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Freight flows and urban hierarchy

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ABSTRACT

Varying hierarchy of freight flows between urban areas is the focus of this study. The results of a French survey that describes shipments sent by firms are used for understanding freight flows. The survey shows that the pattern of freight flows between urban areas in France is hierarchical, but varies depending upon whether the flows are generated by wholesale trade activities or by manufacturing. The differences are explained by the specific organizational characteristics of each of these two activities. Wholesale trade broadly reflects the traditional spatial organization of service activities, with interlocking areas of influence. The spatial organization of manufacturing flows is more complex, which can be attributed to the regional specialization of activities.

1. Introduction

Urban centers are not isolated as they maintain intense relations with their immediate surroundings and with other urban centers. Scholars have long recognized that the classification of an urban center is linked to its position in the network of interurban exchanges. To describe the position of the urban center in the network, researchers often employ the notion of hierarchy, implying that relations between urban centers can be represented by a tree structure, characterized by a rank/size distribution. In some cases, the hierarchy is just a ranking of urban centers based on population distributions (Zipf, 1941) while in other cases the criterion is functional differentiation (Lyons & Salmon, 1995) or integration into global networks (Sassen, 1994). These studies usually rank the most visible and obviously dominant cities at the top: New York, London, and Tokyo in global hierarchies (Sassen, 1994), and London and Paris at the European level (Friedmann, 1986, Hall, 1993). However, the criteria used to empirically situate urban centers within such hierarchies are limited to highly selective features, such as the presence of advanced service producers in those centers for example (Beaverstock, Smith, & Taylor, 1999), and often do not take into account the basis of urban hierarchies. Studies that integrate the top and bottom of urban hierarchies remain scarce (Rozenblat & Pumain, 1993), and such studies focus only on corporate links between companies.

Among the multiple features that are used to define interurban networks, perhaps the most attention has been devoted to transportation networks (Neal, 2011) and the focus is more specifically on passenger flows. Besides a few studies that looked at other means of transport (see for example Green, 1958, Godlund, 1956 on coach networks), most of these works are focused on air links. In this respect, the pioneering study by Taaffe (1962) on connections between urban areas in the United States demonstrated that air networks were strongly hierarchical at the beginning of commercial aviation (the major centers were New York, Chicago, Los Angeles, and San Francisco). Deregulation and a series of technical changes starting from 1978 radically modified market conditions in the United States (Goetz, 1992) and across the world (Goetz & Graham, 2004). Thus the evolution of aviation has led to significant changes in connectivity and flow patterns, notably through the emergence of hub-and-spokes networks (Ivy, 1993). While the major urban centers keep their dominant position in the air network (i.e., New York, London, Paris, Tokyo), the strategies of airlines dictate the roles and positions of other urban centers that keep shifting considerably (Shaw, 1993, Smith & Timberlake, 2001). It nonetheless remains true that the vast majority of medium-sized and small urban centers remain at the periphery of the air network despite the advent of low-cost carriers serving secondary airports (Dobruszkes, 2006). Insofar as these secondary urban centers are at the periphery of or absent from the air network, the aspect of their interurban relationships has been kept out of these studies.

The purpose of this paper is to help fill this void, by integrating higher and lower levels of urban hierarchy. In order to do this, freight flows are analyzed to understand what they highlight on the economic interactions between the urban centers. However, beyond simply deploying a new indicator to analyze interurban relationships, the

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article seeks to elucidate the roles of urban centers of different sizes in the transport system. The rest of the paper is structured as follows. The next section sets out our hypotheses and outlines the data and methods used. Section 3 analyzes the location of the manufacturing industry and wholesale activities. Section 4 describes the distribution of freight flows between urban centers as it relates to their size. It proposes a macroscopic approach to examine the spatial organization of productive systems. The final section offers some concluding remarks and identifies main research priorities.

2. Methodology

2.1. Data

The analyses are based on the 2004 French national shipper survey ECHO, which threw light on transport practices and their logistical determinants (Guilbault & Gouvernal, 2010). Indeed, the survey becomes a useful tool for observing demand by shippers and by physical and organizational transport chains, from the shipper to the end consignee. The survey is mainly focused on business-to-business freight flows. The sample survey in the study consists of 2935 plants, 10,462 shipments, and 9742 complete transport chains. The scope of the survey covers all firms in mainland France, excluding Corsica, with 10 employees or more, operating in wholesale trade, manufacturing (excluding the extractive industries and construction), mail-order sales, agricultural cooperatives, warehousing services, and industrial waste processing centers. Overall, the survey covers approximately 70,000 plants and estimated after-adjustment transport volumes of 985 million metric tons and 738 million shipments (Guilbault & Soppé, 2009).

Moreover, the location of freight activities is identified using the SIRENE database for the year 2004. The survey also contains economic and spatial information on firms, in particular their plant (physical facilities operated by a firm or government department) and their jobs by business sector. Further, it identifies the location of economic activities within the national space and provides a detailed reading of the economic functioning of the flows generated by firms.

2.2. The geographical area of observation of interurban flows

This paper takes into account urban area (UA) to determine the organization of freight flows between the different levels of urban hierarchy. Then determining the urban unit of observation is important. The past decades were characterized by spatial deconcentration of activities, i.e., the tendency for jobs and logistics activities to move from urban to suburban areas (Dablanc & Ross, 2012). The urban sprawl results in an expansion of the urban perimeter in large areas. In this context, the scale of observation must include a wider definition of urban entities. We argue that the urban area is the most adapted scale to analyze interurban freight flows. We adopted the definition of the urban perimeter in this research from the French National Institute of Statistics and Economic Studies (INSEE) definition. The definition is that the urban area is a geographic unit that provides more than 10,000 jobs and includes a suburban unit in which at least 40% of the resident working population works within the central zone or within its catchment area.

2.3. Methodological choices

2.3.1. Size classes of urban areas

The shipper survey's fine stratification by firm activity and size means that its traffic data is statistically representative and it can be used for breaking down the activities economically into major production types. However, it should be kept in mind that the sampling plan does not include a regional breakdown or origin–destination analysis. This means that the shipper survey does not segment shipments by different levels of urban areas. In order to overcome this deficiency, the location (urban areas) of the firms' shipping and receiving freight flows was aggregated into several categories (Appendix A). They were broken down into five levels by size of the urban area, ensuring that the total weight of each one was comparable in terms of population, jobs, and shipments (Table 1). The levels are as follows:

1. The Paris urban area
2. 18 large urban areas (with a population between 400,000 and 1.6 million), which include a dozen regional capitals “outside the Paris area” (i.e., Lyon, Marseille, Lille, Nice, Toulouse, Bordeaux, Strasbourg)
3. 58 medium-sized urban areas (population between 100,000 and 399,000)
4. 85 small urban areas (population between 40,000 and 99,000)
5. 189 very small urban areas (population less that 40,000)
6. Rural areas.

2.3.2. Two units of measurement of flows

Shipment and tonnage are the two units of measurement used in the present study. We chose shipment because it provides an enhanced level of observation for reconstituting traffic chains and is a logistical indicator of shipper practices. The tonnage was also considered because it is a classic value used in transportation research.

In our analysis, freight flows were restricted to the two ends of the shipping chain only. In other words, only the urban areas of origin, at the level of the shipping firm, and the urban areas of destination, at the level of the consignee firm, were only considered. Intermediate logistics platforms in urban areas through which these shipments may transit are not included, because we are only concerned with logistics

Table 1
Background data on urban areas, aggregated by size category.
Source: INSEE, SIRENE (2004).

	Census data 1999		Freight-related activities, SIRENE 2004				
	Population millions	Jobs millions	Plants thousands	Jobs millions	% share of jobs		
					Industry	Wholesale	Storage
Paris urban area	11.2	5.1	16	0.8	66%	32%	2%
Large urban areas +400,000 inhab.	12.8	5.0	16	0.8	73%	25%	2%
Medium-sized urban areas 100,000–399,999 inhab.	11.4	4.4	14	0.8	81%	17%	2%
Small urban areas 40,000–99,999 inhab.	5.4	2.2	8	0.4	85%	14%	2%
Very small urban areas Up to 40,000 inhab.	4.1	1.7	6	0.4	87%	12%	1%
Rural areas	13.4	4.2	17	0.9	90%	9%	1%
Total [a]	58.3	22.7	78	4.1	81%	18%	1%

[a] Inland France, excluding Corsica and overseas territories.