatively more numerous and part of larger connected cities.

Figure 5: Intra- and interfirm linkages by LUR (2010-2019)



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Source: BvD ORBIS - UNIL-IGD, 2010, 2013, 2016, 2019

This superlinear scaling-law demonstrates that local firm linkages are more complex in the most connected cities. It is no surprise that the most connected cities are London, Paris, New York and Tokyo. They did not change their positions during the period, but some cities changed considerably. In particular, Sydney and Singapore joined the front pack in 2016, leaving Hong Kong behind, as it increased much less. Beijing and Shanghai increased in 2019. Moscow's linkages decreased during this period.

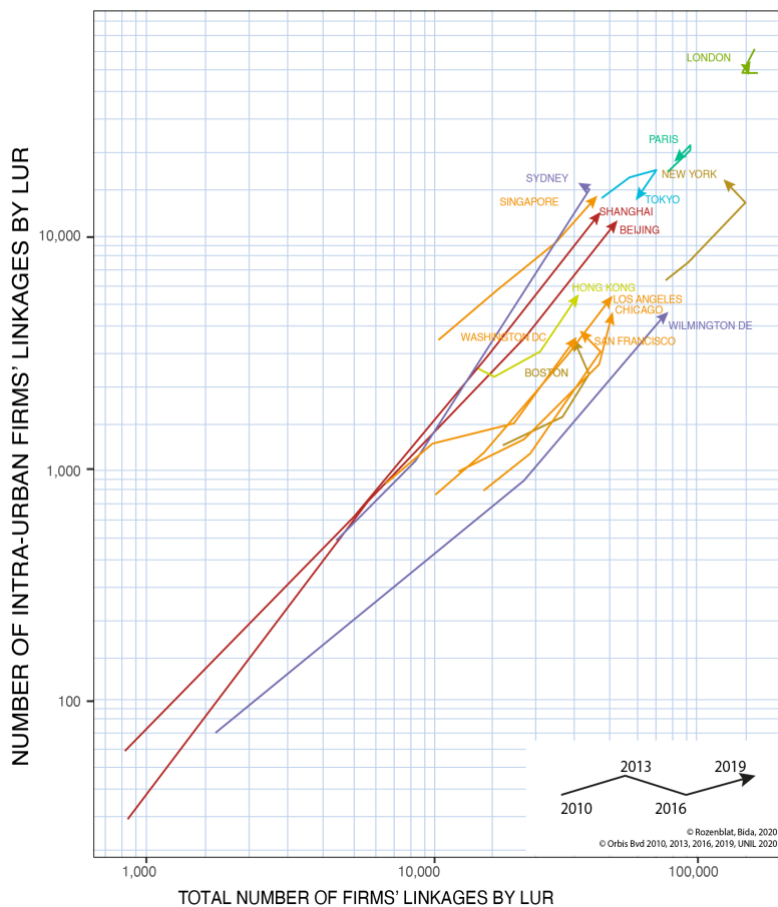
In the graphics, the continental colors of the cities (LURs) also underline a significant difference regarding this proportion: North American cities (red dots under the line) developed much fewer local linkages in proportion to their total linkages than did European ones (dark blue dots above the line). For the cities of other continents, there is no systematic logic regarding this difference. The tax havens, such as Grand Cayman, Bermuda Kinsley, Tortola, lower Guernsey and Jersey, are systematically positioned below the line, demonstrating their weak local activity in relation to their global role.

The superlinear scaling between intraurban and total linkages hides a difference between out-reach linkages (power towards other cities) and the in-reach ones (attractiveness from outside). The distinction between these two directions results in a higher effect of attractiveness for local linkage complexity ($\beta \approx 1.10$ during all the periods) than for power linkages ($\beta \approx 0.80$). This means that firms develop preferentially a larger amount of local linkages when they arrive in a local place rather than when they develop their coordination of the worldwide external activities. This is of high importance for the comprehension of their embeddedness in local places.

Most of the cities increased along the diagonal during the period 2010-2019, meaning there is an allometric growth of the local linkages in relation to the total ones (all the system and its elements grow at the same speed). This is a very common feature for such evolutionary distribution (Bettencourt et al., 2019).

The trajectories do not depend at all on the initial conditions in 2010 nor on the size of the cities. Some national trends reflect the importance of states policies for cities, but these trends are not sufficient enough to affect each position of city evolution inside global networks and their local developments. A graph on the trajectories of the 15 first LURs according to their total number of linkages in 2019 (Fig. 6) illustrates the diversity of trajectories at the top of the hierarchy of the urban system.

Figure 6: Trajectories of 15 cities according to their total and intraurban linkages
FIRST 15 LURs according to their total linkages 2019



The colors of the cities' trajectories correspond to their types according to a classification we implemented for whole cities (we do not show here the whole classification). London, Paris and Tokyo observed an absolute decrease of their firms' linkages but with different speeds. At the opposite end, New York City increased its position much until 2016, as its linkage growth was reinforcing specifically by its intraurban linkages, which increased from 10% of the total in 2010 to 18% in 2019. Boston evolved from 7% in 2010 to a 12% level for intraurban linkages in 2019, experiencing a trajectory very similar to that of New York City. Singapore shared the same trajectory with the U.S. cities of Los Angeles, Chicago, Washington DC and San Francisco. The relative weight of their intraurban linkages was not reinforced much, different from Boston and New York.

The most impressive growth of Shanghai and Beijing demonstrates a difference between the two cities: at the end of the period, Shanghai had a 34% level of intraurban linkages, while Beijing hit only 27%. Hong Kong, compared to the two leading Chinese cities, had a slower growth and was bypassed by them. Sydney and Wilmington, DE (U.S.A.) shared the same kind of trajectory of growth, and Sydney had a higher absolute level.

3 Local linkages inside Large Urban Regions (LURs)

According to these very uneven trajectories of cities, we propose to deepen the examination of two Large Urban Regions that have experienced very opposite evolutions: London and

Rozenblat C. (2021). Intra and inter cities' networks of multinational firms, in Rozenblat C., Neal Z. (eds.) (2021). *Handbook on cities and networks*, Edward Elgar, in press

Beijing. Despite a small increase of external linkages, London saw its total number of linkages decrease from 129,000 total linkages in 2010 to 123,000 in 2019 because of a strong decrease of internal linkages from 65,000 to 50,000, decreasing the share of intraurban linkages from 50% to 41%. Alternatively, Beijing increased its networks in our sample from less than 900 in 2010 to more than 43,000 in 2019. In the meantime, Beijing's intraurban linkages grew from 30 to 11,800, representing an evolution of the share of intraurban linkages from 4% to 27%. These two case studies will illustrate the extent to which multinational firms use intraurban networks to maintain and expand their global activities in two very different economic and political contexts, inducing differences that will be outlined.

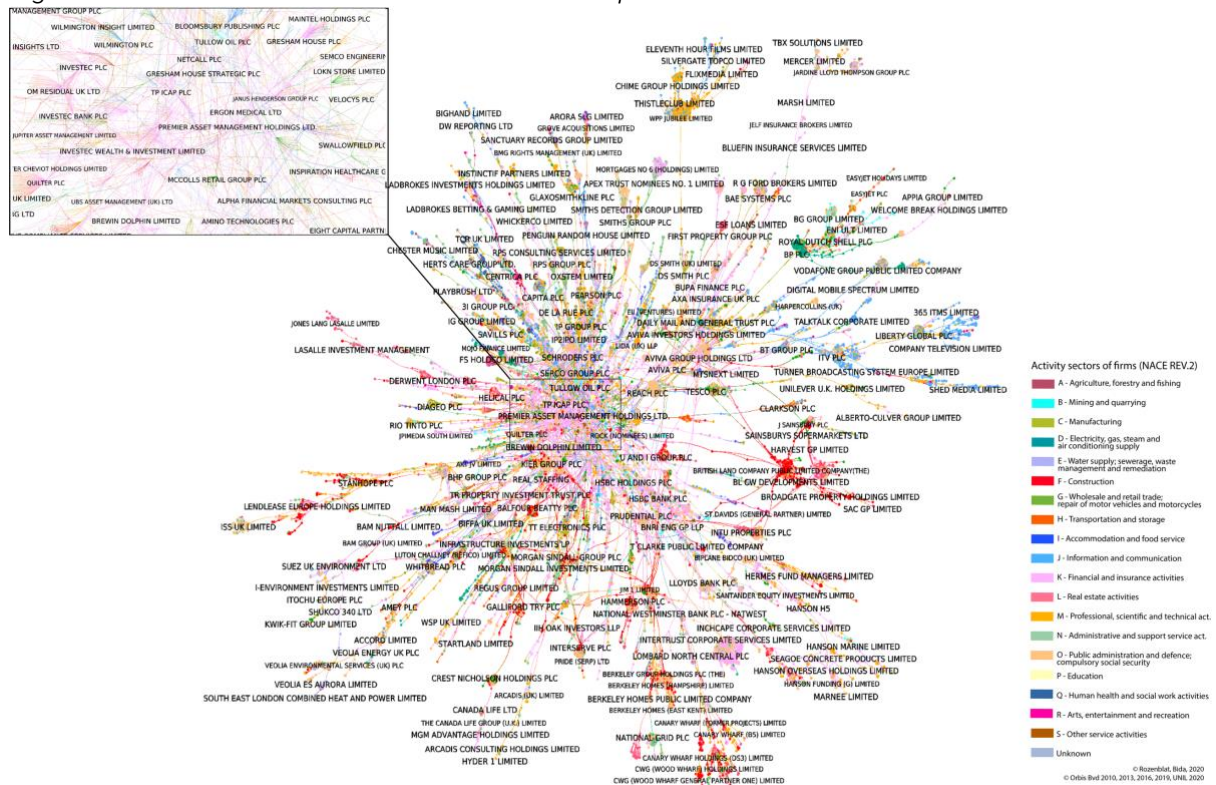
3.1 London's intraurban linkages

London is a place characterized by a long heritage of global management of the development of a worldwide market economy. Containing a myriad of firms all linked together, the 2008 crisis revealed the extent of this intertwined network, demonstrated by the cascading failure of a number of firms (London still comprised 50% of the total linkages in 2010). Due to this decrease, since 2010, the weight of these intraurban linkages has been highly deflated but has remained at the worldwide cities' average, comprising 41% of all London firms' linkages.

3.1.1 London's network components of local linkages

There is a much interest in analyzing London's intraurban linkages that are linked to each other inside the LUR and that constitute what is called a "principal network component". In 2019, the principal network component of London contained more than 20,000 local firms connected together by more than 30,000 ownership linkages that represent 40% of all the firms involved in London's intra-LUR linkages and comprise 60% of their intra-LUR linkages (Fig. 7).

Figure 7: London's intra-LUR main network component in 2019



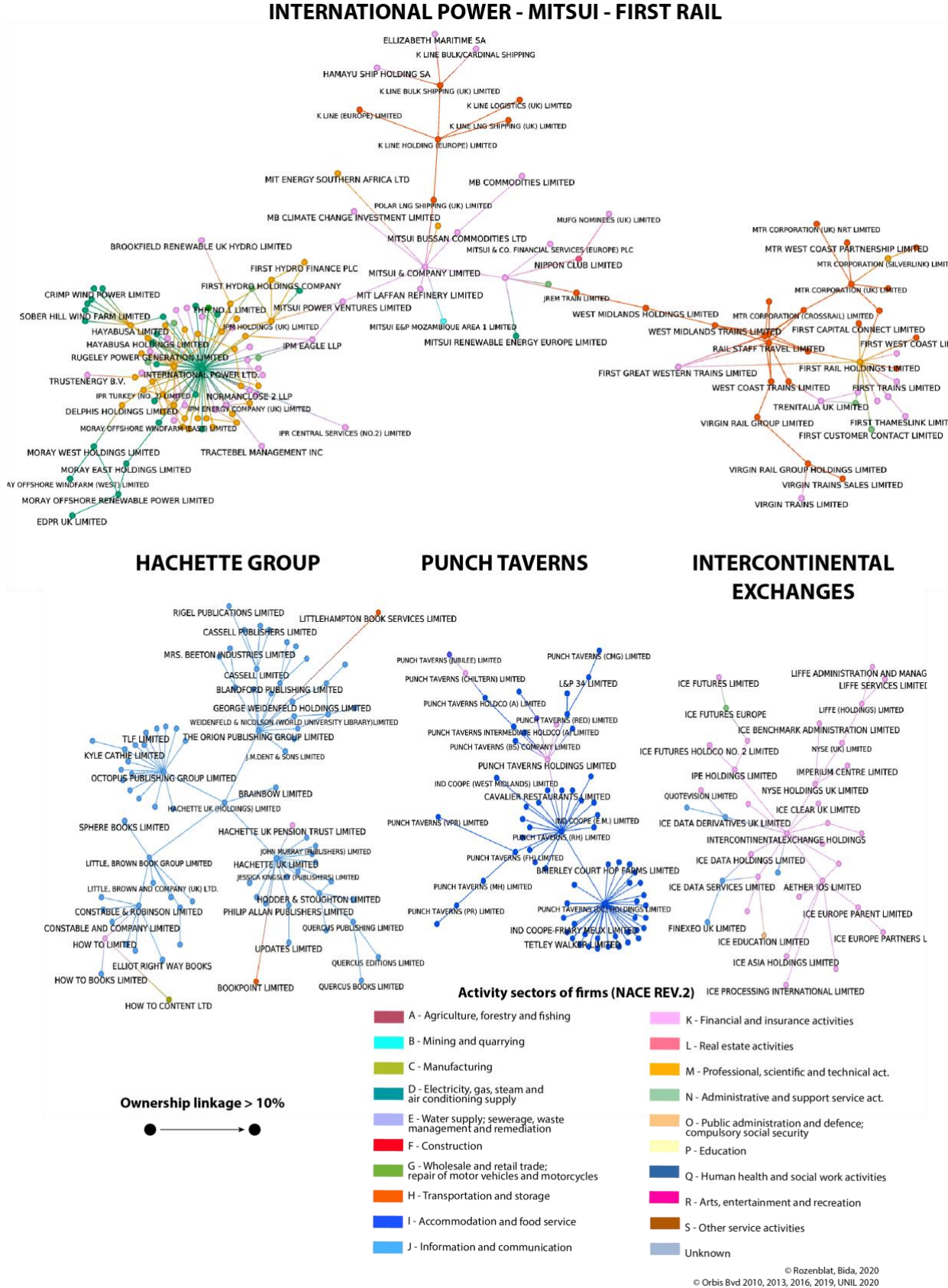
The principal local component of firms that are interlinked by financial ownership relations reveal the strong city system of firms that acquire individual strength by their direct access to the financial and competency resources of the whole system. This main London component is centered around financial and insurance firms that support a myriad of other specialized branches. The most central financial firms of that system (in terms of betweenness centrality) are the *Premier Asset Management Holding* (PAM) company, which specializes in investment management, and the *City of London Investment Management Company Limited* (CLIM), which specializes in closed-end funds (CEFs). These two companies are very interlinked with each other and are even linked socially, as some of the directors of CLIM come from PAM and also from other important rival companies, such as *The Vanguard Group*. Together with more than 3,200 other financial and insurance services companies, such as other investment management companies (e.g., *Aviva Group*, *Legal and General group*, *Schroders*, *Prudential*, and the *Janus Henderson group*), they demonstrate the diversity of London's numerous financial firms, each of which is specialized in very narrow financial sectors. Together with them, the main banks (e.g., *Lloyds*, *Barclays*, and *HSBC*) are also linked. All together, they form the financial core of this main component system (in light pink in Figure 7), permitting the flow of complex investments between them and with other companies specialized by linked branches around this core. The role of real estate companies is particularly central (e.g., *Banner Homes Group*, *The British Land*, *Land Securities Group*, and *Intu Properties*); these companies are situated in different parts of the central network and constitute specific branches. The presence of real estate linkages in the network confirms the role of real estate in the consolidation of parts of portfolio investments and the intimate relationship between capitalization and real estate (Aalbers, 2019). Similarly, construction companies (i.e., the *Berkeley group*, *Taylor Wimpey*, *Balfour Beatty*, *Canary Wharf developments*, and *Kier Building Limited*) provide direct investments in real construction not only in London but also in the whole country and all over the world.

Other main network components include companies involved in wholesale trade (e.g., *Tesco*, *J. Sainsbury*, *Tyson Foods*, *Universal Meat*, *Mark & Spencer*, *BCA Market Place*, *Diploma*, and *Kingfisher*), transportation and storage (e.g., the *First Property Group*, *Clarkson*, *Braemar Shipping*, *British Airways*, *John Swire & Sons*, *Big Yellow*, and *Gama Aviation*), and mining and quarrying (e.g., *Royal Dutch Shell*, *BG Group*, *Rio Tinto*, *Tullow oil*, *BHP Group*, *EnSCO Rowan*, *Sirius Minerals*, *ENI Lاسmo*, and *Esso*). Companies involved in professional, scientific and technical activities include *WPP Jubilee limited*, which is specialized in advertising, media and public relations and invests in more than 400 London companies involved in artwork, film, and design (the orange pack on the top of Figure 7).

In addition to this main network component, London's intraurban linkages comprise more than 2,600 independent network components. Each of these secondary components also contains a mix of several activities. We propose some examples of these smaller networks of firms in order to better understand the arrangement of the activities' complementarities (Fig. 8).

The second main component contains "only" 144 firms linked by 203 ownership relations (Fig. 8-a) and demonstrates well the way in which a foreign firm could insert itself into London's game. *Mitsui* is the core of one of the largest Japanese keiretsu's. Created in 1876, this company is now known as the *Sumitomo Mitsui Banking Corporation* (SMBC). Specializing in raw material trade, *Mitsui* is also active in rail material and construction.

Figure 8-a: Examples of other London's intra-LUR network components in 2019



This scheme demonstrates clearly how *SMBC*, represented by *Mitsui Power Venture Limited*, entered London and established financial contact with *International Power LTD* through both *IPM Holdings* and the *IPM Eagle LLP*, which operate worldwide as investment management firms specifically in the raw materials and energy sectors. On the other side of this relationship, *International Power LTD* is the international part of the *National Power* firm, which was created from the privatization of the nationalized electricity industry of England and Wales in 1990s. It was acquired in totality in 2012 by the *GDF-Suez* French group (now called *ENGI*) and diversified its competencies to all kinds of solar, nuclear, wind electric power generation and power grid management. Its activities in London are conducted through productive companies of electricity generation (in green in the figure) and by exploiting a diverse portfolio of energy sources—renewables, natural gas and coal (similar in operation to *Trustenergy B.V.*, based in the Netherlands but mostly active in Portugal, and to *Moray Offshore*), electric installation and repair (*Swindon Power Technical Services Limited*) and administrative and headquarters activities (in orange). Investment holding companies raise funds (*IPM International BV*, *International Power Group Trustee Limited*, *Rugeley Power Generation Limited*) and sometimes save taxes by being based in Jersey, Gibraltar or Luxembourg (*International Power Luxembourg Holding*).

On the other hand, *Mitsui* is also linked with one of the biggest British rail group of companies, namely, the *First Rail Group*, which encompasses five main companies: *Avanti West Coast* (a joint venture with *Trenitalia*), *Great Western Railway*, *South Western Railway*, *TransPennine Express* and *Hull trains*. This link was made possible by taking control of *West Midlands Holdings Limited* in 2017 (less than 50% ownership but more than 25%), consequently placing Japanese individuals as directors of the firm and reinforcing Japan's participation in the *West Midlands Railway* as part of a joint venture between *Abellio*, the *East Japan Railway Company* and the Japanese conglomerate *Mitsui*. Included also in this local network is *MTR* (Mass Transit Railway Corporation), a Hong Kong company, which manages the Hong Kong metro-system and which built the Guangzhou-Shenzhen-Hong Kong High Speed Rail and many other recent projects in mainland China, in Sweden and in Australia. The double insertion of *Mitsui* in energy, on one hand, and in transportation, on the other hand, enables all the companies to strengthen their position in numerous worldwide projects, e.g., projects from China, Dubai or Australia.

Another incoming example can be seen in the edition sector: the *Hachette Group*, a French company, acquired a large set of British companies that included some British patrimonial publishing companies, such as *J.M. Dent and Company*, fiction publishers, such as the *Orion Group*, and nonfiction publishers, such as the *Octopus group*. Unlike *Mitsui*, the *Hachette* group remains in the unique specialized sector of book editions.

A local firm, the *Punch Tavern*, which comprises 69 companies operating inside London, operates the traditional English pub and has more than 1,300 pubs and breweries all over England, Wales and Scotland (including brands, such as *Pubmaster*, *Inspired Group* and *Avebury Holdings*). It was registered on the stock exchange in 2002 and was acquired by *Patron Capital* and *May Capital* in 2017.

The *Intercontinental Exchange Group* provides electronic trading platforms that operate in global markets through three main components: *ICE* provides market strategic designs; the *NYSE* provides trading for equities, options, Exchange Traded Funds (ETFs) and listings; and *ICE*

Rozenblat C. (2021). Intra and inter cities' networks of multinational firms, in Rozenblat C., Neal Z. (eds.) (2021). *Handbook on cities and networks*, Edward Elgar, in press

Data service provides analytics to enable risk management. Represented in Figure 8-b, another financial service company, *Chaucer Capital Investment*, is specialized in real estate investments. The *Moody's Group* provides more advanced services in information analytics for firm' monitoring. Based in Brussels, The *Bureau van Dijk* which provided all the data used in this chapter, was acquired by *Moody's* in 2016 (which from then on complicated much of our data acquisition procedures).

Figure 8-b: Examples of London's other intra-LUR network components in 2019 (following)

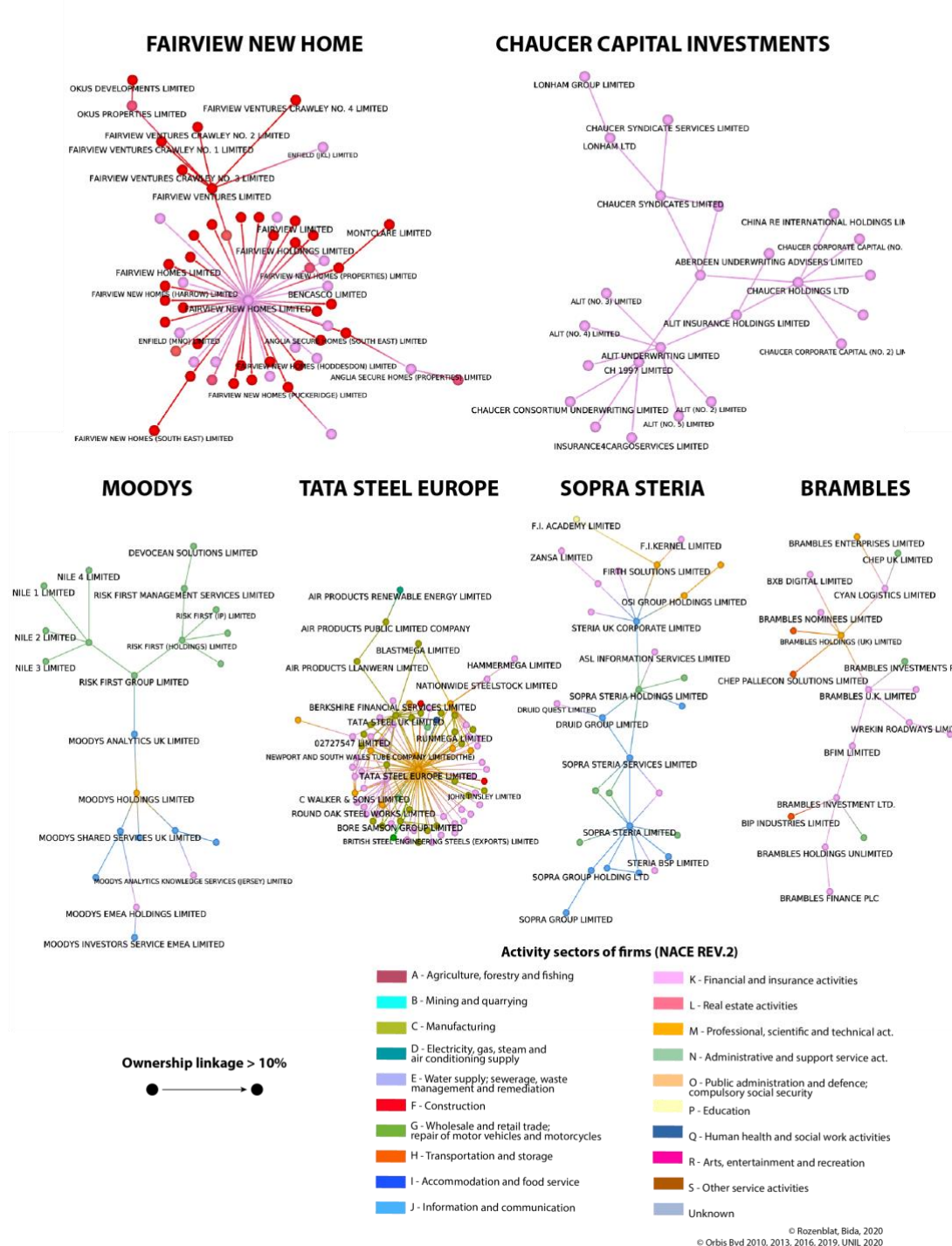


Figure 8-b shows other examples illustrating the diversity of the patterns of these local firm networks in London; this pattern of diversity is demonstrated as much by the networks' shape as by their activity combination. *Fairview New Home* combines strong construction and real estate companies with financial companies; *Tata Steel Europe* together with *Corus management* interlinks 81 companies, combining engineering, finance, human health, trade, manufacturing, real estate and administration to support the financial aspects of London's steel activities; *Sopra Steria* edits specialized software required by scientific companies (in orange), information and communication companies (in blue), and financial service companies (in light pink); in addition, the company also support training with the *F.I Academy* (in yellow). *Brambles* is a logistic company transporting goods all over the globe. Its London plants combine only two logistic companies, which are complemented by scientific, administrative and financial support firms.

3.1.2 Local firm activities in London

In addition to looking at the components, we consider London's total intra-LUR linkages in order to analyze their activities (Tab. 3).

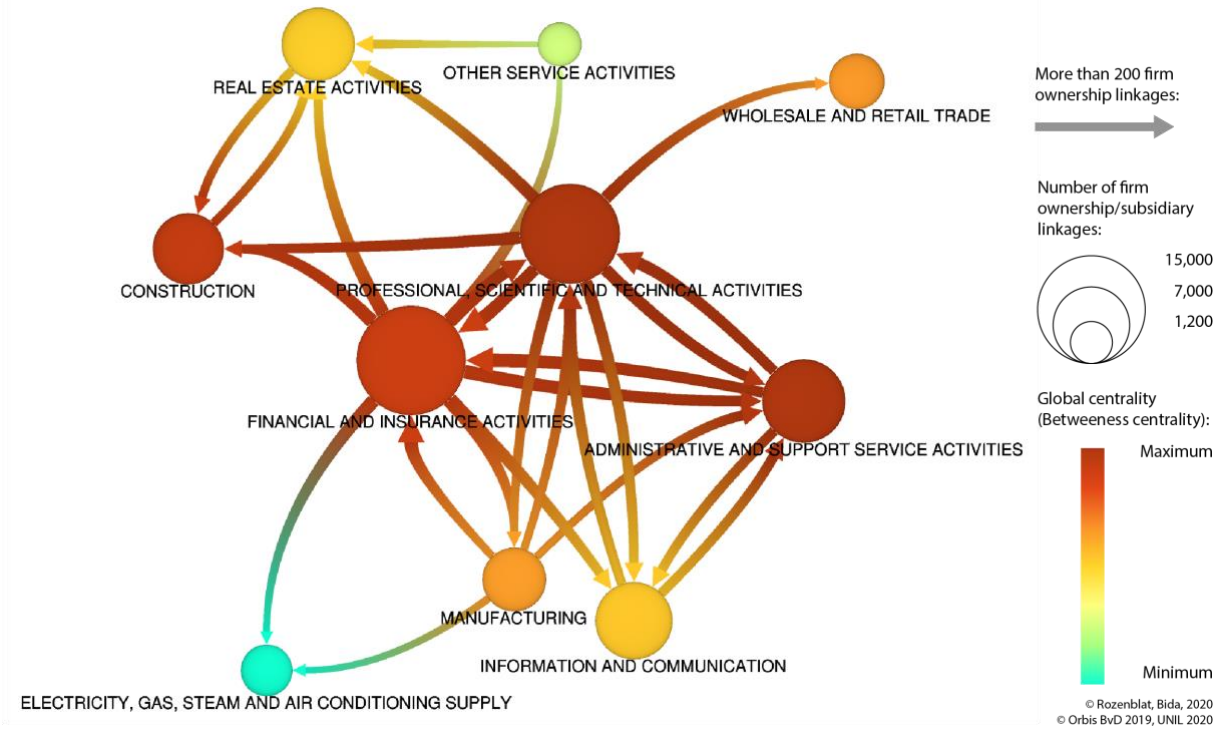
Table 3: Activities of the firms participating in intra-London linkages 2010 - 2019

2010 - ACTIVITY OF FIRMS DEPLOYING LOCAL LINKAGES				2019 - ACTIVITY OF FIRMS DEPLOYING LOCAL LINKAGES			
NACE REV.2		Number of firms	%	NACE REV.2		Number of firms	%
K	FINANCIAL AND INSURANCE ACTIVITIES	9,977	26.3	K	FINANCIAL AND INSURANCE ACTIVITIES	7,558	19.9
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	8,215	21.6	M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	5,688	15.0
F	CONSTRUCTION	4,221	11.1	N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	5,091	13.4
J	INFORMATION AND COMMUNICATION	3,492	9.2	J	INFORMATION AND COMMUNICATION	4,503	11.9
C	MANUFACTURING	2,516	6.6	L	REAL ESTATE ACTIVITIES	2,972	7.8
L	REAL ESTATE ACTIVITIES	2,089	5.5	F	CONSTRUCTION	2,381	6.3
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	2,066	5.4	C	MANUFACTURING	1,974	5.2
G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	1,946	5.1	G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	1,901	5.0
S	OTHER SERVICE ACTIVITIES	1,246	3.3	D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	1,118	2.9
H	TRANSPORTATION AND STORAGE	924	2.4	H	TRANSPORTATION AND STORAGE	888	2.3
R	ARTS, ENTERTAINMENT AND RECREATION	862	2.3	S	OTHER SERVICE ACTIVITIES	721	1.9
B	MINING AND QUARRYING	698	1.8	B	MINING AND QUARRYING	717	1.9
I	ACCOMMODATIONS AND FOOD SERVICE ACT.	615	1.6	I	ACCOMMODATIONS AND FOOD SERVICE ACT.	705	1.9
Q	HUMAN HEALTH AND SOCIAL WORK ACT.	340	0.9	Q	HUMAN HEALTH AND SOCIAL WORK ACT.	668	1.8
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	302	0.8	R	ARTS, ENTERTAINMENT AND RECREATION	453	1.2
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	100	0.3	T	ACTIVITIES OF HOUSEHOLDS AS EMPLOYERS; UNDIFFERENTIATED GOODS- AND SERVICES-PRODUCING ACTIVITIES OF HOUSEHOLDS FOR OWN USE	209	0.6
P	EDUCATION	96	0.3	E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	164	0.4
A	AGRICULTURE, FORESTRY AND FISHING	83	0.2	P	EDUCATION	163	0.4
O	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	36	0.1	O	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	80	0.2
T	ACTIVITIES OF HOUSEHOLDS AS EMPLOYERS; UNDIFFERENTIATED GOODS- AND SERVICES-PRODUCING ACTIVITIES OF HOUSEHOLDS FOR OWN USE	22	0.1	A	AGRICULTURE, FORESTRY AND FISHING	42	0.1
U	ACTIVITIES OF EXTRATERRITORIAL ORGANISATIONS AND BODIES	0	0.0	U	ACTIVITIES OF EXTRATERRITORIAL ORGANISATIONS AND BODIES	4	0.0
No information		16,706		No information		11,174	
TOTAL		56,552		TOTAL		49,174	
With information		39,846	100	With information		38,000	100

According to Table 3, London's firms as a whole participated in activities involving intra-LUR linkages, although since 2010, the number of firms decreased in total and there was a transformation in the firms' intraurban linkages' activity composition. The firms in large part were in the finance sector, insurance sector, and administrative services in 2010, but the share of these two sectors dramatically decreased during the period 2010-2019: these two sectors together represented 47% of all firms in 2010, while they represented only 33% of all firms in 2019. In addition to the decrease of financial and administrative services, there were other activities lost due to the decrease in the number of local network companies in construction, manufacturing, art and entertainment or agriculture, and there was an increase in the number of companies engaged in professional, scientific, technical and information and communication activities; the number of firms engaged in these activities grew both in absolute numbers and in percentages.

Considering their linkages in 2019, 25% of the firms' linkages were owned by financial firms, 20% by firms in professional, scientific and technical activities, and approximately 8% by firms in administration, real estate, manufacturing and trade. The local ownership system is centered on finance, scientific, technical and administrative activities, while other activities formed their main periphery (Fig. 9).

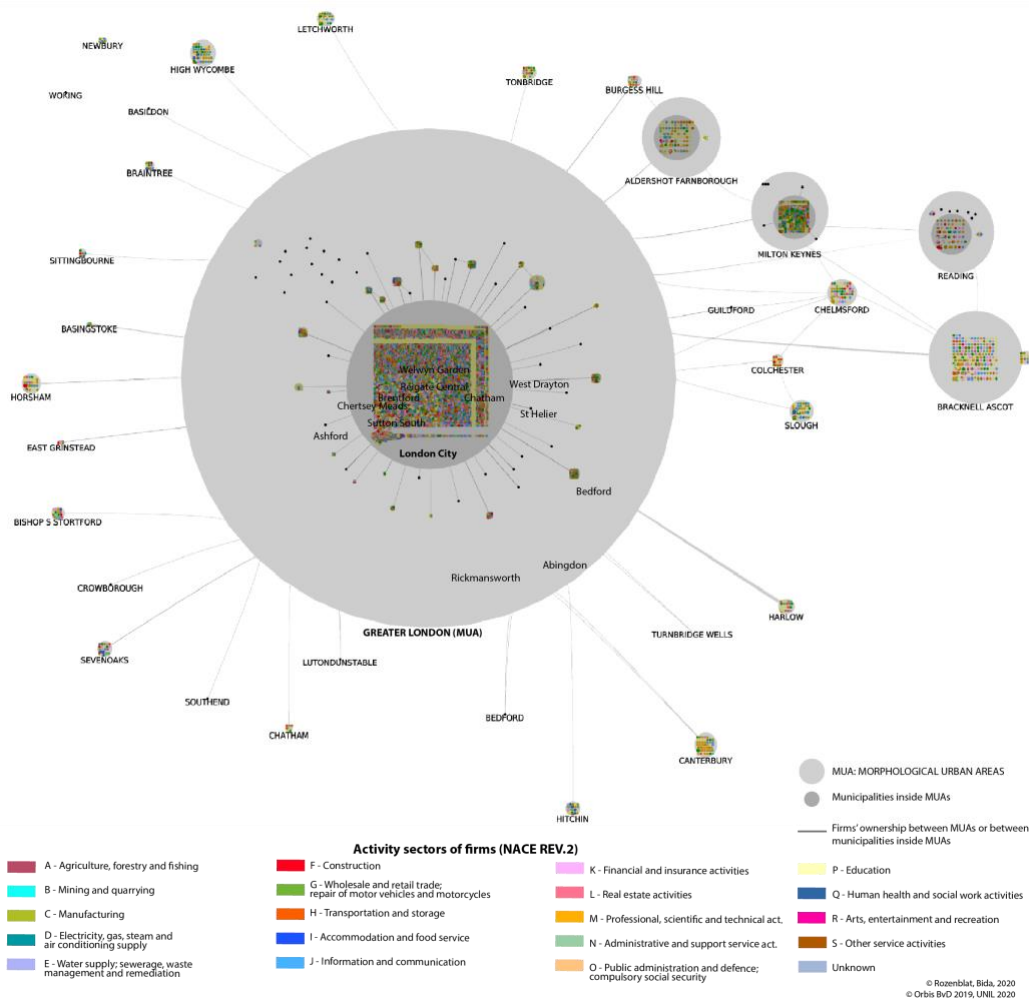
Figure 9: Ownership system between activities of London's intra-LUR firms' network in 2019



3.1.3 London's LUR polycentricity

In terms of the spatial distribution inside the LUR of London, there is a high concentration inside London's morphological urban area (MUA; the equivalent of Greater London)—concentrating 98% of all the firms' linkages (Fig. 10).

Figure 10: London's intra-LUR firms' network polycentrism in 2019



Around the London MUA of Greater London, forming a star, most of the other MUAs of the LUR are only directly linked with firms of the core MUA. The direction of the linkages slightly benefits the owners in London possessing subsidiaries in the periphery (200 links), but the linkages in the opposite direction are quite balanced (130 links). The main component that was observed in Figure 7 is partly distributed in all the surrounding London satellites. This can be seen in services industry companies such as *Personal Assurance* [insurance] (24 linked companies) or industrial ones, such as *Design Group UK* [cards and gift wrap] (18 linked companies), *Essentra* [plastic and fiber products] (31 linked companies) or *Domino's Pizza* (19 linked companies), which are all located in Milton Keynes and belong to the main London component. This is also demonstrated by *Venture Life Group* [Healthcare] in Bracknell Ascot and *Sureserve Compliance Services* [repair services of gas, fire and electrical, water and air conditioned] in Reading.

Other than this "star" that the MUAs constitute around London city, only Milton Keynes, Bracknell Ascot and Reading form a weak polycentric network together with Chelmsford, Colchester, Slough, Guilford and Burgess Hill. Outside London, we count approximately 500 firm links that are located 90% inside the MUAs.

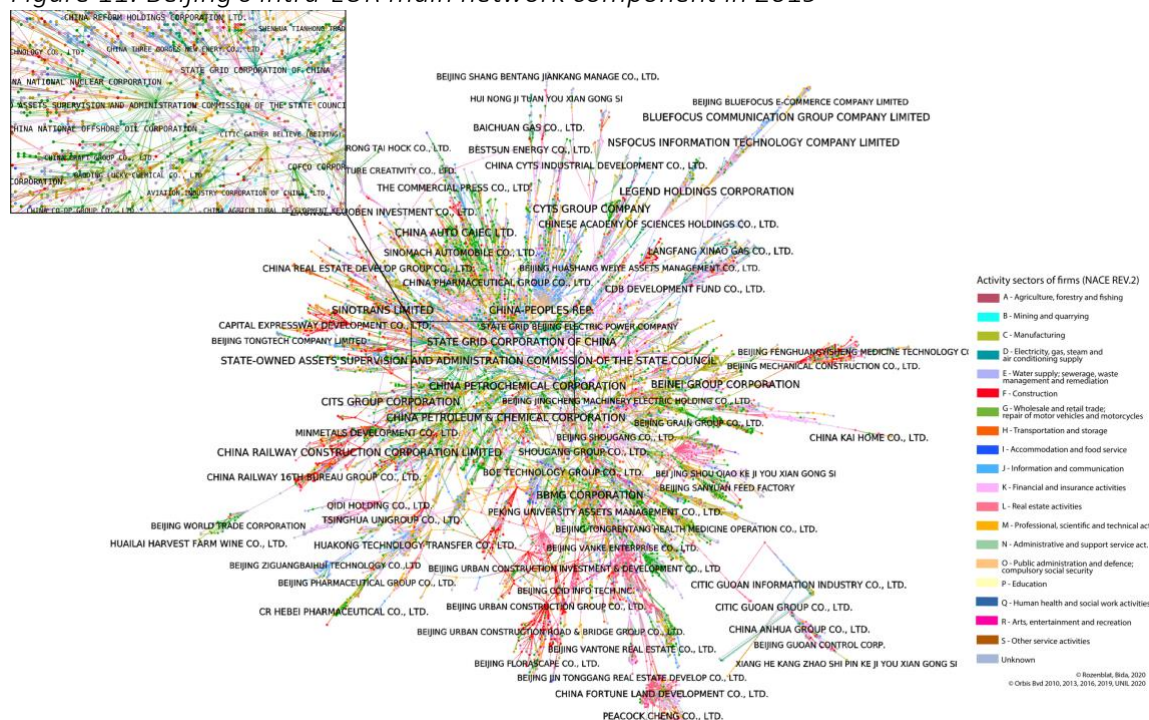
3.2 Beijing's intraurban linkages

Unlike London, Beijing experienced a huge increase in the weight of its global networks, as well as a high level of complexification in its intraurban linkages, which increased from 4% in 2010 to 27% in 2019.

3.2.1 Beijing's network components of local linkages

In 2019, Beijing's main component remained much smaller than that in London, with 8,626 firms and 9,725 linkages (Fig. 11).

Figure 11: Beijing's intra-LUR main network component in 2019



This main component comprises more than 75% of the total 11,416 firms involved in the intraurban firms and 82% of the total intraurban linkages. It is much larger than London's main component, which comprises 40% of all the firms involved in London's intra-LUR linkages and 60% of their intra-LUR linkages. Beijing's main component reflects the organization of the Chinese state, which provides leadership in a very concentrated and hierarchical way.

Beijing's main component is totally centered around the administrative support functions of the *State-owned Assets Supervision and Administration Commission of the State Council* (green star in Figure 8), affirming the importance of the state in financial and economic planning in cooperation with financial state companies, such as *CDB Development Fund Co.*, *the Citic Group Corporation*, *Beijing Huashang Weiye Assets Management*, and *China Chengtong Holdings Group*. Other numerous firms also classified as "administrative and support services" firms occupy the center of this network, each of them oriented to specific activities (e.g., *China Agricultural Development Key Construction Fund*, *Beijing Energy Holding*, *Aviation Industry Corporation Of China*, *Beijing Jingcheng Machinery Electric Holding*, *Beijing Urban Construction Investment & Development*, *Beijing Uni-Construction Group*, and *Peking University Assets Management Co*). Each of these companies directs the activities of specialized manufacturing

or trade companies that are quite close to the central government. This relationship is revealed by green linkages (manufacturing or trade) in the center of this main component.

Beijing's intraurban firm linkages are characterized by a very dominant power arrangement in which all firms are quite close to the central head, with only one or two intermediate edges. It is structured by a dominance of hierarchical linkages and a lack of complexity: on average, Beijing's main intraurban component comprises 1.12 linkages per firm, while that of London comprises 1.5 linkages. Thus, Beijing is much closer to 1, denoting the extreme case in which every firm has only 1 linkage and demonstrating a pure tree structure.

In addition to this huge main component, Beijing has 760 other much smaller local components, the largest of which is the one for *Beijing Haidian Science and Technology*, which contains 28 firms (Fig. 12-a). This company, located in the Haidian district near the former *Beijing Steel and Iron Institute* (today, named the *University of Science and Technology of Beijing*), has supported for more than 20 years the development of the *Haidian Science park*, also called *Zhongguancun*. With approximately 100 Fortune 500 companies that have located their research and development centers in *Haidian Science park* and including several innovative Chinese corporations, such as *Lenovo*, *Founder* and *Baidu.com*, it is one of China's largest and most important high-tech bases. Dedicated to health care services, it supports diversified activities not only in medicine but also in Robots and, more surprising, in jewelry. Its structure is also organized in a star shape and includes financial, manufacturing, and trade companies.

This star shape has also been adopted by other components, such as the *Vantone Real Estate* component that mixes financial and real estate companies together with trade companies and hotels or the component for *Pony Roll Media Culture*, an entertainment company located in Dongcheng and engaged in providing e-tickets for concert. This company was acquired in 2017 by the famous Chinese *Alibaba group Holding*, based in Hangzhou and located 200 km from Shanghai; it is not located in Beijing.

Moreover, focusing on foreign companies entering in the Beijing arena (Fig. 12-b), we found that Siemens and Volkswagen are two German groups that have formed small local components in Beijing. They each appear with two independent components. Siemens has had a presence in China since 1994 and produces electronical components, as shown in the left-hand side component in Figure 12-b.

Figure 12-a: Examples of Beijing's other intra-LUR network components in 2019

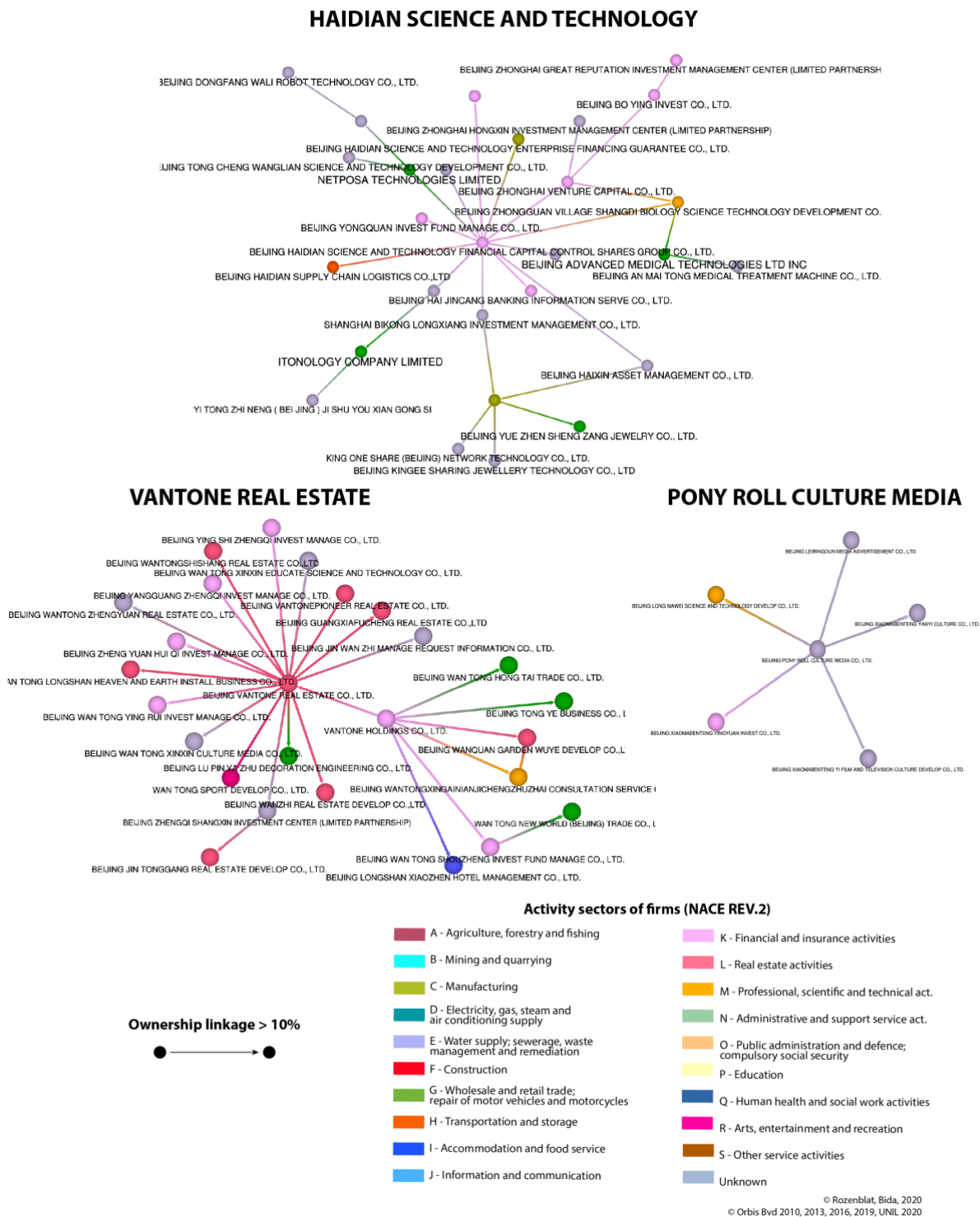
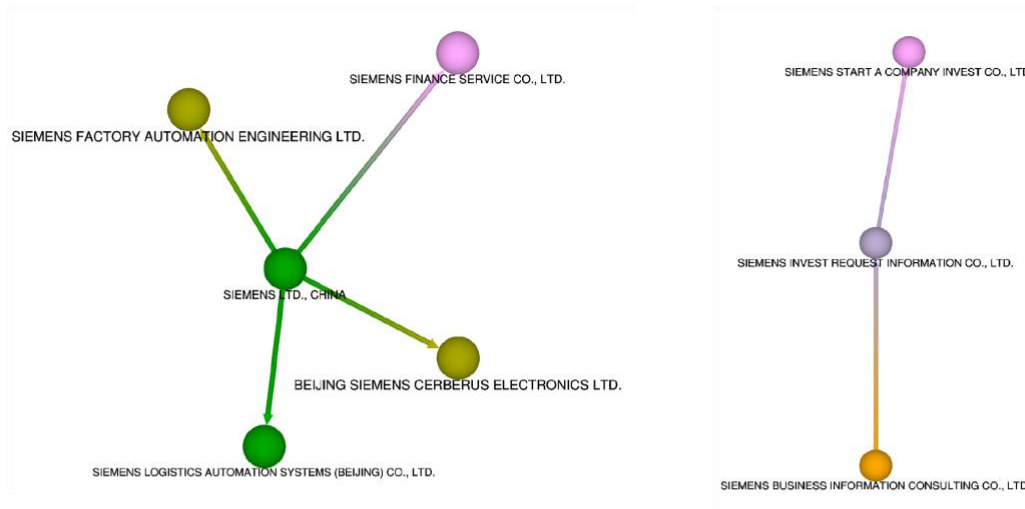
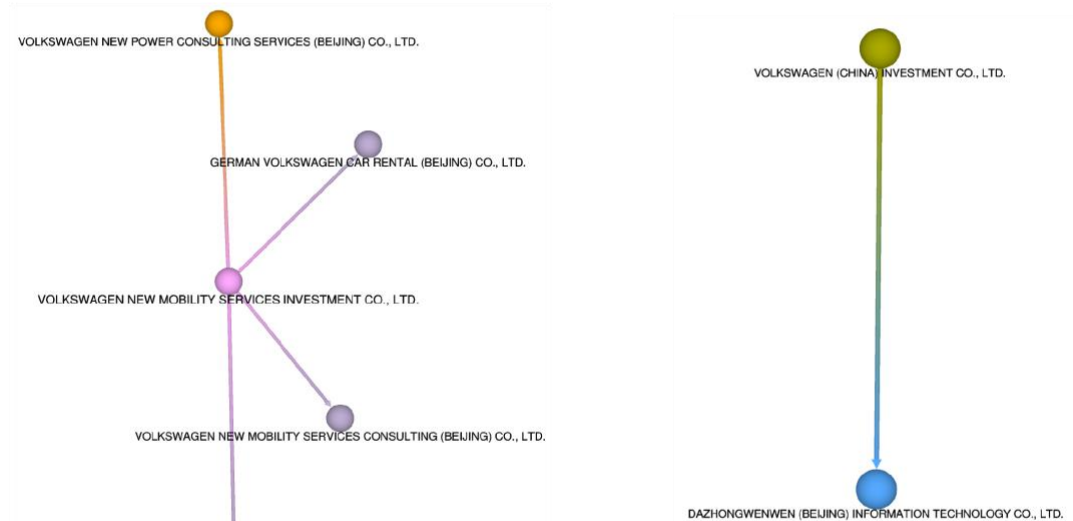


Figure 12-b: Examples of Beijing's other intra-LUR network components in 2019 (following)
SIEMENS



VOLKSWAGEN



Through its second component, namely, the network of *Siemens Invest Request/Business Information Consulting/Start a Company Invest*, which is headquartered in Beijing and has branches in Shanghai, Siemens offers access to the know-how and financial expertise for finding investments in technologies.

Similarly, Volkswagen is present through two independent components and even a third one, which supports a company belonging to the main Beijing component: *Beijing Shangqi Shouchuan Shanghai Volkswagen Maintenance* is partly owned (30%) by the *Beijing Capital Group*. Initially located in 1985 in Shanghai (Automobiles were built in Anting nearby), Volkswagen is now present in all parts of the country (joint ventures and wholly owned enterprises exist in Beijing, Changchun, Shanghai, Chengdu, Nanjing, Dalian and Hong Kong). The Beijing plants mostly provide a financial integration function and include more than 2,300 employees that were previously spread out in four different places in Beijing; these employees were regrouped in a unique headquarters (the Vspace in the Chaoyang district of Beijing along the 3rd ring road) in 2019.

3.2.2 Local firms' activities in Beijing

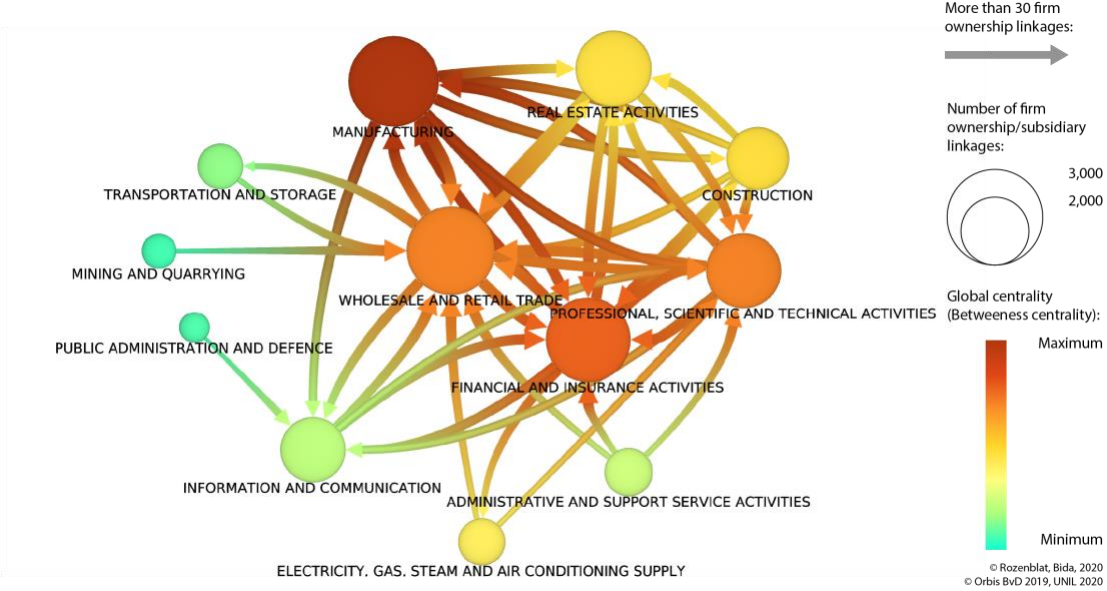
Considering all the firms using intraurban linkages in Beijing, there were very few that participated in activities using intraurban linkages in 2010; most of these firm activities were in finance, insurance and manufacturing, and they expanded dramatically up until 2019 transforming totally the composition of the local firms' ownership networks (Tab. 4).

Table 4: Activities of the firms participating to the intra-Beijing linkages 2010 - 2019

2010 - ACTIVITY OF FIRMS DEPLOYING LOCAL LINKAGES				2019 - ACTIVITY OF FIRMS DEPLOYING LOCAL LINKAGES			
NACE REV.2		Number of firms	%	NACE REV.2		Number of firms	%
K	FINANCIAL AND INSURANCE ACTIVITIES	25	35.2	G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	1'618	18.7
C	MANUFACTURING	21	29.6	M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	1'206	13.9
F	CONSTRUCTION	5	7.0	C	MANUFACTURING	1'176	13.6
J	INFORMATION AND COMMUNICATION	4	5.6	K	FINANCIAL AND INSURANCE ACTIVITIES	1'164	13.4
G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	3	4.2	L	REAL ESTATE ACTIVITIES	1'059	12.2
H	TRANSPORTATION AND STORAGE	3	4.2	J	INFORMATION AND COMMUNICATION	777	9.0
L	REAL ESTATE ACTIVITIES	3	4.2	F	CONSTRUCTION	469	5.4
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	3	4.2	H	TRANSPORTATION AND STORAGE	271	3.1
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	2	2.8	N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	239	2.8
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	1	1.4	D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	231	2.7
I	ACCOMMODATION AND FOOD SERVICE ACTIVITIES	1	1.4	I	ACCOMMODATION AND FOOD SERVICE ACTIVITIES	177	2.0
No information		1		B	MINING AND QUARRYING	58	0.7
TOTAL		72		A	AGRICULTURE, FORESTRY AND FISHING	55	0.6
With information		71	100	E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	55	0.6
				O	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	30	0.3
				R	ARTS, ENTERTAINMENT AND RECREATION	29	0.3
				Q	HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	21	0.2
				P	EDUCATION	18	0.2
				S	OTHER SERVICE ACTIVITIES	11	0.1
				No information		2745	
				TOTAL		11'409	
				With information		8'664	100

The most central activity in the ownership network inside Beijing is manufacturing, followed by financial and insurance activities, professional, scientific and technical activities and wholesale trade (Fig. 13). Note that the network in Figure 13 is not directly comparable to the one of London (Fig. 9) because we had to adapt the thresholds to the scale of Beijing.

Figure 13: Ownership system for the activities of the Beijing's intra-LUR firms' network in 2019

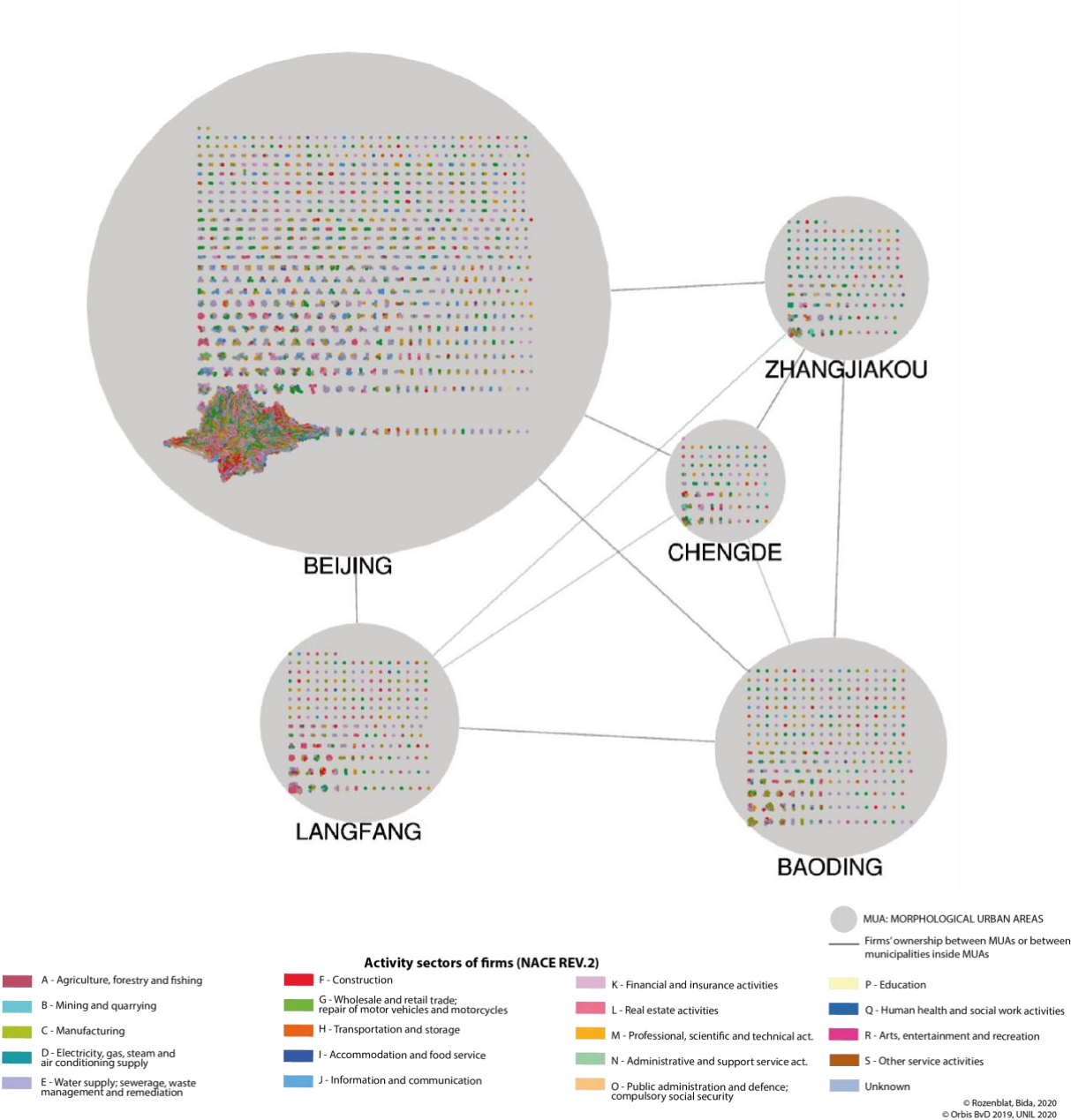


The main difference between Beijing and London in 2019 is the weight in Beijing of manufacturing and wholesale trade, as London is dominated by finance, insurance, administrative and support activities. In both cities, professional, scientific and technical activities are positioned in the center of the system, revealing the place of innovation in each capital city. In London, the administrative and support services seem much stronger (in weight and centrality) than in Beijing because their nature is quite different: in London, these are privately provided services that comprise numerous companies that are spread everywhere in the productive processes. Unlike London, Beijing's administrative and support services are mostly state companies that direct a fewer number of companies in a hierarchical way.

3.2.3 Beijing's LUR polycentricity

Similarly to London, in Beijing, the intra-LUR linkages are mostly concentrated in Beijing's core (Fig. 14): a total of 87% are in Beijing city (corresponding to the official city definition). The number was even higher for London's core, which concentrated 98% of all linkages of the LUR. Therefore, the Beijing urban region is less polarized in the core area, with privileged linkages from the core to the periphery (755 links) rather than in the opposite direction (65 links). The most important link goes from Beijing to Langfang, situated in the South-East at the middle way to Tianjin. In Langfan, there are many extensions of Beijing's main component, especially those linked to *Langfang Jingyu Real Estate Development*, which comprises 117 firms primarily involved in real estate but also includes import/export companies of metallic products. Langfang also hosts the *China Petroleum company* and numerous branches of pipelines and logistics.

Figure 13: Ownership system for the activities of the Beijing's intra-LUR firms' network in 2019



The second linked satellite to Beijing is Baoding, the capital of the Heibei province, situated farther to the southwest of Beijing. With approximately 1 million inhabitants, the city is more industrial, producing electric power equipment (*Baoding Tianwei Baobian Electric*: 21 firms) and cars (Great Wall Motor: 33 firms). The city also includes offices for the *China Lucky Film Corporation* (13 firms), which is the largest photosensitive materials and magnetic recording media manufacturer. Baoding has the same number of firms deploying intraurban linkages as Langfang (450), but the firms are much more linked together inside Baoding and less linked to Beijing.

The city of Zhangjiakou (situated to the northeast of Beijing towards Inner Mongolia) is also very industrial, hosting a very important thermic central power plant and numerous steel, iron and coal companies. Chengde, an historical city and the home of the summer King palace of the Qing dynasty, is situated 200 km northeast of Beijing. Today, in addition to tourism, the city

is specialized in steel production, as provided by the *Chengde Iron and Steel Group*, which is directly supervised from the Beijing's main component. The city also has mining and blasting equipment companies.

The deconcentrating activities of Beijing benefit all these surrounding cities of Hubei province and have resulted in a network rebalancing towards this province; however, the control still comes from the center of the network. Note that we did not include Tianjin in the Beijing's LUR because Tianjin, a coastal important city with more than 15 million inhabitants, has developed its own regional system in its LUR. However, examining the exchanges between the Beijing LUR and the Tianjin LUR, we note the same kind of disequilibrium between the firms' linkages: there are eight times more firms' linkages from the Beijing LUR to the Tianjin LUR than in the opposite direction, and the linkages are oriented essentially towards manufacturing, trade, professional, scientific and technical activities. Thus, the centrifugal movement of the linkages in the Chinese capital is a local, regional and national movement towards the largest regional capitals.

The Chinese main development during the period 2010-2019 has been revealed as the expansion of its intraurban and national networks, strengthening the international ones that also developed so dramatically. The Chinese urban networks' dynamic also reveals the intertwining of the intraurban networks' densification and the interurban expansion of firms.

4. Conclusion

These two examples of London and Beijing are two extreme cases of the transformation of intracity networks in the cities' global expansion: London, which has been the archetype of the global city since the 1990s, reduced its internal linkages (which were too vulnerable and experienced cascading effects) between 2010 and 2019; however, to strengthen its worldwide governance value, it increased its level of diversity of financial services and private administrative support for the numerous firms coming from all over the world. At the opposite end of the spectrum, the Chinese economic global expansion has been sustained by Beijing's strong hierarchical structure, in which international firms are used to reinforce the country's own firms' capabilities. Chinese national networks expanded around Beijing into its surrounding satellite cities in Hubei and into the whole country in order to scale up its firms in its national diversified market. The linkage complexification is far from the one that we find in London, and the shape of the linkages is forged by a controlling regime; however, the focus of the country is the leveraging of many Chinese companies to enable them to face North American and European competition.

We must also consider the national scale expansion that is very important in the Chinese case: the multinational linkages of Beijing essentially expanded nationally (outside Beijing's LUR itself) during the period 2010-2019, from 11% to 63% in 2019, and the intra-Beijing LUR linkages comprised 90% of all its links in 2019. In comparison, London decreased the share of linkages in Great Britain (outside the London LUR) from 13% in 2010 to 10% in 2019.

With much less efficient political structures and smaller national capacities to strengthen the national firms by their own territorial capacities, other BRICs countries' cities have followed the pattern of Chinese cities. Most of the cities in the increasing number of groups owe their internal development to the meeting of external actors and global conditions with the local

human or natural resources: this is the case for the growing number of U.S. cities in this group, as well as for the cities of Vietnam, Liberia or central Asia.

Another extreme case is the one concerning the tax havens. Wilmington DE, as well as Grand Cayman, Bermuda Kinsley or Tortola, does not truly base its network scope on a strong internal complex game of actors. These cities do not have large national economies and are rather part of the game played by actors located in other cities and who only take advantage of the cities' intermediation ability; however, these cities are not major players. The first part of the chapter on the global expansion of the multinational firms' networks at different scales showed how much national scale matters and the extent to which this scale sustains the expansion of their cities abroad. The evidence of the global trend demonstrates the tendencies of cities in which intraurban linkages are quite low (such as the U.S. cities) to relatively increase their local complexities, while the evidence also reveals that the cities that were too intertwined (such as London as well as other European, Russian or Japanese cities) tend to relax their internal linkages for a higher diversity of networks, thus supporting their resilience. The local and national networks also adopt to the shape of the institutions and the regime. This was very clear in China, where most of the networks form star shapes. The embeddedness of foreign networks within Beijing also adopted to this form, as they thus were obliged to adapt to the local society. In this perspective, network and hierarchy must not be opposed, as they intrinsically reflect the organizational structure of the society. Hierarchies (trees or concentrated networks on certain nodes) are specific kinds of mathematical networks that are more centralized and not just circuits. Despite the claim of more equality brought by the networks, the development of complex network studies in the last 20 years showed how far these hierarchized structures (or scale free networks) were much more dominant than the egalitarian ones.

The result of disentangling the different scales and levels of urban networks appears in this chapter through the systematic comparison of the cities' networks at local/global levels and at different scales. The trajectories are very diverse and would deserve in many cases to be examined in much more depth. In particular, it would be worth specifying to what extent each city plays the role of a network "governance node" in the context of the duality of "embedded governance" in their services and economies of scope for their innovation. For example, in a study on Marseilles-Aix en Provence metropolis (Rozenblat, Bellwald, 2015), we demonstrated the extent to which inside this urban area the intra-municipal firms' linkages supported specialized clusters of innovation, while intermunicipal linkages were mostly financial flows coming from the two poles of Marseilles and Aix-en-Provence. It was much easier to underline this double logic in such a medium-sized city than in large metropolises where industrial and financial linkages are so dense and intertwined.

The local flows linked to global flows that we reported here are different in nature than the ones described in the Christaller model (Christaller, 1933). We can recall that the Christaller model described local and regional dependences of inhabitants for daily services. The industrial and financial networks that are at stake here do not replace local services flows but are juxtaposed and intertwined with them to constitute the thickness of the urban societies: These networks are supported by the inherited local spatial structures developed previously due to the service local hierarchies, the legacy of local savoir-faire and to the specificities of the reputation of places. Globalization has caused the dual emergence of the inter- and intracity

Rozenblat C. (2021). Intra and inter cities' networks of multinational firms, in Rozenblat C., Neal Z. (eds.) (2021). *Handbook on cities and networks*, Edward Elgar, in press

networks, and it would be wrong to say that local networks would be less complex than global ones. In the interactive processes of financial functions and information flows, the firms' network dynamics find a balance between intra- and interurban levels, demonstrating the adaptive organizational capacities of the economy within the political and institutional national and international transforming frameworks. The future evolution of this balance towards a greener economy would certainly be helpful for facilitating the development and resilience of cities.

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