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Does public transit reduce car travel externalities? Quasi-natural experiments' evidence from transit strikes

Martin W. Adler*, Jos N. van Ommeren

VU University Amsterdam, Spatial Economics, De Boelelaan 1105, 1081 HV, Amsterdam, The Netherlands

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ABSTRACT

One of the unanswered questions in the field of urban economics is to which extent subsidies to public transit are justified. We examine one of the main benefits of public transit, a reduction in car congestion externalities, the so-called congestion relief benefit, using quasi-natural experimental data on citywide public transit strikes for Rotterdam, a city with mild congestion levels. On weekdays, a strike induces travel times to increase only marginally on the highway ring road (0.017 min/km) but substantially on inner city roads (0.224 min/km). During rush hour, the strike effect is much more pronounced. The congestion relief benefit of public transit is substantial, equivalent to about 80% of the public transit subsidy. We demonstrate that during weekends, travel time does not change noticeably due to strikes. Furthermore, we show that public transit strikes induce similar increases in number of cyclists as number of car travelers suggesting that bicycling-promoting policies to reduce car congestion externalities might be attractive in combination with first-best congestion pricing.

1. Introduction

The provision of public transit is thought to reduce travel time losses and other negative car externalities that are due to car congestion. For this reason, it may be economically justified to subsidize public transit from a welfare perspective as it creates a congestion-relief benefit.[1] Car use and public transit use are not perfect substitutes. Hence, subsidies to public transit provision might be interpreted as a second-best policy. Public transit provision is not the only alternative for policymakers to address negative car externalities. For example, we will provide evidence that bicycling-promoting policies might be another cost-effective way to realize congestion-relief benefits. Our results also indicate that first-best road congestion pricing would be particularly efficient in comparison to second-best public transit subsidies, because the latter encourage cyclists to switch to public transit.

The main goal of this paper is to quantify the congestion-relief benefit of public transit for Rotterdam by analyzing travel time changes due to public transit strikes.[2] Arguably, strikes can be interpreted as exogenous transit supply shocks and therefore as a quasi-natural experiment as argued by a series of studies (Crain and Flynn, 1975; Van Exel and Rietveld, 2001; Aftabuzzaman et al., 2010; Marsden and Docherty, 2013). We are aware of two other papers that use a similar idea. Lo and Hall (2006) and, more recently, Anderson (2014) analyze the effect of a *single* transit strike lasting 35 days on highway speed for Los Angeles. Anderson (2014) finds a substantial congestion relief benefit of public transit provision with a decrease in time delays experienced by car drivers of 0.12 min/km traveled.[3] It is unknown to what extent this result can be generalized to other cities where the share of public transit use

* Corresponding author. +0031 205988106
E-mail address: m.w.adler@vu.nl, martin_w_adler@yahoo.de (M.W. Adler).

[1] Other reasons for public transit subsidies are that public transit's average costs are lower than its marginal costs because of the presence of fixed costs and the 'Mohring (1972) effect'. Car congestion is the main externality of car travel in addition to air pollution and road accidents.

[2] Up to the 90s, strikes received a lot of attention in the economics literature, which shows that the majority of strike days are public sector strikes. For example, 86% of UK strike days are in this sector (ONS, 2014). In many countries, a large share of public sector strikes is with public transit firms. These firms have market power, and are unionized, which are both key strike determinants.

[3] Lo and Hall (2006) report similar speed reductions of 20% to 40%. However, an earlier strike in the year 2000, not analyzed by Lo and Hall (2006) and Anderson (2014) seems to decrease speed by only 5% (The Economist, 2000). Parry and Small (2009) *assume* that public transit provision reduces car travel time by 0.04 min/km traveled, substantially less than the results indicated by Anderson (2014). Similar to Nelson et. al (2007), they conclude that subsidies up to 90% of operating cost may be welfare improving. Also Proost and Van Dender (2008) and Basso and Silva (2014) indicate that during peak hours, it may be beneficial when subsidies cover at least 50% operating cost.

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is much higher or to cities where bicycle use is a viable alternative.[4]

Our analysis differs from Anderson (2014) and Lo and Hall (2006) in a number of ways. First, we focus on a city, Rotterdam in the Netherlands, which, as we will document, is only mildly congested. Second, we analyze the effect of *multiple* strikes of *various* public transit modes (e.g. bus, light rail) that are *citywide*. Third, we examine the strike effect on travel time per kilometer (and flow) for the highway ring road and inner city roads. Fourth, we examine to what extent transit strikes induce public transit travelers to switch into cycling. The latter is particularly relevant, because, as argued by Basso and Silva (2014), public transit subsidies should be evaluated according to other urban policies with a similar aim, such as congestion pricing and bicycling-promoting policies. Finally, by examining heterogeneity in the effect of strikes, we are able to improve our understanding when the public transit relief benefit is particularly pronounced. For example, as one may expect, we find a particularly strong effect during rush hours (but no clear effect during weekends and outside rush hours). In addition, our results suggest that the travel time effect of strikes that last a few hours are similar to that of full-day strikes, indicating that a continuous supply of public transit during the day is essential for travelers.

We show that the congestion relief impact for inner city roads is larger than for highway ring roads by a factor of ten. For the latter, we find an effect that is several times smaller than reported by Anderson (2014). We find a car traveler's travel time benefit of 0.145 min/km from public transit that is equivalent to an annual monetarized saving of €607 million. Hence, the congestion relief benefit of public transit for Rotterdam is substantial and about 80% of the current subsidy to public transit. This suggests that even for cities that exhibit mild congestion levels, subsidies to public transit are to a large extent justified by their congestion relief benefit alone.

2. Data and descriptive statistics

2.1. Introduction

We analyze public transit strikes for the period 2001 to 2011 for Rotterdam, a Dutch city with a metropolitan population of about 1.2 million inhabitants. Public transit use is substantial: 21% of residents and 25% of commuters use it each day. Car ownership is low: only 57% of adults belong to a car-owning household, but the proportion of commuters who travel by car is representative for the Netherlands: about half of the Rotterdam commuters travel by car (De Vries, 2013). Average speed for an entire commuter car trip is about 30 km/h (Savelberg, 2013). As will be documented later on, in Rotterdam there is mild car congestion, as average speed within the city, as well as on the highway ring road is just below the legal maximum speed limit. Also, as is well known, in the Netherlands, the use of the bicycle is quite common. In line with this, the large majority of Rotterdam residents own a bicycle. Bicycle use in Rotterdam is low from a Dutch perspective: 14 % of commuters bicycle on a daily basis (in Amsterdam this percentage is more than double), but comparable to cities such as Hamburg, Delhi, Barcelona, Tokyo and Berlin.[5]

Table 1
Public transit strikes Rotterdam, 2000–2011.

Type	Date		Time	Information
Citywide strikes				
	Wednesday	08-10-2003	10 am to 2 pm	
	Thursday	14-10-2004	Full-day	Also rail
	Wednesday	29-06-2005	Full-day	
	Monday	04-09-2006	12 am to 1 pm	No metro strike, unannounced
	Monday	18-09-2006	8 am to 1 pm	Unannounced
	Monday	25-09-2006	Full-day	
	Wednesday	15-11-2006	10 am to 4 pm	No metro strike
	Wednesday	16-02-2011	Full-day	Reduced schedule
	Tuesday	12-04-2011	9 am to 2 pm	
	Wednesday	11-05-2011	5 am to 9 am	Irregular schedule
	Thursday	09-06-2011	Full-day	
	Wednesday	29-06-2011	9 am to 3 pm	
	Sunday	20-11-2011	Full-day	
Rail strikes (only)				
	Thursday	21-12-2000	Full-day	
	Friday	17-06-2005	Full-day	
Regional bus strike (only)				
	Tuesday	20-05-2008	9 am to 4 pm, after 7 pm	
	Wednesday	21-05-2008		
	Thursday	22-05-2008		
Placebo strikes				
Rail strike	Monday	02-04-2001	No strike	Canceled
Citywide strike	Wednesday	06-10-2009	No strike	Canceled
Citywide strike	Sunday	06-11-2011	No strike	Canceled

Within the Rotterdam metropolitan area there is one public transit operator RET which provides inner-city bus, tram, metro and light rail connections. Regional bus connections, between the municipality of Rotterdam and other municipalities, are provided by another (private) company.[6] Within Rotterdam, many roads have separate bicycle paths, which allow us to measure bicycle use over an extensive period.

We will analyze hourly information about bicycle flow, car flow and travel time for the inner city and about car flow and travel time for the highway ring road (see Sections 2.3 and 2.4) and relate this to the occurrence of strikes (see Section 2.2).[7]

2.2. Strikes

Information on public transit strikes is obtained from the Rotterdam municipality, the public transit operator, newspapers and Internet search. We observe 16 public transit strikes between 2001 and 2011.[8] Table 1 lists these strikes by mode, type, date, time and additional information, such as whether they were announced. We focus on 13 *citywide* transit strikes, defined as strikes that affect all inner-city buses, trams and metro, but also consider two national rail strikes and one regional bus strike.[9] Regional buses also operate on routes inside the city, but during citywide strikes do not stop within the city (in order not to break the strike).

[4] As is well known, in comparison to Los Angeles, almost all European and Asian cities provide levels of public transit that are an order of magnitude higher. Because it is likely that the congestion relief benefit is a concave function of the level of transit provision, the marginal benefit might be lower in these cities.

[5] One of the reasons for the low bicycle use in Rotterdam is that it has been rebuilt as a modern (American) city after its destruction during the Second World War.

[6] Rail is supplied by a semi-public, national rail operator.

[7] Information on inner city traffic is provided by Rotterdam municipality and on highway traffic by TNO.

[8] The large number of strikes is an improvement over Anderson (2014). In the three years following 2011 there were no public transit strikes in Rotterdam.

[9] About one third of Dutch train users combine train use with bicycle or car use (van Goeverden and Egeter, 1993, and van der Loop, 1997), so a train strike may decrease bicycle and car use for some train travelers.