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The distribution of crowding costs in public transport: New evidence from Paris

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A B S T R A C T

Whilst congestion in automobile traffic increases trip durations, this is often not the case in rail-based public transport where congestion rather leads to in-vehicle crowding, often neglected in empirical studies. Using original survey data from Paris, this article assesses the distribution of comfort costs of congestion in public transport. Estimating willingness to pay for less crowded trips at different levels of in-vehicle passenger density we cannot reject a simple linear relationship between crowding costs and density. We apply our results to the cost-benefit analysis of a recent Parisian public transport project.

1. Introduction

From an economic perspective, good urban transport policy should make efficient use of the scarce ressources time and space, subject to public budget constraints. It has come to be accepted that past policies have led to inefficiently high automobile usage in many countries (Newman and Kenworthy, 1989). Transport policies have thus typically focussed on modal shift strategies: increasing the patronage of public transport (PT) systems, especially with the use of congestion or environmental tolls for cars (Lindsey, 2006; Small and Verhoef, 2007; Tsekeris and Voss, 2009) or subsidies for PT (Parry and Small, 2009). Nevertheless, not always were such policies accompanied by increased PT supply. Where supply elasticity is low – as is the case for most rail-based PT systems – density of passengers in PT systems will consequently increase.

The traditional view assumes that transport users' utility depends on time and money only. Under this perspective, as long as the saturation point of PT is not reached (Kraus and Yoshida, 2002), increasing PT usage should almost always lead to a societal gain. With more individuals sharing the fixed costs of PT provision, there will be economies of scale, such as a higher frequency of vehicles in the PT network (Mohring, 1972; Proost and Dender, 2008). Reduced road congestion also decreases costs of automobile transits and environmental externalities (Parry et al., 2007; Malibach et al., 2008). However, this ignores comfort costs of PT congestion occurring well before the network reaches a bottleneck. Considering that individuals care about the amount of space in vehicles, i.e. the inverse of passenger density,[2] crowded travel conditions

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[2] We recognize that apart from passenger density, subjective factors may also play a role in perceived levels of crowding (see Cox et al. (2006) or Mohd Mahudin et al. (2012)). We here focus only on passenger density, thus using crowding and congestion interchangeably in what follows.

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Table 1
Evolution of the Paris subway usage. *Sources:* Syndicat des Transports de la Région Ile-de-France (2009),Observatoire de la mobilité de la ville de Paris (2000) and Observatoire de la mobilité de la ville de Paris (2009). For the density indicator we assume that a train has 557 places, 139 m^2. The regularity indicator is defined as the share of travellers who wait less than 3 min during peak periods.

	Demand (m pass-km)	Supply (m train-km)	Density (pass/m^2)	Regularity (%)
2000	6011	42	1.0	98
2009	7353	48	1.1	98

may decrease their utilities even if travel time is kept constant. Therefore, there is no free lunch by decreasing the attractiveness of automobile transport without improving the supply of PT.

Whereas some authors have integrated such capacity constraints in their theoretical analysis of PT supply and pricing rules (Jansson, 1979; Kraus, 1991), empirical applications did not fully consider crowding costs until recently. Thus Parry and Small (2009) include crowding costs as a dimension of the two modes problem in their theoretical framework analyzing the optimal level of PT subsidies. However, they neglect them when calibrating their model empirically. Recently, research has looked at the effects of PT crowding on the choices among competing investments' projects (Tirachini et al., 2010), on estimates of PT demand (Tirachini et al., 2013), as well as on optimal PT pricing, service frequency and vehicle design (Tirachini et al., 2014). Kilani et al. (2014) compare road and PT pricing in the Paris region during peaks in the presence of PT crowding. Some recent papers also include crowding cost as a component of individuals' route choices over railway systems (Pel et al., 2014; Kato et al., 2010; Leurent and Liu, 2009; Raveau et al., 2011). Empirical evidence on PT crowding has been gathered mainly in Britain and Australia, mainly by consulting firms on behalf of railways regulators (see Li and Hensher (2011) or Wardman and Whelan (2011)). ITF-OECD (2014) summarizes official crowding valuations used in developed countries for socioeconomic assessment of transport projects.

This article adds to this literature by examining the utility costs of PT congestion using contingent valuation methodology (CVM) on a survey collected late 2010 in the Paris subway. We use declared preferences on hypothetical states of nature in order to estimate the distribution of the marginal willingness to pay for less crowded travelling conditions. Importantly, we cannot reject a linear relationship between our measure of density and crowding costs. Moreover, we confirm the result of Tirachini et al. (2014) that PT crowding is a first-order urban externality that should be considered by policy makers.

The Paris area is a good case in point to investigate PT crowding costs. First, the Paris PT network is the most intensively used in Europe (UITP, 2014) and is confronted with chronic crowding issues. Over the last ten years, road space was reallocated from cars to cleaner transport modes (buses, streetcars, bikes). This popular policy of quantity regulation (Prud'homme and Kopp, 2008) has reduced the average speed of cars in Paris by 10% between 2000 and 2007 (Observatoire de la mobilité de la ville de Paris, 2007). Following the rise of travel costs for cars, individual motorised traffic with Paris as destination or origin has diminished by 24% (in passenger-km, pkm, see Kopp (2011)). Whilst usage of motorbikes and bicycles has increased, the majority of the modal switch occurred towards the PT network.

As illustrated in Table 1, PT patronage in the Paris subway increased by 22% between 2000 and 2009 such that now 60% of all trips in Paris use rail-based PT (on at least part of the journey). Supply could not keep up with demand, leading to increased crowding: in-vehicle passenger density grew by 10% between 2000 and 2009.[3] Note that there is no indication that the Paris subway is at a bottleneck, where demand negatively affects regularity and travel time. Thus the share of users having to wait more than 3 min during peaks was constant over the period 2000–2009 (Observatoire de la mobilité de la ville de Paris, 2000; Observatoire de la mobilité de la ville de Paris, 2009).[4] As a result, we can focus our analysis on the comfort costs of PT crowding. Combined with growing road congestion, the deterioration of PT travel conditions has been quoted as an important factor affecting job quality in Paris (Technologia, 2010; ORSTIF, 2010). Commuters' complaints also figure prominently in municipal and regional elections (2008, 2010 and 2014), stressing the relevance of our analysis.

In a recent research paper commissioned by the Parisian PT regulator, Kroes et al. (2013) consider crowding costs in different types of PT. Although their framework used to value crowding costs is similar to ours, our approach presents at least three differences. As opposed to many studies on that topic that are based on online or mail surveys (Kroes et al., 2013; Whelan and Crockett, 2009), we rely on a field survey held directly on subway platforms. Surveys based on personal interactions have been found to provide more reliable estimates[5] and it allows to present hypothetical scenarios to PT users with respect to their current trip conditions, making answers more reliable (Hensher, 2010). Second, our contingent experiments (and corresponding estimates) are based on follow-up questions. As a consequence, we explicitly model the potential dependency of individuals' answers, often stressed by studies in environmental economics (Haab and McConnel, 2003; Alberini et al., 1997; Flachaire and Hollard, 2007), but not always discussed in crowding valuation studies (Li and Hensher, 2011). Finally, we use the distribution of crowding values found to estimate a relationship between crowding costs and levels of in-vehicle passenger density that may be useful for policy analyses.

[3] We have no data about the distribution over time of PT supply, thus we are unable to dis-aggregate the evolution of passenger density across peaks and off-peaks. However, we know that over 2001–2010 the subway demand increased faster during off-peaks (+33%) that during peaks (+13%), see OMNIL (2013). As a consequence, in-vehicle crowding has probably seen a slower increase during peaks than during off-peaks.

[4] This refers only to the subway system in the centre of Paris (métro), not the regional system (RER).

[5] Szolnoki and Hoffman (2013) evaluate extensively the reliability of online, face-to-face and telephone surveys in consumer research.