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Impacts of retailing attractiveness on freight and shopping trip attraction rates

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ABSTRACT

This paper provides an integrated framework for assessing the relations between retailing attractiveness and both freight and shopping trips generated in urban areas. The proposed framework deploys a trip attraction (FTA) and a shopping trip attraction (STA) model then carries out a retailing attractiveness analysis. First, an overview on trip generation and attractiveness related to retailing is made to motivate and position the present work. The paper introduces then the methodological framework and describes the FTA and STA models as well as the attractiveness indicator proposed. After that, both FTA and STA flows are assessed on Lyon's conurbation. Then, the relations between retailing attractiveness and retailing-based trip attraction rates are analysed on the basis of linear regression analysis. The results show that both FTA and STA rates have a direct relation with retailing attractiveness but the category of urban space needs also to be included in those analyses. Finally, as a conclusion, main implications of the proposed framework are addressed for both researchers and practitioners.

1. Introduction

The retailing structure of a city has direct impacts on both the urban economics structure and the overall urban transport system. Indeed, the increase of consumers' purchases at urban retailers has a positive effect on the urban economy, and results also into an increase of both delivery flows to those retailers and household shopping trips (Gonzalez-Feliu, Semet, & Routhier, 2014). However, those transport flows are also a main source of nuisances, such as congestion, pollution or noise, among others (Ségalou, Ambrosini, & Routhier, 2004). For those reasons, it seems important to analyse the relations between the retailing structure and the transport flows generated (attracted) by those retailing activities.

One of the indicators that can be used to first approach the retailing structure potential is that of retailing attractiveness. Related to transport, the retailing attractiveness of a zone can be defined as the potential to generate (attract) trips, both for freight transport or people shopping purposes. Attractiveness indicators can be estimated analogously to accessibility (van Wee, 2016): since accessibility measures the ability of people and/or goods to reach each possible destination from a given origin (Geurs & Van Wee, 2004), attractiveness is the reciprocal measure that estimates the ability of people and/or goods to reach a given destination from each possible origin. Retailing attractiveness has a double effect: first on consumers' trips, and second on delivery flows. Indeed, an attractive zone in retailing activities will potentially attract an important quantity of shopping trips. Consequently, that zone will need to be supplied to satisfy its customers' needs, so it will potentially be an important freight trip generator. However, those relations are not yet addressed in literature, at least at a global level. Indeed, we find in literature many works in trip generation[1] modelling, either for freight trip generation (FTG) or shopping trip generation (STG), but only few works address both categories of flows (Crocco, De Marco, Iaquinta, & Mongelli, 2010; Gonzalez-Feliu, Toilier, Ambrosini, & Routhier, 2014; Nuzzolo & Comi, 2014; Russo & Comi, 2010). Moreover, and to the best of our knowledge those works do not study the relation between retailing structure and trip generation rates is not studied. Although retailing attractiveness has been addressed in several works (Gonzalez-Feliu, Routhier, & Raux, 2010; Kubis & Hartmann, 2007), it is related to only shopping trips and not to delivery flows.

The aim of this paper is to analyse the relations between retailing attractiveness, shopping trip attraction (STA) and freight trip attraction (FTA), i.e. on the trip generation part concerning trips at destination, or attracted by retailing activities. This framework includes an FTA and an STA model, an indicator of retailing attractiveness, and a joint

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[1] Trip generation rates are in general expressed in number of deliveries (or truck stops) in a given period (mainly per day or per week) and can be then related to the number of vehicles in order to reproduce transport flows (Holguín-Veras et al., 2011).

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assessment of both freight and shopping trips related to retailing attractiveness. First, the proposed methodology is presented. Then, the FTA and the STA models are presented and calibrated. After that, the attractiveness indicator is described. Second, a first analysis of assessment results on Lyon's conurbation is presented. Then, a linear regression analysis is presented to relate attractiveness to FTA and STA rates. Finally, implications and potential uses of the proposed framework are presented and discussed as conclusion.

2. Background and hypotheses

The structure of the economic activities of a territory has a direct impact on the goods needs and the logistics that is deployed to supply this territory (Ducret & Gonzalez-Feliu, 2016). This relation takes a special importance in cities (Woudsma, 2001), which economic and urban development leads into an increase of freight needs but also to an increase of transport flows related to supplying the economic activities of those cities (Macharis & Melo, 2011). It is why a series of works on urban goods transport have been developed over the last 40 years (Gonzalez-Feliu, Semet et al., 2014; Macharis & Melo, 2011; Ogden, 1995; Taniguchi & Thompson, 2015; Taniguchi, Thomson, Yamada, & Van Duin, 2001; Watson, 1975).

In literature, we find different visions of urban goods transport (Dablanc, 2007; Macharis & Melo, 2011; Ségalou et al., 2004; Woudsma, 2001). In this paper, we aim to be positioned in a first time at the most global viewpoint (Cattaruzza, Absi, Feillet, & González-Feliu, 2017), i.e. including the following categories of flows:

- Inter-establishments movements (IEM) include all transport flows between two economic activities. They represent about 46% of road occupancy issues by running vehicles[2] and 28% of those by stopped vehicles (Cattaruzza et al., 2017). Those flows can be managed in different ways (own account or third party transport) and concern most economic activities of an urban area (retailers, wholesalers, services, industry, agriculture, etc.), except those related to city management (Ségalou et al., 2004).
- End-consumer movements (ECM) take into account the goods' flows from the purchasing places to the final consumers' locations. They represent about 46% of road occupancy rates by running vehicles[3] but about 64% of those by stopped vehicles according to Cattaruzza et al. (2017). Those flows include shopping trips (motorized or not), home deliveries, out-of-home deliveries and other related transport flows to deliver directly or indirectly the final consumer (Gonzalez-Feliu, Ambrosini, Pluvinet, Toilier, & Routhier, 2012).
- Urban management movements (UMM) include all flows related to the construction, maintenance and other management issues of the city. It represents about 8% of road occupancy both for running and for stopped vehicles (Cattaruzza et al., 2017). Main sub-categories are: waste collection flows, construction materials transport and logistics, network maintenance, household and enterprise moving flows, among others (Gonzalez-Feliu, Toilier, et al., 2014). We also include in those categories other flows necessary to the city's operations not considered as IEM, like hospital, schools and other public establishments' supply and management flows.[4]

This paper focuses on retailing-based flows, both IEM and ECM. Although those flows are widely studied in literature, only few works deal with both flows and, to the best of our knowledge, none of them analyse the relations between both flows and the attractiveness of a zone or a territory.

IEM flows are the most studied ones, as shown by the huge variety and diversity of models (Anand, Quak, van Duin, & Tavasszy, 2012; Comi, Delle Site, Filippi, & Nuzzolo, 2012; Gonzalez-Feliu & Routhier, 2012). Although the approaches and methods are various, we observe that they follow only a few common patterns. We can then distinguish four main macro-categories of models:

- Generation models aim to characterize freight transport demand in terms of number of trucks or commodity quantities at origin and/or destination (Ducret & Gonzalez-Feliu, 2016; Holguín-Veras et al., 2011, 2013; Lawson et al., 2012; Loebl & Crowley, 1976; Maejima, 1979; Meyburg & Stopher, 1974; Sánchez-Díaz, 2016; Sánchez-Díaz, Gonzalez-Feliu, & Ambrosini, 2016; Sánchez-Díaz, Holguín-Veras, & Wang, 2016). Those models do neither forecast the characteristics of trips nor estimate travelled distances, but can be useful in urban planning, as for example for parking dimensioning or dynamic traffic simulation at a single-street level, among others.
- Models derived from the four step framework (Ortuzar & Willumsen, 2001) come from the need of estimating O-D pairs to reproduce transport flows. Three main sub-categories can be observed:
  - o Trip-based models are direct declinations of the same framework used for personal transport (D'Este, 2000; Eriksson, 1997; Ministerie VROM, 1996; Ogden, 1995). The four classical steps are: trip generation, trip distribution (construction of the O-D matrix), modal choice, traffic assignment. In some cases, the four steps are not completed, some models stopping at the distribution or model choice stages (Demetsky, 1974; Janssen & Vollmer, 2005; Slavin, 1976; Watson, 1975)
  - o Commodity-based models start by commodity generation then commodity distribution to define commodity O-D pairs; to complete those phases, a route construction phase gives transport flows (and trip O-D pairs when necessary); finally traffic assignment can also be deployed (Boerkamps & van Binsbergen, 1999; Crocco et al., 2010; Hunt & Stefan, 2007; Nuzzolo & Comi, 2014; Wisetjindawat & Sano, 2003; Wisetjindawat, Sano, & Matsumoto, 2006).
  - o Mixed models combine trip and commodity models to better represent the complexity of the urban goods transport field, as empty vehicle trips (Holguín-Veras, Thorson, & Zorilla, 2010) or the relations between commodity flows and vehicles trips (Ogden, 1978; Gentile & Vigo, 2013; Holguín-Veras & Jaller, 2014).
- Generation + route estimation approaches start by a generation phase but then continue by an estimation of flows (Sonntag, 1985; Aubert & Routhier, 1996; Gonzalez-Feliu, Cedillo-Campos, & Garcia-Alcaraz, 2014; Gonzalez-Feliu, Toilier et al., 2014) without proposing a demand distribution phase.
- Origin-Destination Synthesis (ODS) approaches generate directly O/D matrices from aggregated data, without the trip generation phase (Holguín-Veras & Patil, 2008; List & Turnquist, 1994; Muñuzuri, Cortés, Onieva, & Guadix, 2009, 2011; Sánchez-Díaz, Holguín-Veras, & Ban, 2015). Those approaches remain useful tools for studies applied to well-defined zones when little information is available, since they use very small quantities of data, mainly derived from counts.

Shopping trips are included in many urban personal transport models. However, those models are developed and calibrated on the basis of work trips, which makes that those shopping trips are characterized on the bases of work trips generation patters (Cubukcu, 2001). For that reason, we focus here on models specifically built to estimate shopping trips taking into account their specificities. We can identify three categories of models:

[2] Ségalou et al. (2004) estimate those flows as being between 45 and 50% in terms of road occupancy by running vehicles.

[3] Ségalou et al. (2004) estimate those flows to be between 45 and 55% in terms of road occupancy by running vehicles.

[4] Those activities are not considered explicitly as IEM in the French National Surveys (see Gonzalez-Feliu, Toilier et al., 2014, for a detailed categorization of the French Surveys, and Ambrosini, Patier, & Routhier, 2010, for more details on how the data was collected and analysed).