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Same–same but different? A comparison of food retail and distribution structures in France and Germany

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ABSTRACT

When modeling international freight transport, it is tempting to assume logistical structures for national markets all over the world are almost identical, at least when it comes to specific market segments, e.g. food or fashion. This is not the case, though. Despite several parallels, there are some fundamental differences which are reflected in different logistics food distribution systems and which result in different freight transport demand.

The DLR Institute of Transport Research in cooperation with IFSTTAR France conducted a detailed empirical analysis of the food retail market in France and in Germany. Based on the data collected, the differences in transport demand structures for the same product are outlined. The implications of such differences for the requirements of international freight transport modeling are discussed in conclusion.

1. Introduction

With the continuous spread of the same labels across high streets all over the world, one could expect to encounter similar logistical retail structures everywhere, at least for similar market segments, e.g. food or fashion. Therefore, when modeling international freight transport, it is tempting to assume almost identical logistical structures within national markets and for the same market segments all over the world. However, this is not the case. Despite a globalization of brands, distribution structures within industry still vary significantly from one country to the next and even on a regional level such as Europe. As a consequence, different logistics distribution systems with different freight transport demand can be found.

With its high number of selling points, its important revenue volumes and its relevance for every-day life, the food retail market lends itself as an interesting market for a closer analysis of the impact of retail structures on distribution logistics and transport demand. Therefore, and against the described background, this paper takes a closer look at the food retail industry's structures, using the example of two neighboring EU countries, France and Germany, as they are among the European countries with the highest revenue in food sales.

Like most other retail industries, the food sector is characterized by growing market competition and increasing cost pressure. At the same time, fostered also by online experiences, customers' expectations towards instant availability of an interesting and diverse product assortment are rising continuously. As a consequence, the necessity of optimizing the efficiency of processes and logistics structures is growing, with retailers having to cope with the complex mixture of supply chains of local, regional and global sourcing at the same time.

This complexity of today's retailers' businesses is often further increased by their geographical spread. Furthermore, growing awareness of environmental concerns, demand for sustainable products and the need to optimize the efficiency of processes in order to keep costs at a minimum add to the challenges that the retail sector faces These are further enhanced by more transport-specific issues such as congestion, resulting difficulties to time deliveries and increasing energy prices, namely fuel.

These challenges and the competitive environment of the retail industries have resulted in distinctly different spatial patterns, both on an industrial as well as on a geographical level. This differentiation is due to the fact that retailers try to differentiate themselves from their competitors through their network structure, and that they try to optimize their logistics efficiency: "Retail and service networks are developing and as competition is increasing in the retail environment, the best location is one of the most critical criteria of network performance. This location criterion deals not only with the single store location but also with the global network location." (Cliquet 1998, 206).

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Based on an analysis of the structure of food retailers in France and Germany (Section 3), the present paper investigates their spatial distribution patterns, including logistics hubs, distribution centers and warehouses. These analyses build the basis for the following comparison of distribution structures of the French and German food retail industry. The paper closes with a summary of the findings and an outlook of the impact of the findings on international freight transport modeling and its related data sourcing.

2. Method

This research is based on empirical data, both existing (TradeDimensions) and the authors' own (empirical research in the format of structured interviews). In order to achieve a comparable data basis for the two markets Germany and France, TradeDimensions (2012) data was chosen as it is one data-source that contains data for both countries, covering about 92 percent of food points of sale (POSs) and distribution centers (DCs) and wholesalers linked to food POSs in Germany, as well as about 59 percent of POSs in France. The 92 percent for Germany include about 36,000 food POSs and 1163 related DCs and wholesalers. The 59 percent for France cover data of about 18,470 POSs and 360 DCs and wholesalers. Whilst all locations of big retailers are captured, it is important to bear in mind that small-scale supermarkets or "superettes" are often independent and therefore can be missing in the TradeDimensions data.

The TradeDimensions data is organized in three excel-spreadsheets (for France and Germany each). One table lists the POSs and describes them by using 39 different variables, including a variable for the type of format of the POS. A second excel file of the TradeDimensions data-set lists all DCs and wholesalers. The third table links the POSs to the warehouses by using an individual ID per POS, DC and wholesaler. This way, it is possible to identify each DC and warehouse supplying an individual POS. Then, using the information of the three tables, an adjacency matrix has been created for France and Germany, to describe the link between the POSs and the distribution centers in more detail (Bahoken et al., 2014).

Based on these data analysis, individual retail chains (rather than retail groups) and their spatial distributions were analyzed. In a next step, retailers' locations, relations between outlets and wholesalers, internal and external warehouses/distribution centers were investigated. For this purpose, locations of POSs and their related DCs were geo-referenced and visualized by the means of ArcGIS. Subsequently, the impact of these structures on the related freight transportation structures were described for France and Germany separately, followed by a comparison of their characteristics. The TradeDimensions data analysis was complemented with empirical research in the form of interviews, which were conducted with food retailers in France and Germany. All major food retailers in both countries were requested for an interview. In total, 23 interviews were held, of which about 15 were conducted in France and eight in Germany. Most of the interviews, held in the period from January to April 2012, were conducted on the phone. Questionnaires for France and Germany were identical. The interviews covered the full range of food retail formats, i.e. hypermarkets, supermarkets, discounters and others.

The following paper reflects this research work and compares the distribution systems in food retail in France and Germany. Differences of distribution structures and their impact on transport demand are discussed. The text closes with an analysis of the impact of such differences on the data sourcing for transport modeling and an outlook on what is needed in order to improve data sourcing for freight transport modeling.

3. The food retail systems in France and Germany

3.1. Characteristics of the food retail system in both countries

The increase in complexity of structures described in the introduction, combined with rising cost pressure and customer expectations in the food market, is a process that has been going on for a long time. The efforts to further improve distribution structures of food supply chains started about a hundred years ago: The first logistics initiatives took place early in the 1920s, when branch firms implemented a network of regional warehouses for the procurement of their stores. The first steps for creating these networks were taken by major food retailers (Paché and Crespo de Carvalho, 2002). With retailers usually being the last element prior to the end-consumer in an entire supply system, they are challenged with the need to align their logistics system to those of their suppliers and intermediaries in order to achieve efficient stock management and delivery systems. Consequently, big retailers began to build distribution centers where goods were bundled before their delivery to the points of sale and retailers' warehouses became the major node of the traffic and transport patterns. In the 1990s the organization of food distribution changed from mainly direct store deliveries to a just-in-time format (Fernie et al., 2000), enabled by the advancing developments and use of IT, forecasting and just-in-time deliveries. The downstream actors of the sector, retailers, progressively imposed the location, the volumes and the frequencies of the deliveries to rationalize and optimize the flows and to obtain a lasting competitive advantage (Blanquart et al., 2012). This centralization, combined with the outsourcing of services formerly provided in-house contributed to the creation of a market for third party logistics providers (Fernie et al., 2000). The establishment of delivery structures through retailers' central and regional distribution centers seems complete nowadays.

In theory, one would expect that food retail structures of France and Germany, two adjacent European countries, should be similar to each other. In reality though, several differences can be found instantly.

When comparing their food retail market structures, differences can be noticed already in their framework and basic characteristics (Table 1).

There are 21 percent more grocery shops in Germany than in France. In line with this, the number of employees is higher in Germany. It is noticeable that, despite these values, turnover in food retail is much higher in France.

Furthermore, there is a difference in the consumer habits between these two countries when it comes to the budget spent on

Table 1
Food retail – framework data 2012.

Country	Number of inhabitants in millions	Number of grocery shops/outlets	Number of employees in millions	Food turnover in billion €
France	65.43	31,970	0.5	183.7[b]
Germany	81.8	38,866[a]	1.2	161.7

[a] Without drugstores and specified stores.
[b] Without specified stores like bakeries or butchers. Source: HDE (2013), EHI Retail Institute (2013), Nielsen Company (2014), Eurostat (2013), INSEE (2012).

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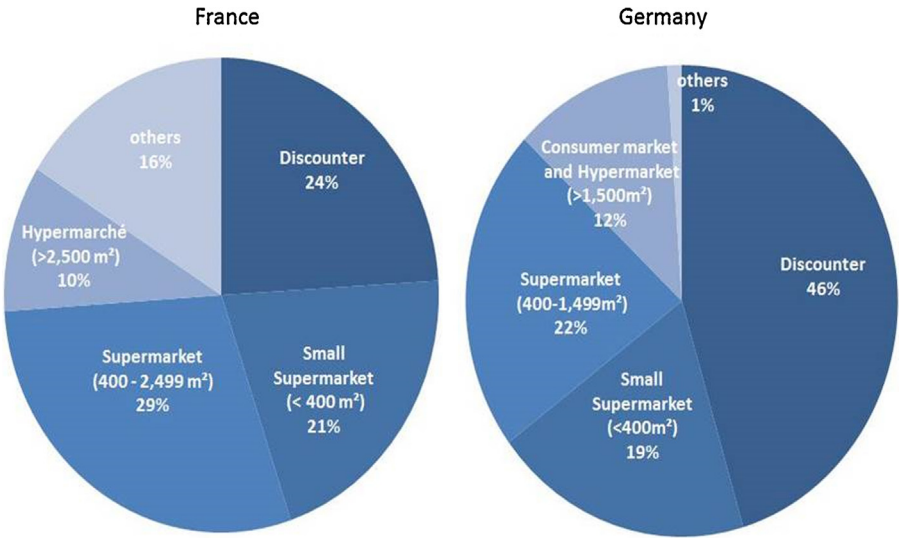

Fig. 1. Share of total number of POSs by type of format 2012 (specialist shops not included).
Source: TradeDimensions (2012).

food and non-alcoholic drinks: whereas German households spent around 11 percent of their total consumer spending on food and non-alcoholic drinks in 2010, French households spent around 13.5 percent (BVE, 2012).

Also, selling concepts vary between both countries, both concerning the size of stores as well as the sales concepts (e.g. click-and-drive is a successful concept in France but not in Germany) and the assortment (e.g. frozen food stores, popular in France and scarce in Germany). The following definition will be applied for the various concepts and formats:

- Small super market (<400 m^2).
- Supermarkets (400–1499 m^2 Germany, 400–2499 m^2 France).
- Consumer markets & hypermarkets (≥1500 m^2 Germany, ≥2500 m^2 France).
- Discounters (low-price strategy; normally 300–900 m^2).
- Others (click & drive, organic POS, freeze stores etc.).

Whereas in Germany discounters dominate the market, in France supermarkets have the highest share in terms of number of outlets. On the other hand, the share of small-scale supermarkets is nearly the same for both countries, as is the share of hypermarkets, which seems to be approximately identical in Germany and France (Fig. 1). But there is a noticeable difference when it comes to the size of these hypermarkets, though, with the French hypermarkets being considerably bigger with an average of 5416 m^2. The smaller sales areas in Germany and the high share of discounters can be explained to a large extent by regulations: in most urban areas shops are limited to a maximum sales area of 800 m^2. All food retailers who strive for bigger sales areas have to prove that their shops will not have negative effects on adjacent shops and central shopping areas. Discounters, whose sale areas normally fall below this, are favored by this law (Blanquart et al., 2013).

Looking at the turnover by type of format, a similar picture emerges for the spread of format shares: In Germany, with a total turnover of 62.1 billion euros, which represents 44 percent of the grocery market share, discounters have the highest turnover of all formats (USDA Foreign Agriculture Service, 2012). In contrast, discounters in France hold a market share of only around 10 percent (Bosshammer, 2011). There the highest share of food turnover is generated by the large scale supermarkets (Hypermarché). Comparing the percentage of sales per shop size in both countries, it becomes apparent that discounters with a sales area of 400–999 m^2 are well established and dominate the food retailing market in Germany. They account for 52 percent of all food sales. In contrast, the small-scale supermarkets and discounters in France cover only 20 percent of all food sales. A general trend in both countries is a decrease in numbers of food outlets in the last years, but an expansion in the total sales area, which is in line with the concentration also observed in other industries.

Another interesting difference between both markets is related to the ownership of the retailers: the German market is characterized by independent small and medium-sized food retailers. Most of them are family owned and often they are organized in networks and cooperatives. On the French market, groups and corporate stores are dominant. Both countries have one thing in common: a small number of retail groups dominate the grocery market. In Germany the top five retail groups are responsible for three quarters of all food sales (TradeDimensions, 2012). In France, the picture is similar: 77 percent of food sales are generated by the top seven food retailers. In both countries the leading retailers operate several differently branded chains with various types of retail formats, such as small neighborhood stores, discounters, consumer markets or hypermarkets. Of particular interest is that, besides one Danish discounter we rarely find non-German supermarket chains on the German market, whereby German food retailers can be found in other European countries, e.g. in France. French retailers are present in most European countries but not in Germany.

Summarizing, it is to be said that, despite their geographical vicinity and the fact that both countries are part of the EU and its legislation, remarkable differences can be found between the markets of food retail in Germany and France. These differences are the result of various factors: historic developments, local legislation differences, different regulations, geographical constraints, varying consumer behavior and many more. The comparison reflects that, even for a small fragment of our overall economy – food retail – the market structures and sources of data available to describe these markets vary substantially. A comparison of the markets is feasible, but achieving full transparency is not possible, as quality of data, coverage of markets, data access, clustering of data and data definitions vary.

The following section analyzes how far the differences in market structures impact the spatial patterns of the retail system

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and, subsequently, its transport demand. Based on this understanding the requirements towards improvement of data sourcing for freight transport modeling will be derived.

3.2. Spatial patterns of the retail systems

There are different ways to illustrate the spatial distribution of POSs. One possibility is to map them out, (Fig. 2), which instantly makes visible the higher number and concentration of POSs in Germany. As expected, most POSs and their highest density are to be found in urban areas. With more than 0.9 POSs per square kilometer, the highest food store density exists in these areas. Furthermore, more retailers can be found next to the sea and near the country border in France. In Germany, the highest density of POS can be found in Berlin and the western part of the country. These regions also have a higher number in population and a higher purchasing power per capita. In general, the eastern part of Germany has fewer big cities and more rural areas than the western part.

The high concentration of POSs in urban areas suggests that the number of outlets can be directly linked to the number of population. The relationship between commercial activity and urban space has long been discussed in the field of urban geography. Most theoretical models assume that retail establishments follow movements of households, rather than households being attracted by existing retail structures that match their needs. It seems that there is a better coverage of POSs in southern Germany than in the north. This is true for the total number of POSs, but when the total number of POSs is linked to the number of inhabitants of an area, it becomes obvious, that in total there is a higher offering per capita in the north (Fig. 3). In absolute numbers we find 2194 inhabitants/POS in the north and 2289 inhabitants/POS in the south of Germany.

Like in Germany, in the north of France more POSs per inhabitant can be found in the north of France than in the south. This higher offering per capita is further emphasized by the sales area per inhabitant. In total, there is more sales area per inhabitant in the north than in the south of both countries. On a country level, though, the average sales area per inhabitant in France (300–400 m^2/1,000 inhabitant) is smaller than in Germany (400–600 m^2/1,000 inhabitant), even though the shop sizes are much bigger (Metro Group, 2014). Comparing both countries, we find considerably more inhabitants per POS in Germany than in France, as illustrated in Fig. 3. This confirms the observation made earlier: POSs are smaller in Germany, often located in centers of towns.

To further visualize the difference in spatial distribution of POSs in France and Germany, Thiessen-Polygons are used in the following. For the calculation of these polygons perpendicular bisectors of the POS are defined. The intersections of the lines form vertices which result in Thiessen-polygons. By this method the distance between all given POSs is considered, so that the potential catchment area can be illustrated. Fig. 4 illustrates this Thiessen-Olygon-Calculation for all POSs. As a result the high network density of POSs in Germany becomes obvious (the darker the colour the denser is the network of POSs).

There are only a few regions that have a catchment area bigger as 100 km^2. The density of inhabitants per POS, which is highest in urban areas, at the borders, and in coastal areas in France is in line with the above described absolute number of POSs. The overall network of POSs is not as dense as in Germany, which is not surprising as the population density is lower in France, too, so that such a dense network is not needed.

After analysing the spatial distribution of POSs, the locations of the retailers distribution centers will now be analysed. To have product-filled shelves and yet not to overstock, an efficient supply system is of utmost importance.

4. Consequences for the geography of retail warehousing and transport demand

4.1. Distribution structures in France and Germany

Retail companies continuously try to rationalize their distribution infrastructure and to make more efficient use of their resources. A core characteristic of the resulting logistics development in recent years is the continued tendency to centralized procurement by means of distribution centers. This leads to a reduction in the number and size of wholesalers' warehouses, and to the consolidation of stocks at a small number of very large regional distribution centers (RDCs). Warehouses and distribution centers play an important role as their location can be crucial for an optimized delivery structure for a retailer's supply chain. Despite their relevance, not all DCs are owned by retailers, though. DCs can be company internal, owned by the same owner as the POSs they supply to, or external, belonging to a third company, e.g. a wholesaler.

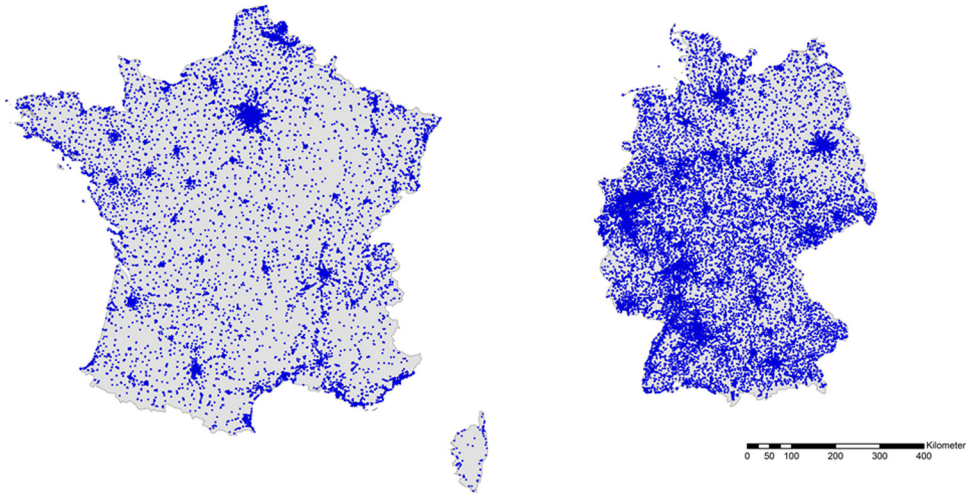

Fig. 2. Distribution of POS in France and Germany.

Source: TradeDimensions (2012).

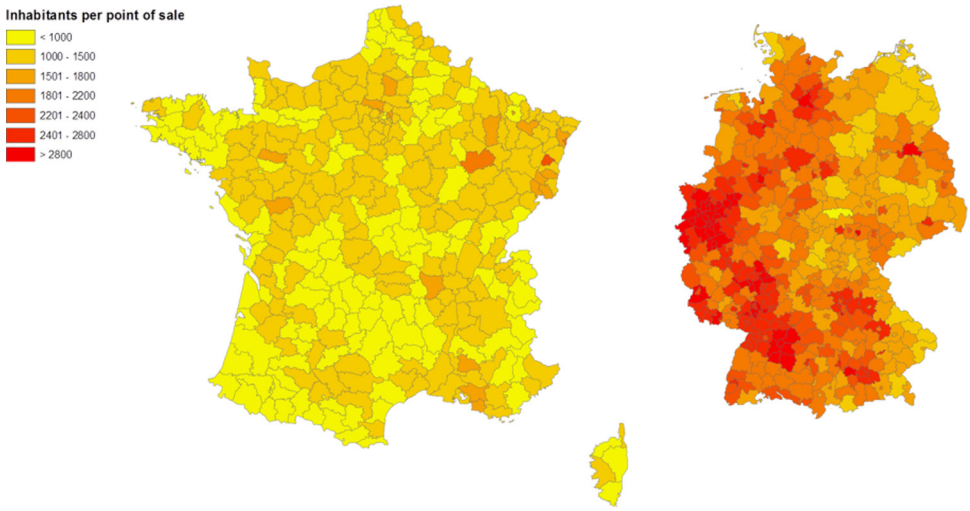

Fig. 3. Inhabitants per point of sales in France and Germany.
Source: TradeDimensions (2012), Statistisches Bundesamt, INSEE (2012).

Due to the fact that no information is available on whether the management of external warehouses is outsourced or not, the following analysis focuses on internal warehouses, as these can be indicative of retailers spatial strategies.

Looking at the TradeDimensions data in more detail, an initial dissimilarity between France and Germany is notable straight away: there are more distribution centers and warehouses in Germany (over 530 sites) used for deliveries to POSs than in France (around 360 warehouses in total). Around half of the 530 sites in Germany are owned by retailers, others belong to service providers and wholesalers which deliver their goods directly to the POSs.

In spatial terms, German DCs are relatively evenly distributed throughout the country, while in France they are concentrated around Paris and partly around Lyon (Fig. 5). Looking at transportation access, all German distribution centers have an average distance to motorways of two (up) to five kilometers. The only exception is a discounter that is solely represented in a small northern part of Germany. Also in France, the sites of distribution centers are located near motorways. Furthermore, in both countries the distribution centers are located near to urban areas, close to the agglomerations of POSs.

As the total number of DCs on its own cannot explain differences in distribution structures, the differences between retail formats will be analyzed hereafter in order to understand the extent to which the choice of a logistical organization is influenced by the location of a retail shop and the retail format.

4.2. Distribution centers by retail formats

As the empirical research in the form of interviews revealed, there is a general difference between the DC network of supermarkets and discounters in Germany. This is also confirmed by the

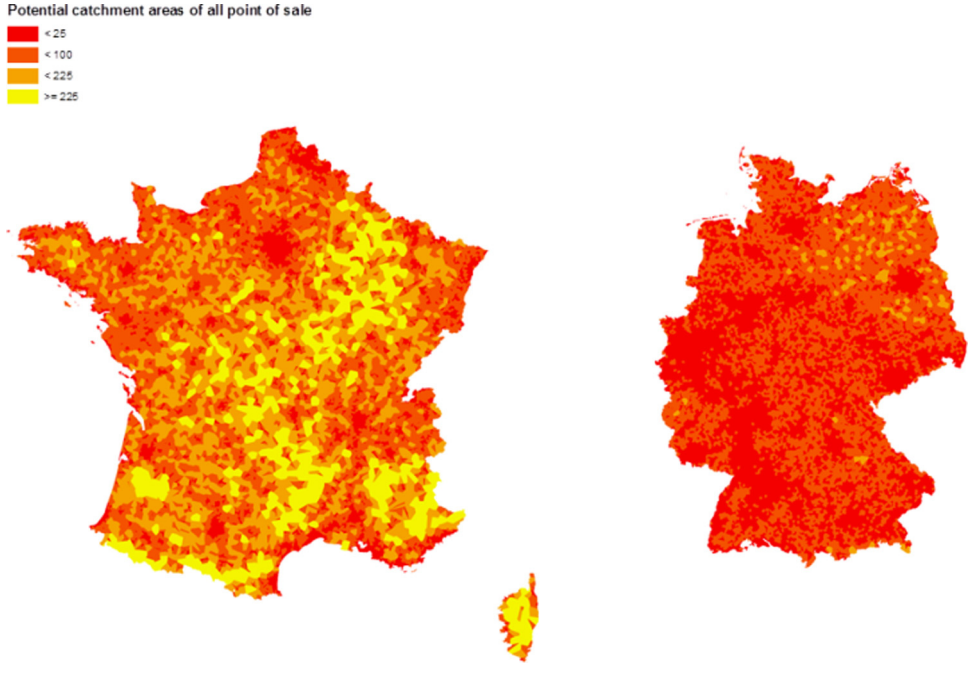

Fig. 4. Potential catchment areas of all POS in km^2.
Source: TradeDimensions (2012).

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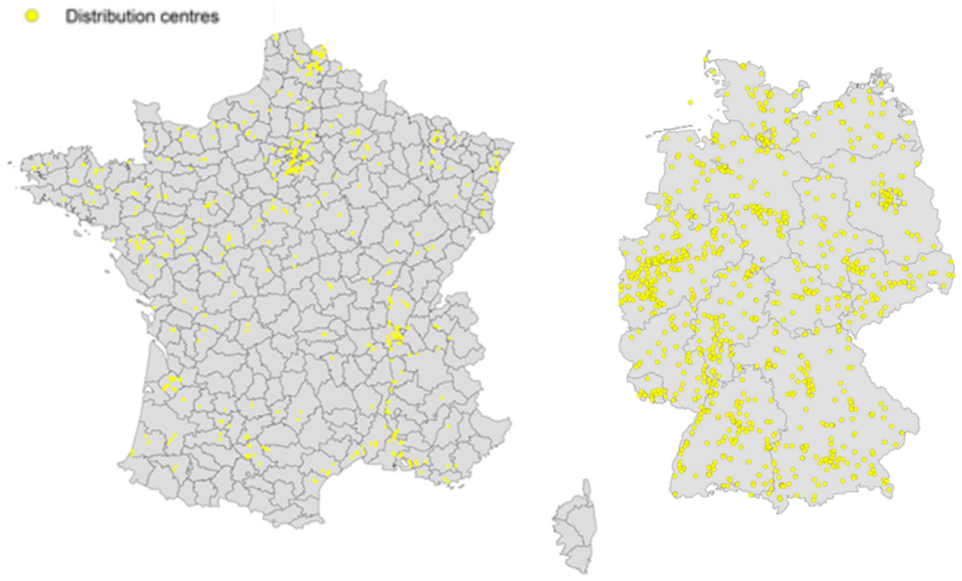

Fig. 5. Distribution centers in France and Germany.
Source: TradeDimensions (2012).

TradeDimensions data: supermarkets, consumer markets and department stores use a lot of third party warehouses and distribution centers, whereas discount retailers use primarily their own (internal) distribution centers. Exceptions are warehouses for fruits and vegetables. These are usually run by wholesalers who directly distribute the goods from their site to the discounters' POSs. All in all, supermarkets have the highest number of distribution centers, which can be related to their dense network all over Germany. Hypermarkets have only a few of their own warehouses and supplement their distribution network with several external warehouses. Furthermore, they use wholesalers' sites as distribution centers.

In Germany, discounters have the highest number of company-dedicated distribution centers, which can be explained by their big network structure of POSs and the fact that they do not use external warehouses. For comparing retailers' internal warehouse structures, all company-owned warehouses and their related POSs were visualized in maps on the basis of the TradeDimensions data. Through the visualization of the affiliation of POSs to DCs, dissimilarities between different retail formats become apparent.

Fig. 6 compares exemplary spatial patterns of a supermarket chain's distribution centers with those of a discounter in Germany. The lines demonstrate the links between the distribution centers (indicated in yellow) and the POSs (indicated in blue). Firstly, a decentralized distribution structure for both types of format can be noticed. Secondly, it becomes apparent that the supermarket outlets are supplied by more than one distribution center, whereas discounter outlets are only supplied by a single DC. The distribution centers are located outside the cities close to suburbs. Furthermore, a clear regional responsibility of all POSs is

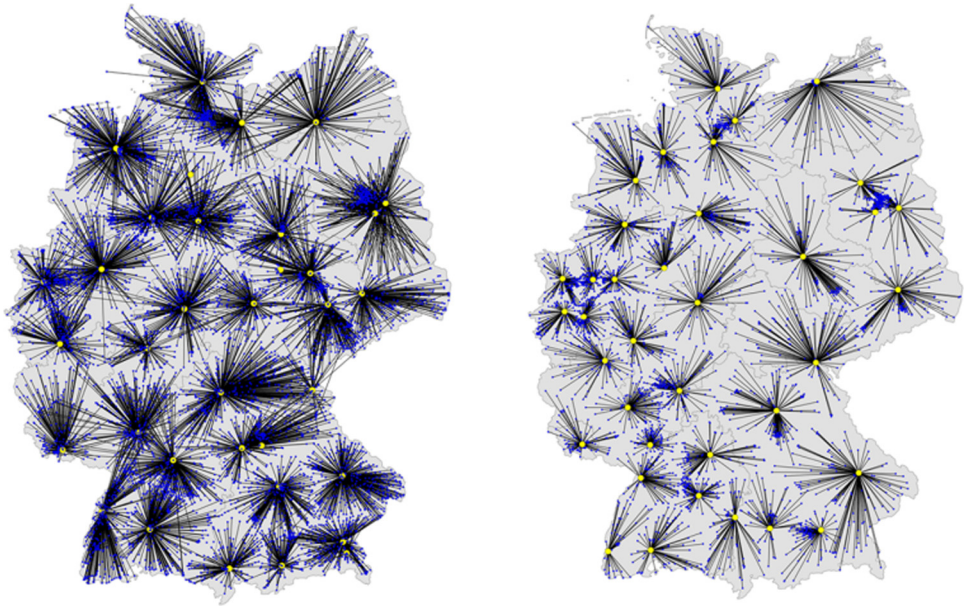

Fig. 6. Spatial distribution of a supermarket (left) and a discounter with their related distribution centers (right). (For interpretation of the references to color in the text, the reader is referred to the web version of this article.)
Source: TradeDimensions (2012).

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noticeable. The number of discounters' distribution centers is higher in rural areas. Due to the denser DC network, the distances between discounters' DCs and POS are the shortest. These findings can be considered as representative for all other German supermarket and discounter chains.

As far as relations of locations are concerned, consumer markets and other large scale food retailers show the longest distance between their warehouses and DCs and their outlets. Moreover, there are several overlaps so that one outlet tends to have several supplying DCs. DCs tend to be located in the middle of the POSs they deliver to, whereas non-company owned, third-party owned warehouses complement the supply chain structure for supermarkets, hypermarkets and a few discounters.

Furthermore, Fig. 6 seems to indicate that discounter-distribution centers deliver to less POSs than a supermarket-distribution center. Looking at all forms of discounters and supermarkets, though, this conclusion has to be reneged. In this case, it is not sufficient to look at the number of outlets which are supplied on average by one DC only. It is important to take into consideration the numbers and ranges of assortment offered at a POS, in addition to its spatial presence. Discounters with a small number of articles (800–1000 articles) and hard discounters such as Aldi or Lidl, have the smallest territories per DC, with an average of 50–120 POSs per DC, whereas there is no difference between the service POSs per DC for discounters with a large assortment and supermarkets. Difference between the latter two categories can be related to the number of total stores and their regional presence, though. Furthermore, it can be noticed that the discounters with a bigger assortment belong to retail groups that operate several differently branded chains with various types of retail formats. Depending on the size of their outlet network, a DC serves up to 250 POSs. In terms of consumer markets and hypermarkets, the number of outlets that are served by a single internal distribution center can range from 50 to 150, supplemented by several external DCs. These usually supply goods such as beverages or pastry and bakery products. The comparison shows that, in general, differences in retail logistics are closely linked to the retail format as well as to the assortment breadth and depth. This is even applicable within retail holdings: retailers who own different retail formats operate different logistics strategies and also different logistics sites for each of their chains.

Assessing the number of DCs that serve one single grocery site, this number ranges from 1 to 5 DCs. 96 percent of all discounters are served by such a dedicated DC, whereas the other formats are served on average by more than one. Smaller supermarkets are served by 1.4 distribution centers. For grocery stores with more than 400 m^2 the number of related DCs rises to 1.6 DCs per supermarket, whereas we have 1.9 DCs per consumer market and 2.2 DCs per department store. According to these numbers, it can be concluded that the number of DCs and warehouses supplying an outlet rises with the size of the outlet's sales area. The average distances between POSs and the company's own DCs range from 25 km to 125 km and is closely related to the density of the DCs in an area: the higher the density of the DC network, the smaller the distance between DC and POS.

To allow a comparison of similar retailers and their distribution structures, Fig. 7 shows the spatial distribution of one French supermarket chain and one German discounter chain (same chain used as in Fig. 6). The figure reflects the more centralized distribution structure in France compared to the structure in Germany. Against the background of the interviews and the data analyzed, it seems that logistics developments follow two spatial patterns:

- Polarization: logistics facilities are increasingly concentrated in very large metropolitan areas at the (relative) expense of medium sized cities and rural areas.
- Logistics sprawl: warehouses are moved from core urban areas to suburban and exurban areas.

There are some further particularities of French food retailing which need to be pointed out: Even though retailers have regional DCs in France, much of the distribution is made by at least one DC which is located near Paris so that in total each POS—no matter if discounter, supermarket or hypermarket—has at least two supplying DCs.

The logistics organization for large retailers is based on the geographical breakdown of the country in a few logistics regions (e.g., five for Auchan and nine for Intermarché). The number of logistics regions is the result of the arbitration between the transport costs and the costs of such logistics hubs. On average, DCs dedicated to food deliver to POSs within a range of 300 km. Regarding the TradeDimesions data for France, the median of the POS numbers delivered by each DC is 79, the average is 143 (Bahoken et al., 2014).

Further to the described concentration phenomenon for supermarkets, this is also applicable for discounters. Besides the central DCs, Fig. 7 demonstrates that, even though we find regional distribution centers in France, the DC structure of French supermarket-retailers is much more decentralized than that of German discounters.

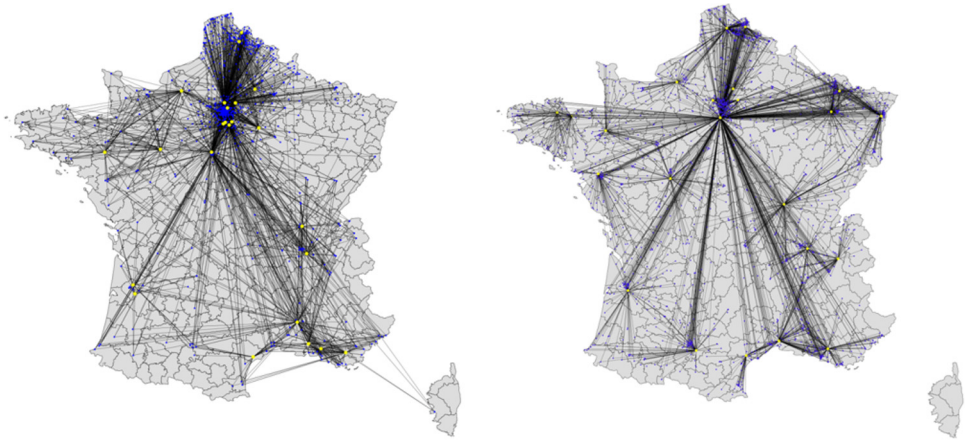

Fig. 7. Spatial distribution of a French supermarket (left) and a discounter with their related distribution centers (right).
Source: TradeDimensions (2012).

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5. Summary and impact of findings on freight modeling

The above analysis has revealed that for the same market in adjacent countries, in this case food retailing in France and Germany, differences as well as similarities can be found in distribution patterns and supply structures. In both markets a trend towards an expansion of the total sales area and an increase in the total of food stores can be observed. Also, both food markets are dominated by a small number of retail groups in the food sector which generate about three quarter of all food sales. There are some noticeable differences, though. The network of retail outlets is denser in Germany than in France, and the successful retail formats in each market are different, too: whereas in Germany discounters make the most turnover, in France the format of hypermarkets is more popular.

By considering the features of the POSs together with the spatial patterns of their DCs, the present analysis of distribution structures was deepened. The research investigated the link between the characteristics of food retail systems (formats, size of POS) and the geography of their DCs in France and Germany. The analysis of the distribution structures indicated that distribution centers are located nearby agglomerations of POSs in both markets. The detailed comparison of food retailers in Germany and France shows, however, that the spatial distribution of DCs is not only related to the availability of resources (infrastructures etc.). The spatial pattern also depends on the specific retail system's characteristics. In fact, the geography of DCs is strongly related to the format and to the size of stores. Nevertheless, a more regionally oriented catchment area of DCs in Germany became evident during the analyses, which is reflected by a decentralized structure of DCs. The analyzed data and interviews for France and Germany also confirm the conclusions of Andreoli et al. (2010) that the recent trend in the geography of retailers' warehousing has also been driven by industry consolidations and the microeconomics of big-box retailing, where advantage is gained from economies of scale in production, sourcing, and distribution (Bonacich and Wilson, 2008). Furthermore, there are still national specificities behind the macro forces of globalization. In addition to these complex systems of country, location, format and size-specific differentiation, food-retailers develop specific logistics' organizations by type of product: grocery, household and personal care, beverages, perishables, frozen food or general goods.

What are the implications of these findings on transport modeling? The identified structural and spatial differences have an impact on freight transport with respect to (driven) distances but also in regards to characteristics of routes. As stated above, the reasons for such different spatial patterns are multiple and not always easy to assess: historical developments, influences of regulations by law, as well as geographical and demographical structures are some of them. It became clear that framework data such as turnover is not by itself sufficient information when it comes to modeling freight transport. Also, information about the number of outlets, types of retail format, assortment and sales area help to increase precision. In a comparison of freight transport structures it can be noted that, despite their geographical and structural vicinity, even two adjacent countries such as France and Germany have very different spatial patterns for their food retail related distribution transport. As different national structures affect transport demand and transport flows, a future challenge will be to find a way how national differences, which effect transport demand, can be reflected in transport models.

In this context another challenge for international transport modeling, which also impacted the research works for this paper, is the availability of data. The data available for different national markets varies significantly: definitions for classes of goods differ as do periods for which data is collected, for example. Even comparable data that one would assume easily accessible, such as turnover or number of outlets can be difficult to find due to differences in definitions. In the case of food retail, for example, this means that in terms of food turnover it is not always clear whether statistics include sales of specialized stores, drugstores or others. We experienced that even the figures for the total number of outlets for one country differ significantly from one source to another. As a consequence, direct comparisons of markets are difficult, and conclusions drawn for one market cannot necessarily be transferred to another market. Even data which seems to be similar at first sight is not automatically transferable. Only when it is established that markets contain comparable structures and are characterized by the same parameters are analogies feasible. Friedrich (2010) addresses another data restriction which occurs when it comes to data needs for freight transport modeling: statistics concentrate on traffic or number of vehicles but often lack in considering logistic systems.

Therefore, as far as international freight transport modeling is concerned, the analyses of structures of one country do not necessarily allow the modeling of structures of another country. Data needs to be sourced, its compatibility needs to be ensured and structures have to be compared in detail for each country separately. Trans-border traffic analysis also needs thorough investigation in regards to the comparability of information available. This complexity is further enhanced by the fact that time periods of data collections by official statistics bodies often differ between countries as well as by the fact that classes of goods are not yet defined on an internationally applicable level.

Standardization of data would therefore be one of the essential steps needed in order to facilitate successful international freight transport modeling. Such international data standards would allow for easier comparison of markets to analyze their structures and modeling of international freight transport interfaces. Such international data standards become even more important in the context of big data. If such standards are put in place, big data can contribute to building the basis of international freight transport models. This could enable the simulation of more efficient global transport chains, helping to find approaches for reducing supply-chain emissions and ensuring that transport infrastructure can be used in an optimized way. If not, big data will remain an accumulation of numbers.

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