SCENARIOS OF COMMERCIAL ZONING TO REDUCE IMPACTS OF FREIGHT MOVEMENT IN THE CITY

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ABSTRACT

In this paper, we propose an original approach which could help the policy makers and the urban planners to make decisions concerning the development or preservation of different kind of retail establishments. The decisions could be taken by having a good knowledge on the impacts of freight movement which are generated on upstream by the stores.
This research provides the modelling of impacts of freight transport in town and is part of the program development of model Freturb. Based on french Urban Goods Movement surveys, we use data on goods entering the shops. Those data allows us to build a table of conformity between retail establishments of various scales, considering the quantity of goods reported to number of jobs. In other words, how many small shops, in a given activity and in a given number of jobs, does it take to replace a hypermarket or a supermarket, and vice versa?
The contribution of this research is mainly situated in terms of methodology and in providing unpublished data on the consumption of households in a city through the goods supplied by retail establishments. It is thus possible to built scenarios of change in the distribution of various forms of retail trade and to forecast their impact on the urban goods movement.

Keywords: urban goods movement, commercial zoning, retail activity, forecasting, sustainability

INTRODUCTION

The work presented comes from a process started in France in the early 1990s. Policymakers and the research in socio-economics of transport have initiated a program on urban logistics thematic. Hence national surveys "Urban Goods Movement" (UGM) have

started, covering all types of activities in the urban space. Then the project continued, with the built of model Freturb (Aubert, Routhier 1998) (Routhier, Toilier, 2007).
This is a unique approach because it is a nationwide program that has resulted in the late 1990s; the results of surveys located in three different cities, showed stable ratios from a city to another city. It subsequently leaded to create a model to help public authorities for their UGM diagnosis. This model allows to quantify the impacts of freight transport in the city. What is expected by policymakers from modelling is principally the generation of delivery and pick-up operations, and the number of kilometers that transport operator has to produce to complete these operations. In addition, a module produces the impact of the parking of vehicles making delivery operations in the city.
In terms of simulation, two key demands remain unanswered:

- Public actors want to know the impacts of their actions and changes of the regulations or developments resulting in the behaviour of transportation stakeholders.
- Freight operators and public actors want to find out economically possible, better solutions of organization of goods supply for the city. For this we must find equilibrium between reducing the inconvenience and efficiency of urban logistics system.

For purposes of simulations, we consider that there are three major keys in urban distribution system: the organization, the vehicle and location. The organization will be seen here from both sides, from the perspective of the shipper (loader) and from the carrier's point of view.
In this paper, we focus on the retail business. French UGM surveys have shown that the final distribution (the last link in the supply chain to the consumer, ie the movement of purchases) represents more than half of all urban transportation (movement) of goods (in km Private Car Unit, Ambrosini, Routhier, 2004).

The organization of this distribution is therefore a key objective, and the forms taken by businesses is crucial for the impacts they produce. Tthis question has been raised in a research project funded by the French Environmental Agency (ADEME) for the Ministry of Sustainable Development, the project « Environnement Rental Housing Energy Transportation - ETHEL II » (Routhier et al, 2009).

BACKGROUND ISSUES, AND PURPOSE

Today we are able to simulate the generation and transportation impacts of urban goods in a city, with a model like Freturb developed in France from more than a decade. On the other side, we can generate and quantify the movements of household purchases (Gonzalez-Feliu J. et al., 2010).
We detail below the gains of the research program in France on these issues, and then we introduce the new issues that have allowed this new part of the research.

Background of the research

The model Freturb is now able to produce results about the impacts resulting from transportation of goods on any urban area; the model only needs a file listing all establishments of all activities. The model allows to isolate one or another activity, or large

business, to know the contribution of these in the general impacts (parking, traffic). It proceeds by analogy, given the invariant ratios that were determined during three national surveys UGM in France.
We will refer to the specific UGM activity nomenclature, stratified into 8 classes (large fields of economic activity), and in 45 layers then separated into 115 strata, taking into account classes of employment levels. Among the available data, we are interested in data on retail activity. So from these classifications, we retain only two classes of 8 (the "small shops" and "mass distribution"), and only 15 out of 45 layers (mass distribution is found in 3 layers, coloured in the following tables, and small shops are more detailed in 12 levels, in white in the tables).
The following table shows the stakes of this work, on both perimeters that we speak about in this paper: Bordeaux in 1995 (data of the survey) and Lyons in 2005 (applying test for simulation): number of jobs in retailing, mileage generated by deliveries to shops, mileage in private cars generated by these businesses, for purchasing by households. The field on which we focus is 10-15% jobs, and more than 10% of km PCU (private car unit).

	Lyon, 2005 Urban Area		**Bordeaux, 1995** Agglomeration	
	Retail business	*vs.* all activities	Retail business	*vs.* all activities
Jobs	small shops: 94 800 mass distribution: 17 320	13,5% *(829 900)*	36 975 8 053	15,9% (*283 200)*
Number of establishments	small shops: 20 998 mass distribution: 227	17,4% *(122 148)*	8 262 107	22,8% *(36 713)*
No. km a week (including deliveries and pick-ups)	2 706 000 km PCU and 26Mkm shopping trips	11,6% *(23 360 000)*		

Table 1: main figures of the city-model and the city survey

The movement of goods to the downstream retail represent a very important part of freight transport in cities: about 70% of total movements of goods in town. This information is often neglected, because these same movements made by individuals with their car, are also within the scope of surveys on individuals travels, and are therefore more often treated as individuals behaviour than as goods movements. Their apprehension is quite complex, as shown by Segalou (1999) and Gonzalez-Feliu et al (2010).

Purpose

The final distribution of goods would comprise the last logistic link in urban area, plus the travel of consumer (shopping trip) between the place of purchase and the consumer's home. This movement may be made by households themselves, in the case of the classical pattern of retailing, in which the consumer has to make the conveyance choice, including private car. In the case of new schemes of remote retailing (home deliveries, etc.), the last trip will be internalized within the urban logistics, and form a final link between freight warehouse and the home or a point of repository for consumer goods very close to his home. For part of the

simulation on the movement of household purchases, the reader may refer to the paper of Gonzalez-Feliu and Raux (2010). We speak in a submission from "retail" in a broad sense. In fact, retail trade, strictly speaking, is the resale at retail, of goods which were previously bought in bulk. We include in our analysis, in addition to that pure activity of resale, some crafts and tertiary that have for main function the sale of goods or services produced in the facility, such as the bakery.
We aim to develop as key passage between models of urban development; the question relating to the choices that are made by authorities and developers in terms of commercial zoning. It is crucial because commercial equipment, seen in a land use way has a long lifetime. The choices made today have implications in fifty or hundred years. Whatever planners decide, the city continues to live, households have to puchase; but there are different alternatives in the tools available to practice this supply.
The developers of urban space are now faced with the challenge of producing a “clean” city, but they are not able to simulate the impacts of new development in terms of transport volumes generated. This problem is particularly acute in the field of retail activities. While big commercial centers is part of a highly optimized logistic circuit, the thought on purchases motorised trips it induces downstream is generally limited to calculating the size of the parking. We know however that the establishing of small businesses in an urban area of sufficient density, allows households to move from automotive for their supplies.
The purpose of this research is to produce a series of equivalences between three main categories of retail businesses, in terms of weight and types of goods.
The main objective is to simulate the effects of the implementation of various schemes of final distribution of goods on the traffic and the environment. The changing of supply of shops for the population is a variable that the urban planners can control and restrain.

The work involves the evaluation of changes in scale of the retail activity and thus assess what impact these changes in number of establishments, number of jobs and number of miles devoted to the distribution of goods. It is a contribution to available tools for evaluating and optimizing the distribution of goods in urban areas, in terms of sustainable development. The numbers of establishments and jobs contribute respectively to economic aspects and social issues; distances involved in road motor vehicle concerns the environmental part. For an application of the environmental component, refer to the paper of Gonzalez-Feliu, Ambrosini and Routhier (2010) about reducing the impact of urban logistics with a factor of 4.

Limits of the approach

We exclude for the moment, because of a lack of data, and given our assumptions, to make a simulation of the entire supply chain of stores in town. For example, although there are clearly major effects, that should be measured: in a scenario of multiplication of small shops, the effects on wholesale trade will not be assessed.
Starting from this issue and the social demand as mentioned above, we propose here a method to calculate the equivalence between the three main schemes of distribution to consumers in France: small retail shops, supermarkets and hypermarkets.

THE PROPOSED METHODOLOGY

We have a rich material and still not sufficiently exploited: the national survey “Urban Freight Transport” which was made on three sites in the late 1990s. Of the three cities surveyed, the data of Bordeaux seems to be of good quality and we should allow an investigation into the nature and volume of goods entering and exiting establishments in town.
To present the results in a form we construct scenarios about equivalent retail activities, of similar nature and of different sizes, with the calculation of the impacts of different situations (all retail in hypermarkets, all retail in small shops, and so on).

Available data on goods flows in the city

In order to answer the questions exposed, we used data from national surveys UGM, and we specifically used the data on goods flows generated by commercial establishments. Surveys on the carriage of goods in the city focused on three cities in the late 1990s, but the data about the content of deliveries and collections at the entrance and exit of establishments has good quality for the survey that was conducted in Bordeaux in 1995. So on this basis we have built our equivalences construction.

French national survey on UGM

The survey methodology (Patier and Routhier, 2009b) consists of nested questionnaires. The observed individuals are the establishments of all activities in the town, and each establishment creates “movements” (one operation, for a receipt or for a shipment of goods). Each movement gives one or more “goods sheets” in which the products handled are described (packaging, nature and weight, in particular). This first part of the survey is to know the behaviour of establishments, in terms of urban logistics. A second part of the survey concerns more specifically the transport, and allowed the model to allocate a portion of the distances travelled by vehicles to each site. For one record "operation" there is one record “transport” but there may be multiple records “goods”.
An important feature of the survey has been to seek to ensure the representation of different “skills” (butcher, bakery, drugstore, etc..), particularly in the distribution sector, by a number of establishments surveyed statistically valid.
The survey of Bordeaux (Ambrosini and Routhier Patier, 1997) focused on more than 1,500 establishments in all types of activity, including 564 in the retail activity, 541 small shops and 23 establishments like supermarkets or hypermarkets.

Data on goods

Of the 541 small businesses surveyed, they are 459 providing at least one valid form about goods, as detailed in the following table.

Type of retail establishment	Number of est.	Number of workers	Mean number of jobs in an establishment	*number of valid goods records in Bordeaux' survey*
hypermarket	10	2655	266	*613*
specialized department store	2	300	150	*34*
supermarket	11	453	41	*131*
minimarkets	9	28	3,1	*83*
clothing, shoes and leather	49	183	3,7	*146*
butcher's	29	83	2,9	*116*
groceries, alimentation	45	107	2,4	*193*
baker's and confectioner's	56	273	4,9	*225*
café, hotel, restaurant	53	219	4,1	*245*
pharmacy	19	85	4,5	*96*
hardware	24	50	2,1	*101*
furniture	22	159	7,2	*128*
stationer's and bookseller's	49	128	2,6	*227*
other	83	380	4,6	*308*
non-sedentary	21	32	1,5	*68*
total	482			*2714*

Table 2: number of establishments that have completed at least one sheet about goods in the survey of Bordeaux, number of jobs, and number of forms filled, by stratum.

Because they are not substitutable with other businesses, automotive trade and fuel material supply have been excluded of the study.

Several hypothesis

The data processing was made regarding a few assumptions detailed below:

H1) In retail activity, the goods received by an establishment, undergoes either no or minimal transformation. We use this shortcut to overcome a major difficulty raised by this issue: aggregate data on the subject of final consumption are not readily accessible, or even absent. The field of consumption is generally split by sector, and data are private.

H2) Customers are few influenced by the type of store they frequent. It means that the volume and the nature of goods purchased by a household is not influenced by the categories of stores.

H3) The number of jobs in each retail establishment reflects the volume of activity. By setting this hypothesis, we have the idea that economic optimization is reached in most retail stores; so the amount of goods received (and distributed) per job is the same in each

sector studied. Therefore, we can define our main indicator: the weight generated by job in a retail establishment, for each sector, on a usual week.

H4) The generalization of the results is permitted, a simulation whereas the structures of each activity remain the same from one city to another (central assumption in the simulation approach Freturb initiated by the Laboratory since the early 1990s). The survey data are generalizable to any urban space, as shown in the comparison of surveys in the three French cities (Patier and Routhier, 2009).

H5) The structures that are defined for each type of retail activity, reflect patterns that are stable and it is possible to connect the data on goods carried and their characteristics (weight, nature and packaging), with thin segmentation of retail activities, as presented in the method presented below.

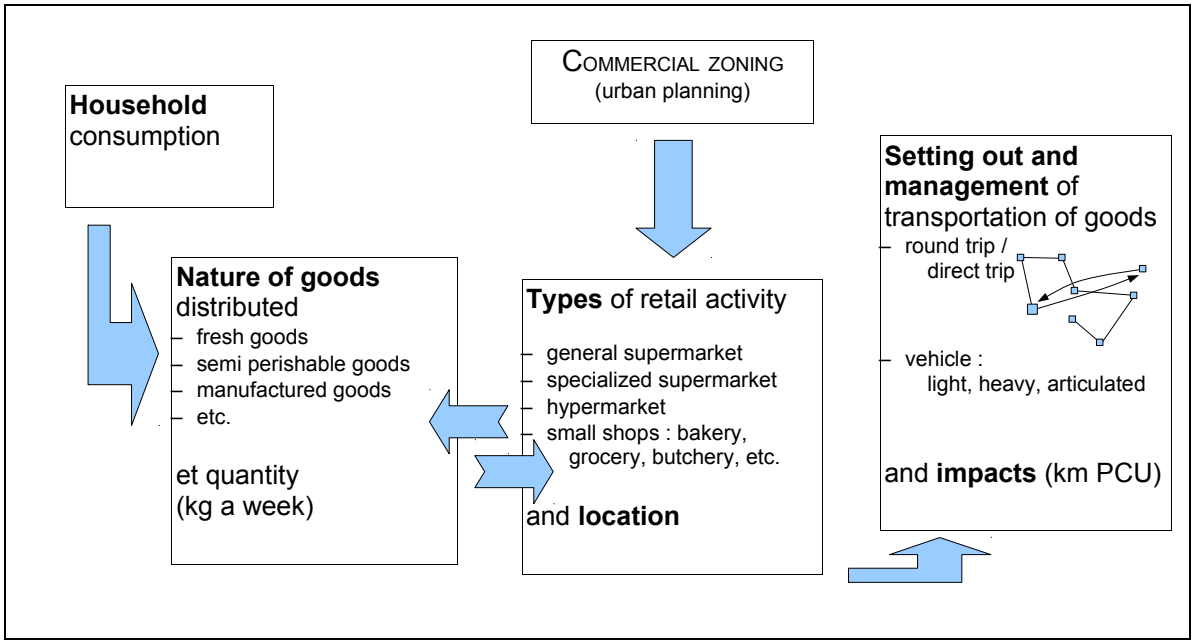
The construction method of correspondence between scales of retail activities

Here is the major contribution of this communication: the building process for a correspondences table, which becomes our “simulation engine” at the end of the work in order to measure effects of different situations. The tables gives substitution possibilities between types of retailing activities.

We have developed a method for computing equivalences between categories of businesses in retail activity, by two ways: the activity (skill) and the scale (size of establishments).
The only data we can directly make use is the number of jobs in establishments of "retail" identified in the SIRENE database, or the number of establishments on the studied territory.
The types of activity involved (small stores and huge stores) are listed in the following table.
Seeking a minimum of consistency in our work, the use and compatibility of the activities involved, we excluded from this exercise very specialized activities that do not allow a switch from one scale to the other. We excluded activities related to the automotive and fuel supply and fuel materials (in the baseline in Lyon 2005, 981 establishments), also activities concerning the collective catering (435 establishments in Lyon).
Two issues were treated simultaneously:

- How many jobs are needed in a supermarket, in a hypermarket and in small shops, considering different “counters” or “departments” (meat, grocery, dairy, drugstore, etc..), to distribute the same quantity of goods?
- How many small shops, in a given activity and in a given number of jobs, does it take to replace a hypermarket or a supermarket, and vice versa?

In this simulation approach, we mix four levels of observation that are the weight necessary to city life (consumption), the nature and quantity of goods passing in commercial establishments, the scale and location of these stores, and transportation behaviour leaded by the commercial equipment in the city.



Box: levers between observation levels used in commercial zoning analysis

Expecting equivalences between different categories of stores, by activity

The categories of retail activity have to be considered separately to determine the number of equivalent establishments that are created or destroyed between the scenarios. The major challenge was to calculate how many small shops are the equivalent for a hypermarket, and in what proportions the different types of small shops disappear.
Indeed, we make the assumption that all categories of small shops are found in the departments of most supermarkets and hypermarkets. So we calculated a volume of activity, by nature of goods, in order to resolve the central question: how many small businesses in different categories are created to compensate for the loss of a hypermarket, or rather what effect shall have, in terms of loss of small stores, the creation of a new hypermarket, for a constant volume of consumption.
The purpose of our questioning is the replacement "one for one" in consumption volumes generated by the retail activity, and not to make a research in marketing field about the incentives to consume that would cause some form of commercial planning.

Expecting equivalences between the levels of retail stores, depending on the size of the establishments

Assuming that stores with common characteristics, generate substantially the same volumes, in either city they are located (hypothesis verified by the research for Freturb modelling) we have build standard ratios by activity and have applied them to our study site, Lyon. So we formulate the hypothesis of transferability (H4 described above).
The major ratio which is calculated, and permits the simulation, is the average weight of goods received a week by an establishment. This indicator is calculated according to different kinds of goods (fresh goods, semi-perishable products, manufactured goods, chemicals, etc.). We started off with the idea that the mix of natures of goods moving in a

retail establishment is a reflection of his “skill”, and it is from this information we were able to calculate the equivalence between different scales of retailing, between the non-specialized hyper- or supermarkets, and the specialized small stores.
The categorization used for the types of goods is relatively coarse: UGM surveys build this data to a dozen positions, including segments that we have directly excluded from the analysis because they do not constitute “final goods” such as waste, mineral raw or intermediate products of agriculture.
In order to build equivalences, we have defined three categories of businesses, by commercial scale, corresponding to three modes of urban development, in terms of commercial zoning offer. The first one is the hypermarkets and likened to, they are huge establishments, that need place and generate many shopping trips made by car. The second one is the supermarkets and likened to, they are an intermediate level, have a optimized logistic organisation, and have a customer catchment area restricted to the quarter. The third one is the small shops; they can be non-specialized, like the minimarkets, but most of them are highly specialized, and therefore only one or two categories of nature of goods are moving through them.
For each type of establishment, categorized using a nomenclature combining type of activity and salaried workforce (the nomenclature come from UGM national surveys, and resulting directly from the nomenclature exposed earlier), we reported an average amount of goods from ten different kinds. By standardizing the data (base 100), we were then able to report the quantity of goods passing through the very large department stores, through the supermarkets and similar, and finally through all small shops of different types. This allowed us to identify equivalence ratios between the types of retail businesses, taking into account the goods sold in stores.

Type of retail establishment	**Weight by worker** *(kg a week)*
hypermarket	1560
specialized department store	466
supermarket	580
minimarkets	535
clothing, shoes and leather	152
butcher's	395
groceries, alimentation	553
baker's and confectioner's	554
café, hotel, restaurant	64
pharmacy	101
hardware	161
furniture	192
stationer's and bookseller's	479
other	115
non-sedentary	451

Table: the ratio Weight by job (aggregated data) for large categories of stores

As for a first intermediate result, the typology in three categories permits to build the switching keys between three large scale of retail establishments:

For the same amount of goods, in weight
(487 tons a week for an average establishment of hypermarkets and similar type)

1 average hypermarket	<>	9,6 supermarkets and similar	<>	474 small proximity shops
344 jobs		364 jobs		1 981 jobs

minimarkets	4
clothing, shoes and leather	35
butcher's	12
groceries, alimentation	24
baker's and confectioner's	33
café, hotel, restaurant	178
pharmacy	18
hardware	6
furniture	6
stationer's and bookseller's	11
other	89
non-sedentary	58

From this result, with the delicacy of nature of goods that are carried by different categories of small shops and supermarkets, we can simulate scenarios, including those described below.

Simulation tools

To produce quantitative results and thus illustrate the social utility of the approach, we implement two successive simulation tools:

- First, an enrichment of the raw SIRENE database is made with procedures in the model Freturb. This pretreatment is needed, especially to find retail establishments, commonly associated with the categories of “proximity shops” but which by their size, will eventually be assigned in the categories of specialized supermarkets or huge stores;
- Second, passage through the table of correspondences with the definition of market share (in tonnage) for each three scales of retail establishments;
- Third, the new profile of the study area (each establishment newly created or erased is assigned spatially) is passed in the model Freturb to simulate the effects of the changes, particularly in terms of kilometers upstream from the stores.

The simulation opportunities created by the table of correspondence: a short illustration by two families of scenarios and their results

The simulation of scenarios drawn here focuses on changes occurring in the retail sector, upstream from the last deposit of the goods. In the case of store-based retailing, this place may have different characteristics (size and nature, from the largest hypermarket in the outskirts to the smallest corner store) and the simulation considers only the upstream part of the goods movement.
In this research, we do not take into account the potential value of the "last mile" (eg an increase in transport for hire or high optimization of vehicle tours by using computerized tools). We assume a trend in the distribution patterns of goods very similar to the current situation. We propose simulation, with constant population, constant consumption volume, and constant transportation schemes. Only the retail activities are moving.

The territory covered by the simulation is the large urban area of Lyon, for which we have the database of establishments (SIRENE) for 2005. The SIRENE data base, filtered for including only the retail activities of interest, involves 20 546 units, extracted from a base which includes 122 148 establishments (all activities).

Before processing equivalences by using the table, we aggregated data on the entire territory. The output of the table is a non-spatial data. Thus, the simulation of km PCU by the model Freturb needs spatialized data on establishments. So the creation of new establishments (and possibly selective destruction), have to be be spatialized. In order to assign adequate categories of retail activities, to adequate zones (the urban area is divided into 33 zones), we set several hypothesis:

- small shops follow the population
- hypermarkets follow their competitors, and after that in case of saturation, they follow the population; specialized department stores follow the hypermarkets
- supermarkets follow the population (our zones are large enough, so we do not have any pure residential zone)
- in case of difficulty of assignment, huge stores prefer the suburbs and small shops prefer the density of central zones.

In the simulation, we neither take into account the projected growth or new developments in commercial zoning. The object of this simulation is to completely isolate the effects expected from the transformation of the structure of retailing. So the database of establishements is modified on

Simulation in the extreme: replacement of all establishments in one category (family 1)

To highlight the breaks at work in the scenarios, we chose firstly to simulate developments in the extreme. The purpose of this work has not been to obtain a realistic vision of the future patterns of final distribution of goods, this is only to set the limits which the system is capable to evolve within.

Assessing the impact of changes that may occur on urban logistics of retailing is done in three distinct scenarios.
The scenarios reflect caricatural changes in the commercial activity:

- Scenario 1a « full hypermarket": it simulates the transfer of all commercial activity in shopping malls. It adds new ones, central or peripheral, in proportion to the offer that is destroyed by the removal of small stores, supermarkets and proximity medium sized retailing establishments.
- Scenario 1b « full supermarket and assimilated » following the same logic as the previous scenario, the entire final distribution of goods is done in supermarkets and likened stores. In our data on types of goods in the Bordeaux' survey, supermarkets and likened establishments have the particularity of not handling all kinds of goods. The residual goods quantity, which can not be absorbed, should keep in small shops. More than 98% of the goods could be absorbed, thank to the specialized establishments which take place in this second category.
- Scenario 1c "full small stores" is simulated by the transfer of all commercial activity in the small local shops, minimarkets and convenience stores.

	scenario 1a "full hypermarket"	scenario 1b "full supermarket"	scenario 1c "full small shops"
No. of establishments	80	1 520	32 516
Employment (no. of jobs)	26 021	57 860	168 464
vs. reference	*- 86 794*	*- 54 956*	*+ 55 649*
km PCU (urban freight, except shopping trips)	430 667	1 330 494	2 126 474

Table: results of extremes scenarios (100%): number of establishments, employment and km PCU for deliveries.

This table shows two outstanding results:

1) the hypermarkets in the scenario 1a generate three times less kilometers than supermarkets in scenario 1b, and five times less than the small shops in scenario 1c. This is quite apart from the fact that shopping trips are not taken into account. It is shown in Gonzalez-Feliu et al. (2010) that shopping trips made by car towards hypermarkets are a lot more important than towards small shops: the balance (in km PCU) is therefore unfavourable for hypermarkets and supermarkets;
2) the number of deleted jobs is very important in the large stores scenarios (both 1a and 1b), even though scenario 1c shows a great increase of jobs.

While the small business has disappeared, the only 80 retail establishments remaining on the entire urban area are: 51 hypermarkets and 29 specialized huge stores. We also observe the jobs creation and destruction. The consequences of the scenarios are certainly to be observed in terms of freight transport; that is our main purpose. However policy makers and more generally all economic actors must subscribe to a boarder objective, that is sustainable development, including the social component in which employment is central.

Simulation of intermediate scenarios: seeking alternative acceptable developments (family 2)

Aware that the family 1 of scenarios just allows us to know the limits within which the distribution system in the city would evolve, the family 2 is a proposition to create mixed configurations. We create new situations whose characteristics are, in input, the amount of the total weight needed by the area of the study, respectively supported by the hypermarkets, by the supermarkets and similar, and by the small shops. So it is a generalization of the scenarios presented previously: in scenario 1a, hypermarkets supported 100% of the total weight of consumption, and both supermarkets and small shops 0%.

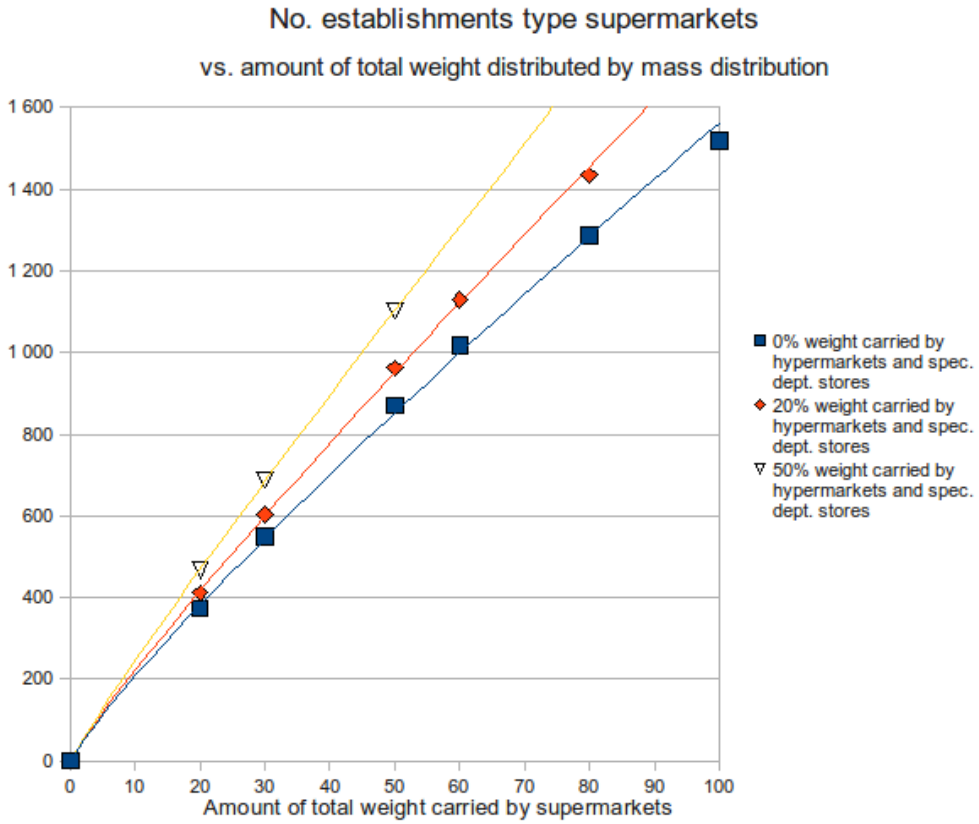


Chart: results of intermediate scenarios: number of establishments type supermarkets depending on the amount of the total needs they support

For a same amount carried by the supermarkets (e. g. 30% of total weight needed by the urban area), we can observe that the city needs less supermarkets in case of inexistence of hypermarkets (square spots) than if 50% of the distribution is made by these huge stores (triangular spots). This result could show that small shops (respectively involved in 70% and in 20% of the distribution) have a better capacity to carry all the goods, by the variety and the flexibility they offer in commercial zoning. Of course the simulation locks the internal structure of the hypermarkets, and the performance of these in terms of adaptability should be integrated.

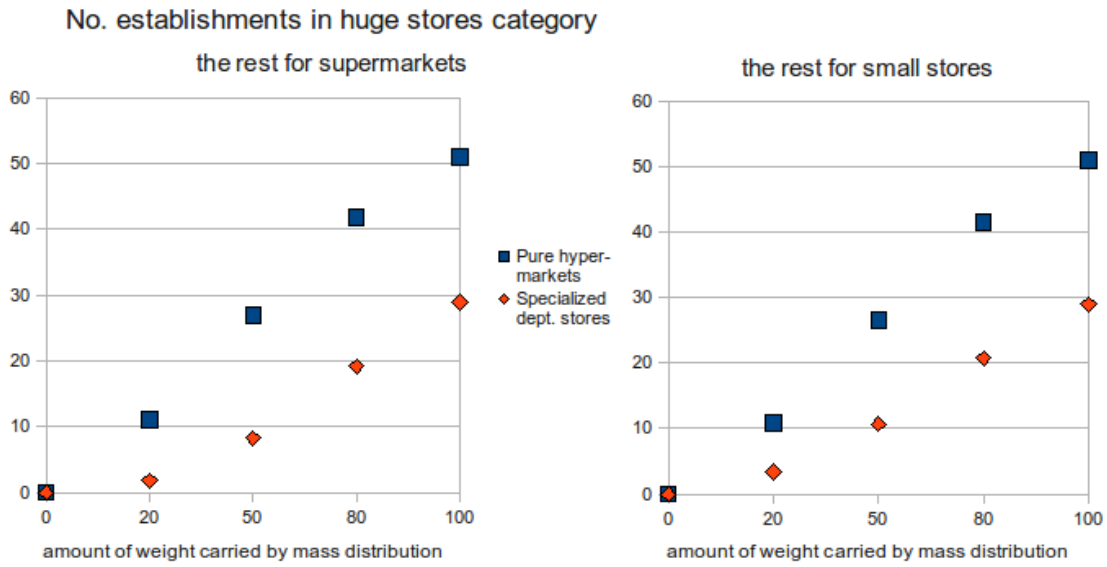


Chart: results of intermediate scenarios: number of establishments type huge stores (hypermarkets and specialized department stores) depending on the amount of the total needs they support, in two situations.

Because hypermarkets are huge structures, and because they carry all types of goods, the number of establishments needed follows the amount of total weight they carry.
More surprisingly, in intermediate situations, the number of specialized huge stores is a little bit lower if the rest of the needs is provided by supermarkets and similar, than if the rest is provided by the small shops. The result comes from the variety in the types of establishments that exists in the “mid-size specialized stores”; these one can balance more easily the loss of huge structures than the small shops, maybe because “small shops” formula does not exist anymore for a long time for some activities.

MAIN RESULTS

Several improvements have been done on the results already acquired in the Ethel II project. They focus on two areas:

- better understanding of volumes and types of goods that the medium size retail surfaces mobilise (supermarkets and similar), while volumes of small shops and those of very large establishments were already well known
- the simulation of changes to extreme had already been done; it has been impoved, and now we propose mixed situations for scenarios expected realistic.

Better knowledge about volumes in retail activity in the city

The first result of this work is the production for the first time, comprehensive data on the consumption volume (tonnage), not based on the population or an average portfolio of the household, but based on the number and size of retail stores which are supply points of the final consumer.

So we can produce new results, about average behaviours of individuals observed in the national surveys on Urban Goods Movement, and then reported on the study case by the simulation tool. In Lyons' urban area in 2005, considering the database SIRENE which lists all establishments of the retail activity, we simulate a total of 33,500 tonnes per week. Considering the data on population, which is known for the year 2006, that makes two tons per household, or 850 kg per person per year for the urban area of Lyons (except automotive and fuel consumption).
This estimation should be compared with data existing in other countries.
Our contribution to the knowledge of transportation is to produce data given by weight, and not in value as it is often made in economic studies. The data by weight is not helpful to general economic approaches, but seems to be fundamental to the transport economics, at the time where several thoughts are conducted on the theme of the pooling.

A table for calculating equivalence between scales of stores

Thank to the building of equivalences between different categories of stores, it becomes possible to forecast the effects of commercial zoning scenarios.
The simulation tool that we developed requires an input end, non-spatial, the number of establishments of each category (about 35 categories, considering the nature of activity for specialized retailing, and considering the size expressed in number of jobs)

Introducing a dynamic simulation tool of global distribution system

The quantification of travels upstream from the retail stores is carried by the model Freturb (Module 1 and 3, respectively about generation of deliveries and production of km PCU). In addition, knowing the travels made by car by households for purchasing, you have a global model, because it take into account the amount data entering the shops (supposedly outgoing) and also a number of households going to the shops. So you can simulate dynamicaly the changes that occur with several new hypothesis.

CONCLUSION AND FUTURE DEVELOPMENTS

We chose initially to restrict the analysis to action circle of retail business. By doing this, we observe only one little part of the complex chain of distribution of goods in town. A major improvement would be to extend the action circle of the tool.
Secondly, we hope to improve the land use aspect of the tool. At this time, our tool proceeds considering roughly the existing spatial structure of the retail activity. This aspect has to be improved, in a more disaggregated way during the process of simulation.
The research results are mainly in the methodology. The proposed numerical results are given for illustration of the use that can be made of the proposed equivalence table.
Many future developments are already considered: linking the modes of organization, the properties of space (impacts of density and other characteristics), highly integrated logistics for small supermarkets (or large malls), asking about pooling impacts, specially for the small shops, and of course building the same tool for the entire urban logistic system.

The data used in this paper is from 1995; it could have evolved over time. The coming national surveys in 2010-2011 in Paris metropolitan area and in other cities will help consolidate the data and the simulation tool.

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