

# CITIES IN MULTI-SCALE AND MULTI-DIMENSIONAL PROCESSES OF GLOBALIZATION

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#### Abstract:

This study of multinational firms networks aim to explore the "duality" between world urban integration and firms' networks extensions, focusing on the imbrication of multi-scale advantages and on differences between economic sectors. An empirical study is developed on the network of the 1 million ownership links between direct and indirect 800'000 subsidiaries of the 3'000 first multinational firms of the world. All units have been located at the scale of cities (delineated in a comparative way).

The multi-scale approach and the multi-dimensional one (by activity sector) show the remaining coherence of national and continental territories that interplay with cities in order to support and create these global links. A very new approach showing the intra-urban links has revealed the importance of local linkages in the production of global networks. The main activities in the core of the whole networks are finance and information and communication, while the more growing sector seems to be the ones whose hierarchize more the cities: research and information-communication. In this respect, German cities and capital cities, which are specialized in these sectors, seem to have future advantage.

### Introduction

Although globalization of multinational firms occurs at international scale, more diverse geographical levels (regional, national, trans-border, continental) matter to orient their spatial organization and it is mostly concentrated into great urban areas. Besides these geographical aspects, different strategies of the firms, according to the amplitude and shape of the extent of their networks, and according to their activity sector, remain essential to understand the development of such transnational networks (Dunning, 1998, 2009; Mc Cann, Mudambi, 2005). These different dimensions (geographic, economic and organizational) create high differentiation between cities to integrate the dynamic of globalization, and their capacities to support and leverage the multiple systems of interaction that place them in direct competition with each other in the struggle to attract the most productive or prestigious activities (Begg, 1999).

One can identify three main aspects of these processes:

- The "duality" between urban development and firms' networks extensions;
- The imbrications of multi-scale advantages both for the origin of the owners, and for the location of subsidiaries (and between them, for the indirect paths, networks often pass through, for financial or organizational reasons);
- The various strategies of firms of different economic sectors according to their technological level and to their economic cycles.

Crossing these three dimensions through the networks of multinational firms, leads to approach multinational firms, cities and other geographical scales, in their common dynamic processes. This paper aims to develop such a way, in order to understand better the position of cities inside multinational firms' networks, and their possible future extensions.

### 1- Network approach linking cities and multinational firms

The relation between cities and multinational firms is intrinsically linked to their own networks' properties. The goal of the cities' governments is to attract development thanks to their good position inside different multinational firms' networks, while the goal of



multinational firms is to combine appropriate resources in order to gain advantages facing concurrencies. In these dynamics, networks on the one hand, transform cities, while on the other hand, cities shape networks. Cities constitute the social, economic and political environments that maximize interactions creating local and global networks. At the same time, cities feed off the same networks for the construction of their social, economic and political fabrics. Thus, cities and business networks constitute together a "duality", in which business networks have now increased potential to structure cities (Neal, 2008). In return, though, businesses locate around the highly differentiated resource and market availabilities that they draw from urban territories. It would therefore become clear that the space of flows and the space of places are closely connected in the structure and dynamics of cities, thus constituting "systems within system of cities" (Berry, 1964; Pumain, 1997). In this way, urban resources and urban interactions are intrinsically interdependent, and, as Hall and Pain suggest, "the degree of interrelationship among cities is a reflection of the concentration of advanced services within them; but conversely, this concentration reflects the degree of actual and potential connectivity between them; the process is circular and cumulative" (2006, p.7). The city is often defined either at the meso-level, according to its internal components, or at the macro-level, according to its external networks, but rarely by taking account the both at once (Meijers, 2005; Green, 2007; Hall, 2007). Yet it would appear that the two levels are strongly connected both by the networks that constitute them and by the emerging processes that transform them (Lane, 2006; Pumain, 2006). According to Doreen Massey (2007), "The local is not only a product of the global but that global itself is produced in local places" (p.107). We are a long way here from the idea of the establishment of a global scale entirely disconnected from the local scale. We are rather faced with a situation in which numerous levels of geographical scales constitute organizational levels that are entirely articulated on the structures of corporate development, but which are also organized on the basis of the investment transfer activities of financial companies.

Through the setting up of their subsidiaries and production units and through the weaving of their internal and external exchange networks, the multinational corporations position each environment and each city, within a complex system of interdependency. Synergies develop within places (Marshall, 1920; Ohlin, 1933; Hoover, 1937, 1948; Jacobs, 1969; Henderson, 1988; Ellison & Glaeser, 1997; Camagni, 1999; Gordon, Mc Cann, 2000; Duranton & Puga, 2004) and between places (Castells, 1996; Rozenblat, 2010). Networks of cities are reinforced if they occur between cities where local interactions are well developed. Values are created at the level of individual partners or institutional networks acting in the economic and governance dimensions of the firm and interacting with territories' properties and institutions (Gereffi, 1996; Gereffi et al., 2005, Mc Cann, Mudambi, 2005). The network approach allows identify processes that develop inside and between cities and in interaction with territorial organizations at various geographical scales that integrate different economic and social systems and institutional rules.

### 2- Multi-scale development of networks

Cities share similar destinies, being closely linked to each other by the same global actors. There are then places with some functions that benefit the industrial business system and they offer the conditions to access to the economic networks' powers. The position of their firms in the multinational networks confer some resources of power, which are not localized and static, but a dynamic process involving several actors in interaction. The headquarters controlling different subsidiaries is a part of this power. The cities where headquarters are



located encompass people and institutions, which possess the decision power and attract other people and institutions ambitioning to access to the central power.

At different privileged relational scales, business networks develop where local or regional clusters integrate the longest-range networks capable of articulating different specific urban factors. According to Doz & al. (2001), our perception of systems becomes a global perspective on the world, complete with technology pockets, "intelligent markets" (i.e. specific markets) and identified capacities. These firms, however, which really function in a totally "global" manner and which give perfect consideration to the complementarity that should exist between their different geographical and topological units are extremely rare (Rugman, 2001). Rather, the establishment of networks at multiple geographical levels seems mostly to emerge in organizational networks-and not only those of transportation (Dicken & al., 2001). As Whitley (1998) has demonstrated, even though agent networks do transcend geographical scales (Castells, 1996), the organizational levels of the "global commodity chain" crystallize in some specific scales from the local to the global. In this context, multinational corporations do not develop in open and homogeneous territories, but rather transversely connect a system of territories (well-fitting or not) and produce their rules and regulations. The "transnational field" continues to be strongly structured by the "international field", on which depend "exchange rates, labour market regulation and fiscal conditionsthose "externalities" from which the business can draw advantage—and the scale and state of the market" (Dollfus, 2001, pp. 104-105). From this perspective then, the continental level increases its cohesive role through the establishment of free trade zones, thus reinforcing continental systems (Dunning, 2002, 2009; Rozenblat, 2004a), and national level remains very important in the globalization processes (Sassen, 2007).

# 3- Corporate networks and "global value chains"

The concept of the "global value chain", which informs contemporary corporate governance, predicates the multi-dimensional nature of localized "clusters". Such clusters are rooted in local urban environments that are at once interdependent and "inter-influential" (Krätke, 2002). Thus businesses can combine a wide range of strategies to increase their markets, while at the same time minimising the costs and risks of their strategic localizations. Alongside their investment in diversified localization, they also deploy a wide range of activities and types of transnational interdependency: exporting, sub-contracting, outsourcing of intermediate products and business partnerships. With regard to sub-contracting and the issue of hierarchical networks, companies are able to transfer production and thus investment risks to local businesses. New forms of investment such as franchising and sub-contracting for example cause production to be organized at new geographical scales. Many transnational companies concentrate their activities on those capabilities, such as research and development or specialized production, that generate high-yield value and which constitute crucial links in the value chain (Gereffi &al., 2005).

The "Global Value Chain" (Porter, 1996, 2000, 2003; Gereffi, 1996), recognizes four major dimensions determining the distribution of functions and responsibilities between different, and often widely spaced, production units: an economic input-output structure of production, services and resources; a structure of governance; a differentiated space; and territorialized institutions. In a territorialized approach, the last two dimensions—spatial and institutional— can be thought of a single entity: namely territory. Such an approach therefore conceives of three interdependent dimensions: a company's *governance*, the *economic system* in which the



company operates, and the *territories* that host it (Dicken and Malmberg, 2001; Rozenblat, 2004b, 2007). This tri-dimensional system notably develops at the scale of the urban system, which, through its specific relational properties (size, connectivity and diversity), provides networked companies with the advantages of variety, flexibility and stability that they value (Rallet, 1993; Camagni, 2002).

The forms of the governance of multinational business networks capable of minimizing transactional costs (Coase, 1937; Williamson, 1975) have been characterized by Powell (1990) as being biased towards network forms that distinguish from the Manichean opposition of "market" versus "hierarchy" that was first postulated by Williamson (1975) and whose opposing elements are respectively dominated by demand and by production. According to Powell, "networks" consist in a sequential range of transactions taking place in a context of generalized interactions. The functional aims of such a "network" is to capture "tacit" knowhow (Nelson, Winter, 1982), to increase flexibility, and to improve the ability to adapt rapidly to economic conditions—primarily by leveraging those relationships of trust that increase the quality and the duration of specific interactions. In this way, not all interactions have the same likelihood of taking place. More fruitful relationships tend to continue over the longer term within relationship "chains" that are, to a greater or a lesser extent, formalized and "restrictive". Such relationship chains adjust to prevailing social and economic conditions (Powell, 1990, p.323). As a result, it appears hybrid network/hierarchy/markets models. Gereffi & al. (2005) extended this analysis of forms of governance by defining a continuum of five types of relationship in which three types of global value chain network are situated between the market relationship and the hierarchical one. These three network types are: "modular", "relational" and "captive". They are essentially distinguishable each from the other according to the relative complexity of their transactions, to their relative ability to codify those transactions and to their relative capacity for autonomous sub-contracting (Gereffi & al., 2005).

By extending their internal networks, businesses aim to simultaneously appropriate markets, the networks of small and medium-sized businesses and localized social and institutional networks. In this way, groups of firms develop: made up of numerous subsidiaries that each captures markets and resources, which are then made available to the whole group. Of course, these subsidiary networks amount to only a small part of the whole transactional network (partners, alliances, sub-contracting, etc.). They nonetheless constitute a highly structuring grid within the overall network of multinational corporations. They provide a picture of the comparative production investment of companies, as well as of company command structures. The shapes of companies' subsidiary networks are distinguishable from each other principally in terms of their depth (number of subsidiary levels), the degree to which command is concentrated in them and their level of integration in the parent company (in terms of production, information and management) (Francfort & al., 1995). The miss-match between their respective product cycles and their location (intra-urban on the one hand and inter-urban on the other) (Vernon, 1966; Dunning, 1992) allows a balance to be maintained, within a vast global firm network, between more or less technologically advanced products on the one hand and more or less profitable products on the other. Processes of individual risk minimization are amplified when a number of companies ally or when one company buy another one with the aim of conquering new markets. In such new markets, learning the cultural and sociological specificities of an unfamiliar environment often necessitates recourse to audit companies, which allow transaction costs to be minimized by providing information about the environment and interpersonal contacts within local networks (Ernst & Young, 2007).



Different processes are created when businesses develop work divisions, which leverage the specializations of cities (the nature of these processes is manifested by organizational structures that are more "global" than market-oriented in their approach—or as Porter (1996) precised, structures which are "horizontal" rather than "vertical"). In such cases, the adaptation takes place more within the inter-urban network than directed at local markets. Sharing between different companies, particularly the sharing of technology, is more frequent. And the organization of the value chain takes in a larger number of more widely spread subsidiaries, so that the organization is usually more centralized (often at a continental level: Doz & al., 2001). The establishment of such complementarities confers possibilities for specific developments, especially if the specializations in question are grounded on knowhow that is not easily transferable from one environment to another (Badaracco, 1991; Colletis, Pecqueur, 1996). Such specializations improve or diminish those localized capabilities that are the instruments of the competition between firms for markets (Castells, 1996; Rutherford, 2005).

The specialization of activities introduced by long-range networks, the multi-scale constraints and the urban accumulation of historical positions in multinational firms networks, make all together very complex, the geographical process of cities' globalization. The position of each city inside these networks must been explained by multi-criteria, especially, by the geographical membership to countries and continents, the size of the cities, their specializations, and also by the different strategies of the corporations according to their economic sector.

# 4- Database construction

In order to measure the positions of cities through such corporation networks, we built a database including all the direct and indirect subsidiaries of the first 3'000 worldwide companies groups by their turnover (Orbis, Bureau Van Dijck, 2010). Different data were tested in 2006 before to choose this particular database. It appeared clearly that this data constituted the "best" information in comparison of Dun & Bradstreet or Kompass, and this choice seems to be confirmed by many people nowadays.

Each group is seen as a (quasi) tree, owning subsidiaries which themselves own other subsidiaries and so on. It is a quasi-tree, because some subsidiaries are owned by several owners, and one observes some feed back in the networks of investments, sometimes directly with mutual reciprocal investment. It results a sample of 800'000 subsidiaries located all over the world, linked by 1 million financial links, which are directly or indirectly owned by the main first 3'000 groups (we observed the maximum of 34 levels of subsidiarity in a single network (Shell), but in other cases, some loops render the "level" non relevant). These subsidiaries are defined by their activity sector (NACE), their turnover and number of employees when it is available, and by their owners and subsidiaries.

The information about the weight of the financial link is not always indicated (only in 60% of the cases). So, there is a choice between two options: the first one consists in taking into account the weight of the links (and delete the 40% of the links not informed) (which is not precised but which is surely done in Glattfelder, Battiston, 2009; Vittali et al., 2011); a second option consists in keeping every ownership links without any weight for each link. Then we made the second choice, knowing that one can't weight the ownership links, but we'll



aggregate the links of ownership by metropolitan areas, considering the "number of links" between and within these areas.

In order to define comparative cities, each individual firm, member of a group, was precisely located by Metropolitan Area : Functional Urban Areas (FUA) in Europe according to the ESPON definition 2010; Metropolitan Statistical Areas (MSA) for USA and Canada, and equivalent for the main cities of the world according to manual researches on Google map) (IGUL, 2010). The links were aggregated by their Metropolitan Areas of origin and destination, linking about 1'200 metropolitan areas all over the world. These areas concentrate more than 80% of the total links of the database.

Beside the territorial question of Metropolitan areas, as we would like to show the regionalization of the world, the free trade zones would be relevant in order to classify different cities. However, as the free trade zones are very numerous and overlap each other, it was difficult to select the "good" levels of these zones. Then, we preferred to take, in a first step, the "continental zones" in 6 regions as defined by UN.

The economic specialization of linkages between firms was defined by the NACE European nomenclature of activities of the subsidiary. When the activity of a subsidiary was not declared, we used the activity of its direct principal owner. We did not use the 4 numbers code of activity, which is informed in ORBIS, but we aggregated them by large groups of activities (defined as letters in NACE rev.2.1, 2006). It gives 19 types of main activities (there are 21 but two of them are not concern by multinational firms).

# 5- Graph of multinational firms in the world cities' system

The approach of such large network needs some specific tools for networks analysis, which are now offered by physicists and computer scientists. In a first step, one can ignore the geographical position of cities and underline their position inside the network. The graph of figure 1 indicates the distance between cities through their links of multinational firms networks. More two cities exchange directly subsidiaries, or are linked to the same other cities (structural equivalence), more they are represented close to each other.





The main group is formed by the dense network of European and North American cities at the centre, linked with South American and Asian ones situated at the periphery. London, New York and Paris constitute the main core of the system supported by many other American and European cities, which confer to them this high centrality. Asia is principally linked to North American cities and is cut into two parts: Japanese cities are disconnected from Chinese, South East Asian and Australian cities. They are not following the same paths in globalization. At the centre, the cities forming the core of the global localizations of multinational firms are crucial to link together all cities of their respective continent. Paris, London and New York are embedded in a dense network of cities formed essentially by their continental cities. The world position of these large global cities allows the peripheral cities to access to all over the world. A strongly isolated group is formed around Moscow, which serves as a gateway between Russian cities and the rest of the world.

So a strong effect of continent is widely visible on this graph, showing a continental cohesion coupled with a hierarchy between cities that reveal their past and actual centralities and capacities to attract and maintain global links.

# 6- Organization of multinational firms in the world cities' system

In order to underline the effect of geographical tendencies, we classified the links according to their geographical scales (Tab.1). The different scales are exclusive, meaning that intranational doesn't include intra-urban and so on... We distinguished these links according to the origin of the ultimate owner (Tab.1-A), to the location of the direct owner (Tab.1-B) or to the location of the subsidiary (Tab.1-C).

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	Geographical scales of World networks											
Continent of the Ultimate	Intra-	urban	Intra-n	ational	Intra-continental		Inter-continental		TOTAL			
Owner	Nber %		Nber	%	Nber	%	Nber %		Nber	%		
Africa	2	8.70	11	47.83	0	0.00	10	43.48	23	100.00		
Eastern Asia -Oceania	16'044	15.17	62'900	59.47	7'989	7.55	18'826	17.80	105'759	100.00		
Europe	200'698	26.71	285'116	37.95	120'590	16.05	144'929	19.29	751'333	100.00		
South America	535	21.75	749	30.45	287	11.67	889	36.14	2'460	100.00		
North America	18'816	20.95	44'286	49.31	8'372	9.32	18'331	20.41	89'805	100.00		
Western Asia	23'098	35.71	17'228	26.63	8'961	13.85	15'403	23.81	64'690	100.00		
Missing information	984	33.88	912	31.40	556	19.15	452	15.56	2'904	100.00		
TOTAL	260'177	25.58	411'202	40.43	146'755	14.43	198'840	19.55	1'016'974	100.00		
@Rozenblat_20												

 Table 1

 Geographical scales of the links according to location of the firms

A- According to the origin of the ultimate owners

#### B- According to the location of the direct owners

	Geographical scales of World networks												
Continent of the Direct Owner	Intra-	urban	Intra-national		Intra-co	ntinental	Inter-cor	ntinental	TOTAL				
	Nber	%	Nber	%	Nber	%	Nber	%	Nber	%			
Africa	322	7.56	2'393	56.20	336	7.89	1'207	28.35	4'258	100.00			
Eastern Asia -Oceania	15'630	13.16	74'425	62.67	11'831	9.96	16'865	14.20	118'751	100.00			
Europe	223'060	35.87	185'015	29.75	117'840	18.95	95'996	15.44	621'911	100.00			
South America	1'922	7.97	3'870	16.04	2'727	11.30	15'609	64.69	24'128	100.00			
North America	19'094	7.80	] 144'052	58.86	13'530	5.53	68'054	27.81	244'730	100.00			
Western Asia	149	5.29	1'428	50.67	491	17.42	750	26.61	2'818	100.00			
Missing information	] 0	0.00	] 19	34.62	0	0.00	359	65.38	378	100.00			
TOTAL	260'177	25.58	411'202	40.43	146'755	14.43	198'840	19.55	1'016'974	100.00			

@Rozenblat, 2011

#### C- According to the location of the subsidiaries

	Geographical scales of World networks											
Continent of the Subsidiaries	Intra-urban		Intra-national		Intra-cor	ntinental	Inter-cor	ntinental	TOTAL			
	Nber	%	Nber	%	Nber	%	Nber	%	Nber	%		
Africa	326	2.90	2'394	21.29	332	2.95	8'191	72.85	11'243	100.00		
Eastern Asia -Oceania	15'632	9.83	74'426	46.80	11'829	7.44	57'132	35.93	159'019	100.00		
Europe	223'057	38.94	185'014	32.30	117'843	20.57	46'951	8.20	572'865	100.00		
South America	1'923	4.65	3'870	9.35	2'726	6.59	32'850	79.41	41'369	100.00		
North America	19'090	8.37	144'051	63.13	13'534	5.93	51'514	22.58	228'189	100.00		
Western Asia	149	3.84	1'428	36.80	491	12.65	1'812	46.70	3'880	100.00		
Missing information	0	0.00	19	7.32	0	0.00	] o	92.68	390	100.00		
TOTAL	260'177	25.58	411'202	40.43	146'755	14.43	198'840	19.55	1'016'974	100.00		
Paranhist 2												



The principal information given by these tables is the low share of inter-continental links and the remaining two thirds of intra-national linkages. Less than 20% of links are intercontinental but it varies a lot according to the location of owners or subsidiaries. In this respect, the direct owners seem to differentiate more the continents than the ultimate owners do (Table 1 A and B). This phenomenon can be explained by the different steps that are taken by the networks: for example, South American ultimate owners invest more than the average outside the continent, but when one considers the direct owners, it's even the double because they do the same thing, amplifying this effect especially for offshores like Cayman Islands. It is the opposite for African continent, where the local ultimate owners are very anecdotic and mostly oriented to outside the continent, while the external investors go directly to the subsidiaries (Tab.1-C) or by intra-national steps (Tab.1-C).

Another interesting information from this table is the non-symmetrical orientation of multinational firms starting from of going to some continents. The more relevant continent for this phenomenon is Eastern Asia, where ownership remains mostly inside the continent (and even countries), while the subsidiaries are much more than the average directly owned by other continents. For Europe, the inter-continental ultimate ownership is close to the average, while the direct ownership and the subsidiaries show a high intra-continental integration. A relatively high intra-national integration appears for North America, which does not take place of the inter-continental ownership (which is rather higher than the average), but compensates low intra-urban links compared to Europe.

Another very original data produced here is the part of local links (inside the Urban Areas), which represents more than 25%. The local complexity created by many enterprises, located very closed to each other, and financially linked together, is rarely taken into account (because of the lack of data). The figure 2 represents the proportion of these "local links" where owner and subsidiaries are located in the same metropolitan area. At the world scale, it seems obvious that this phenomenon concerns especially European and Asian cities, but very few American cities.



Figure 2 Local ownership of cities in the networks of multinational firms



This difference comes from several reasons. For China, the way multinational firms settle is most of the time by buying state Chinese enterprises or building a green field enterprise in join venture with the national state. For Japan and Taiwan, conglomerates (or Keiretsu) were the way to build the new economy in globalization. In the meantime, Hong-Kong built its economy through the crossing and meeting of service and financial firms organizing trade of "made in China" products. For Europe, the European Community construction, permitted enterprises to exchange investments and to group their weight in order to fight at the European and global scale. Especially London and Great Britain cities are very concerned by this phenomenon (64% of the subsidiaries owned by enterprises planted in London are local, 75% for Leeds, 84% for Middleborough or 90% for Lincoln). Great Britain is the world financial system where every firm of the world pretending to play at the global scale has to be settled, especially for North American firms, to create contact with European and Asian firms (Sassen, 1991; Taylor, 2001). It confirms what Doreen Massey (2007) declares about the local production of the globalization of London (previously quoted). In one hand, this could be interpreted as a very positive effect because more a milieu is complex, more it has got chance to adapt to crisis and to promote emergence of innovations. It is what dramatically lacked to the soviet system and every Eastern countries has seen increase the complexity of their productive system thanks to foreign subsidiaries and also thanks to the recent emergence of local firms (Stark, Vedres, 2006). But in the other hand, every firms being linked to every other ones, it creates a vulnerability of "domino effect" allowing a very speed diffusion of lack of investment, we just experimented with the actual crisis of the stock exchange.

Another assumption on geographical scales of networks is based on activity sectors (Table 2).

Table 2

	Geographical scales of World networks														
	Intra-urban			Intra-national			Intra-continental			Inter-continental			TOTAL		
ACTIVITY SECTORS	Nber	% Row	% Column	Nber	% Row	% Column	Nber	% Row	% Column	Nber	% Row	% Column	Nber	% Row	% Column
A_AGRICULTURE	5'408	11.89	0.33	11'430	69.52	1.23	2'301	8.60	0.43	3'220	10.00	0.37	22'359	100.00	0.72
B_MINING	867	17.57	1.52	5'070	43.46	2.38	627	14.17	2.17	729	24.80	2.81	7'293	100.00	2.21
C_MANUFACTURING	3'955	15.51	11.82	9'781	40.35	19.45	3'189	15.94	21.54	5'581	28.20	28.14	22'506	100.00	19.50
D_ENERGY_SUPPLY	30'758	27.19	2.67	79'993	47.68	2.96	31'606	11.49	2.00	55'908	13.64	1.75	198'265	100.00	2.51
E_WATER_SUPPLY	6'938	24.07	0.72	12'165	56.44	1.07	2'932	9.38	0.50	3'481	10.11	0.40	25'516	100.00	0.77
F_CONSTRUCTION	1'885	37.66	6.81	4'420	43.26	4.95	735	9.86	3.16	792	9.22	2.18	7'832	100.00	4.63
G_WHOLESALE_TRADE	17'727	21.62	8.48	20'360	39.88	9.90	4'639	20.55	14.29	4'341	17.95	9.22	47'067	100.00	10.04
H_TRANSPORT_STORAGE	22'071	24.97	3.29	40'708	45.01	3.75	20'975	13.89	3.25	18'318	16.13	2.78	102'072	100.00	3.37
I_ACCOMO_FOOD_SERV	8'564	26.55	1.37	15'437	40.45	1.32	4'763	11.11	1.01	5'531	21.89	1.48	34'295	100.00	1.32
J_INFORMATION_COMM	3'556	27.39	6.82	5'418	36.53	5.76	1'488	15.05	6.64	2'932	21.02	6.86	13'394	100.00	6.37
K_FINANCIAL_INSURANC	17'750	22.27	22.83	23'670	41.55	26.94	9'751	13.93	25.30	13'622	22.25	29.85	64'793	100.00	26.22
L_REAL_ESTATE	59'388	46.54	8.17	110'780	32.37	3.59	37'135	11.00	3.42	59'322	10.08	2.32	266'625	100.00	4.49
M_RESEARCH	21'246	36.04	9.69	14'777	32.22	5.48	5'023	17.23	8.21	4'602	14.51	5.11	45'648	100.00	6.88
N_ADMINISTRATION	25'212	43.67	7.84	22'544	29.60	3.36	12'054	13.45	4.28	10'153	13.27	3.12	69'963	100.00	4.60
O_EDUCATION	20'410	19.00	0.40	13'835	47.60	0.64	6'288	17.73	0.67	6'202	15.67	0.43	46'735	100.00	0.54
P_PUBLIC_ADMIN	1'046	31.62	0.46	2'621	54.04	0.50	976	4.72	0.12	863	9.62	0.18	5'506	100.00	0.37
Q_HEALTH_SOCIAL_WORK	1'193	21.91	1.00	2'039	64.17	1.86	178	4.76	0.39	363	9.17	0.55	3'773	100.00	1.17
R_ART_ENT	2'607	41.97	1.08	7'636	36.23	0.59	566	8.89	0.41	1'091	12.91	0.44	11'900	100.00	0.66
S_OTHER_SERV	2'819	46.49	2.60	2'433	41.68	1.48	597	6.39	0.64	867	5.43	0.40	6'716	100.00	1.43
No NACE code	6'777	24.19	2.08	6'076	51.12	2.78	932	10.29	1.57	791	14.40	1.62	14'576	100.00	2.20
TOTAL	260'177	25.59	100.00	411'202	40.44	100.00	146'755	14.43	100.00	198'840	19.54	100.00	1'016'974	100.00	100.00

Geographical scales of the links according to activity sectors of the firms

ozenblat, 20'

The distinction between activity sectors shows some high differentiations according to the kind and stages in the economic cycles and internationalization. The sectors most developed at inter-continental scales are mining, manufacturing, accommodation and food services, information and communication and financial services and insurances. The total inter-continental links are in majority (58%) in manufacturing and financial services and insurances (% in column). The most intra-continentalized sectors are wholesale trade, research and education. The sectors remaining most concentrated inside national level are, without any surprise, agriculture, water supply, public administration and Health and social work.

The activity sectors contributing more in the intra-urban linkages are financial services (22.85% in column) even if they are less developed at this scale compared to the column average (26.22%). Other sectors are very well developed at intra-urban scale, even if they do



not represent a big weight in the total intra-urban links. It is the case of real estate, administration (private and public), art and entertainment and other services.

The differences between the geographical radiance of the networks of the sectors appear relevant in term of understanding the role of each of them in the internationalization of multinational firms. The manufacturing sector, with more than one hundred years history of internationalization is the most important at the inter-continental level, while wholesale trade is mostly over-represented at the continental level.

# 7- Cities' hierarchies by networks of multinational firms by activity sector

The orientation of multinational firms' networks creates some uneven hierarchies that complete these general patterns. The more some networks introduce a high hierarchy, the more they are selective for their choice of location in the cities' system. According to previous works, the stage of activity diffusion is revealed by the kind of spatial concentration (Vernon, 1966): growing activities are in a first stage concentrated in few cities, and then this concentration decrease when it becomes mature because of its spatial diffusion, but when it becomes very banal, the activity can concentrate again (Pumain et al., 2006; Rozenblat, Pumain, 2007).

Different methods exist to evaluate this effect. A first method is based on a measure of the frequencies of cities according to their level of concentration. This distribution is usually "fat tailed" and can be approximated by a "power law", of the form  $p(x) = x^{-\beta}$  (Barabasi, Albert, 1999; Newman, 2005). This consists in measuring the frequencies of cities according to their level of concentration. The concentrations of the different activity sectors are compared in figure 3.







The slopes of the "power-law" distributions (exponent ß) are related to the activities, which hierarchize more the cities' system. The activity sectors with more pronounced concentration are education, research, public administration and agriculture. At the opposite side, manufacturing and wholesale trade, which are the more ancient and widely diffused in the world are less hierarchized. Finance and Insurance, and Information-communication introduce less hierarchy between cities than one could expect. Two reasons could explain such result: firstly, this measure gives a large weight to the numerous small concentrations (explaining why agriculture has got a high slope), and secondly, the distributions are not all strongly power-law (this is informed by the confidence intervals, and for the distributions presented in Figure 3, the power law hypothesis can be rejected if we use a strict test based in maximum likelihood (A. Clauset et al., 2009)).

A second method was then used to give precise measures, of the capacity of each activity sector, to introduce hierarchy in the city system compared to the whole system: the "scaling law" distribution (Pumain et al., 2006). It is based on correlations of the distribution of a certain specialty, with a general measure of the cities. We made many tests using different variables like cities' population as the general measure of cities, but the correlations are not significant enough to compare the different activities. In fact, population of cities doesn't mean the same thing for developed countries than for developing ones. Finally, we used the number of subsidiaries for each activity in function of the total number of subsidiaries (fig.4).





Here also, the slopes of the "scaling-law" distributions (exponent ß) underline the activities, which hierarchize more the cities' system by their location of subsidiaries. Two activity sectors introduce more concentration then the average distribution: research and informationcommunication (with  $\beta > 1$ ). These two sectors have got their networks at an earlier stage of development than the other ones. Wholesale trade introduces a hierarchy close to the average, while manufacturing is lower. Some sectors have distributions of their subsidiaries amount cities very different from the general distribution: it is revealed by a low  $R^2$ . It is the case of agriculture, education and public administration.

The similarity between the different activity sectors' networks has been measured by the QAP correlations between the 19 matrixes of networks (Krackhardt, 1987) (fig.5).



Figure 5 QAP correlations between the distribution of networks of multinational firms



The core activities networks, having more relations with other ones, are informationcommunication, and finance and insurance. These two activities appear here in their capacity to sustain the development of other activities, it is what explains their central role in the whole system of the networks. Only mining and energy supply sectors develop some different specific networks between cities, but are quite close each other. Other sectors distinguish a lot to the other ones and do not appear in the figure: Agriculture, administration, education, and health and social work.

# 8- Cities' specializations inside the networks of multinational firms

All these networks specialize more or less cities in certain kind of activities. We applied classifications of cities by the number of their owned subsidiaries (ultimate or intermediate owners) (fig.6.A) and by the number of located subsidiaries (fig.6.B) by activity cancelling all the local subsidiaries (we used a classification with Xi2 distance on the contingence table).

Figure 6

Activity specialization of cities according to networks of multinational firms A- Ownerships' activity specialization by Urban Area



B- Subsidiaries' activity specialization by Urban Area





The classification on ownerships reveals the high specialization of North American cities in controlling industries, finance and insurance all over the world, but other ones that are small size cities are specialized in Finance (Charlotte) or in Health (Nashville concentrating more than 250 Health corporation, with the biggest one Hospital Corporation of America, owning clinics all over the world). The Japanese cities also appear quite homogeneous. In Europe, cities are more diversified, with Paris, Brussels, Amsterdam and Copenhagen, specialized in Finance, insurance and real estate, while London has got a close specialization but more oriented to art and entertainment. German and Austrian cities are specialized in research, finance and insurance, while most of the Italian cities, Ljubljana, Stockholm, Warsaw or Moscow are specialized in transport (automobile sector). Madrid and Barcelona are oriented to construction, which has got supported the real estate bubble developed in the years 2000 and now in crisis. In China, Hong-Kong and Beijing are specialized in finance and real estate, while Shanghai is more oriented to manufacturing. It's the same for India where Delhi is specialized in finance and real estate while Mumbai more in manufacturing.

The classification on subsidiaries provides more diversification between cities of each country (cities are also more numerous), but also less specialization in general (the specialization of the classes are quite low). Here we've got more differentiation of American cities between those which have a very low specialization in manufacturing and health (in clear blue), and the other ones, in general of smaller size, concentrating more industry (Vancouver and Calgary), or whole sale trade (especially in Western coast and in the South with Mexico city). Japanese cities have a small specialization in manufacturing, like most of the Asian cities (except Hong-Kong remaining with a specialization in Finance). For European cities, most of the British cities are specialized in financial and administration activities, while French cities, and all Eastern and South capitals are oriented to wholesale trade, information-communication and real estate. German cities are divided between specialization in research and real estate for Munich and Frankfurt.

### 9- Discussion

The main idea, we can firstly conclude from these very general classifications, is a kind of remaining of homogeneity of cities by continent and by country. Even if they appear with a certain diversification, cities of each country remain generally more close to each other than to cities of other countries or continents, even if the same kind of specialization can occur in cities of different continents. In this respect, German cities specialized in research activities and European capital cities specialized in Information and Communication, have got a certain advantage for concentrating such activities appearing as the more selective ones in figure 4.

A second remark is the proximity of the two classifications, of ownerships on one hand and subsidiaries on the other hand. Even if the second one introduces more national diversification between cities, they look like a lot each other. This means that ownership specialization in a certain activity in cities attracts concurrent corporations' subsidiaries from other cities. A good example of this phenomenon is the attractiveness, even today, of Detroit for European and Japanese automobile sector (Rozenblat, 2010). This assumption must been deepen, in particular in relation with the 25% of local links occurring inside cities (Fig.2). This phenomenon would place the role of cities as a strong connector both for subsidiaries and headquarters, and also between them (and some subsidiaries are themselves headquarters).

Interplay between continental and national levels and cities, forms the strong base of the development of multinational firms' networks. With two third of the links remaining inside



countries, and only 20% in inter-continental scale, the cities remain embedded for a large part in their own territories. It doesn't mean that the inter-continental linkages does not matter to select the different cities, and further analyses, distinguishing networks at different scales could help to understand better this multi-level complexity.

For the multi-dimensional view of these networks according to their activity sectors, it has been clear that some activities like finance and information-communication are central in the system, and that the most growing ones are also those which integrate the strongest hierarchy between cities: research, information and communication are these activities which concentrate more in some cities. The link with the economic cycles is glimpsed even if not yet absolutely measured. The further depth of this approach, would certainly reveal, in a more detailed sector codes, and by individual corporate networks, different strategies of market or labor orientations, organized through different activities integrated inside the same corporations.

# Conclusion

This study of multinational firms networks aimed to explore the "duality" between world urban development and firms' networks extensions, focusing on the imbrication of multi-scale advantages and on differences between economic sectors. A whole world study of multinational firms networks located at the scale of cities (delineated in a comparative way) was never developed previously in such way.

The multi-scale approach as well as the activity specialization showed the remaining coherence of national and continental territories that interplay with cities in order to support and create these global links. A very new approach showing the intra-urban links has revealed the importance of local linkages in the production of global networks. The main activities in the core of the whole networks are finance and information and communication, while the more growing sector seems to be the ones whose hierarchize more the cities: research and information and communication.

These first results also open new questions about the articulation between inter-continental and other geographical scales. Is there a relation between the density of intra-urban linkages and the integration of the cities in the global networks? Are there cities playing the role of bridges (or "hubs") between inter-continental and intra-continental organizations? In which manner and to which extent, central cities in the system attract more the new networks, following the process of preferential attachment explaining high hierarchies? How to identify clubs of specialized cities? Further depth will be developed to answer these questions. For the expected future of the position of cities inside these networks, and the evolving role of countries and continent cohesions, a diachronic study will verify the possible evolution of the trends that were underlined.

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