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The economic contribution of public bike-share to the sustainability and efficient functioning of cities

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ABSTRACT

An expanding literature has explored the benefits of public bike-share schemes from various perspectives, including user characteristics, journey time savings, convenience, health benefits and reductions in motor vehicle use. However, rather few papers have examined bike-share schemes in economic terms. In this paper we place these benefits in an economic context of private individual benefits and public good benefits. Using data from a survey of bike-share users in Dublin, Ireland, we critically examine the relative value of these benefits and their impact on the spatial functioning of cities. We demonstrate that, for this particular scheme, the benefits associated with time savings far exceed the benefits that are commonly claimed for modal transfer. We go on to describe how, by delivering time savings and improving spatial connectivity, bike-share schemes reduce effective density and supply both conventional and wider economic benefits for the urban economy that are commensurate with investment in public transport schemes. Finally, we show how investment in the Dublin bike-share scheme has a positive benefit-cost ratio that exceeds estimates based on a more restricted appraisal.

1. Introduction

Urban administrations have sought to encourage cycling as an efficient means of movement and a sustainable form of transport (Pucher & Buehler, 2005). There are also benefits to the liveability of cities and to public health (Borjesson & Eliasson, 2012) These include the potential for cycling to reduce motor vehicle use along with the external social cost this imposes in terms of pollution, greenhouse gases, dirt, noise, and congestion (Saelensminde, 2004; Shaheen , Guzman , & Zhang, 2012).

However, various studies have revealed the challenge that policy makers face in attempting to raise the modal share of cycling (Ehrgott, Wang , Raith , & Van Houtte, 2012) due, for example, to the physical demands of lengthy journeys, safety considerations or the anxiety cyclists can feel when in close proximity to traffic (Macmillan et al., 2014; Nolund & Kunreuther, 1995; Parkin et al., 2008; Rietveld & Daniel, 2004; Saelensminde, 2004). Consequently, it is argued that an increase in urban cycling is more likely to be achieved through a comprehensive cycle infrastructure including cycle lanes, cycle parking facilities, dedicated traffic lights and traffic flow moderation (Buck and Buehler, 2012; Caulfield, 2014; Ehrgott et al., 2012; Peattie & Peattie, 2009; Ryley, 2006; Yang, Sahlqvist , Mcminn , Griffin , & Ogilvie, 2010) In particular, cycle lanes have been found to have a significant impact on the uptake of cycling (Barnes & Thompson, 2006; Hunt & Abraham, 2007; Saelensminde, 2004; Yang et al., 2010).

Public bike-share (PBS) can be a part of this infrastructure. Within the last ten years there has been a rapid increase in the number of PBS schemes around the world which are now estimated to amount to over 1000 (Metro bike, 2016). These schemes consist of strategically sited bicycle docking stations from which users can borrow a bicycle, typically for a short journey, before returning it to the same or another station. Users pay an annual subscription that allows for free use within a set time period or pay on site for a fixed period. Although PBS has been around since the mid-1990s, technological advances have enhanced its efficiency and increased its attraction to the public (Corcoran and Li, 2014; Shaheen et al., 2012). Automated bicycle stations facilitate access and security. Smartphone apps are now also being introduced to allow users to identify the location and availability of bicycles.

DeMaio (2009) argues that PBS schemes typically contribute to an average increase of 1.0-1.5% in bicycle modal share in the first year of operation. The popularity of these systems derives from their capacity to meet user needs in relation to work, non-work and leisure trips. In this context, studies have demonstrated that

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users are provided with a considerable incentive when PBS facilities are integrated with public transport (Bachand-Marleau et al., 2011; Martens, 2007; Pucher & Buehler, 2008). PBS offers much improved connectivity between destinations, including first and last mile connections between home, public transport and work places (Shaheen et al., 2012). In this respect, PBS has a distinct advantage in that the benefits extend to a population beyond that of the geographical area where the scheme is physically located.

PBS is not without its costs. For example, installing stations is costly, requiring the removal of asphalt or paving stones, underrouting of wiring and hook-ups to electrical sources (DeMaio 2009; ITDP 2013). Bike stations can also replace parking or public space (Buehler & Hamre, 2014). In all cases, there is a need for public authorities to be convinced of the virtues of this investment compared with investment in other modes of transport (Krizek, 2007). Objectivity requires that bicycle facilities are evaluated in the same manner. However, while PBS typically appeal to a smaller segment of the population than some other types of public transport, the relative scale of investment also tends to be smaller.

2. Economic benefits of public bike-share

2.1. Economic assessment

There have been economic assessments of the benefits of cycling, for example Borjesson and Eliasson (2012), Krizek (2007) and Saelensminde (2004), and of the impact on businesses adjacent to bike stations for PBS (Buehler & Hamre, 2014), but not of the wider economic benefits of PBS. A challenge to the analysis of the costs and benefits is the availability of data on use patterns and management costs. This situation is changing as on-board computers provide data on stocks and flows (Corcoran and Li, 2014; O'brien , Cheshire , & Batty, 2013), although such data is often regarded as being commercially sensitive. More specific details on use characteristics, journeys and user perceptions must be collected through surveys of users.

2.2. Private benefits

In common with other transport investments, bicycle infrastructure and PBS provides a mixture of private benefits to users and public good benefits. Demand for PBS depends on users realising private benefits. These include cost savings, savings on journey time, convenience, health and perceived utility benefits to well-being (Fishman et al., 2014; Fuller et al., 2011; Shaheen et al., 2010). By comparison, bicycle ownership involves purchase costs, maintenance costs and the risk of theft, considerations that may deter potential users. For PBS, costs are limited to subscription or rental costs and to the optional purchase of appropriate clothing and head gear. PBS is therefore an option for both existing cyclists and for people who do not own a bicycle (Martens, 2007).

A major benefit of cycling generally is the capacity to shorten journey times relative to other forms of transport where these are subject to congestion or delay (Sener et al., 2009). Borjesson and Elliasson (2012) find that people who cycle regularly place a high value on time and desire to complete a journey swiftly. In this respect, PBS has the further virtue that it allows users to circumvent the usual trade-off between the attraction of cycling for short trips and the physical demands of cycling over longer journeys. It is available on demand for short trips and can be used in conjunction with public transport or even the private car as a part of longer trips. Various studies (e.g. (Buehler & Hamre, 2014; Faghih-Imani, Eluru, El-Geneidy, Rabbat, & Haq, 2014, Fishman et al., 2014; Martin & Shaheen 2014; Rixey, 2013) have found that savings in journey time are a key motivation for use. However, the gbenefit of these time savings has not been estimated in economic terms.

2.3. Public benefits

2.3.1. Business sales

Buehler & Hamre (2014) examined the perceptions of retail business managers towards PBS and found mixed attitudes with 20% recording a negative impact on the neighbourhood, while 70% reported a positive impact. Perceptions of change in sales were found to vary by location and nature of product. These also appeared to depend on the characteristics of the cyclists. For instance 16% of cyclists reported new spending in certain locations due to the new accessibility permitted by PBS.

2.3.2. Health benefits

The private benefits realised by individual users extend to public benefits through increased uptake of cycling and the benefits this provides to the wider population. Examples are the private and public aspects to journey time savings and the relationship between reduced private motor vehicle use and reduced external costs of congestion, pollution and CO_2 emissions (Saelensminde 2004; Shaheen et al., 2012).

Health is another area in which private and public benefits are intertwined. Cycling is a recommended means of physical exercise which provides private benefits to the individual, but also contributes to improved public health and reduced expenditure on healthcare (Boland & Murphy, 2012). Many instances of heart disease, type-2 diabetes, breast cancer and colon cancer could be avoided by maintaining a moderate level of activity for 30 min per day (Bize et al., 2007).[1] Inactivity has been estimated to cost developed countries between €150 and €300 per citizen according the World Health Organisation (WHO, 2004). Even larger benefits have been identified where improved health contributes to reduced premature mortality (Deenihan & Caulfield, 2014; Gotschi, 2011). There are also potential social benefits in terms of improved productivity at work (van Amelsvoort et al., 2006). Although it is notoriously difficult to attribute overall health benefits to any one activity, PBS provides a distinct contribution in this respect as it allows for exercise in association with work or other trips as distinct from cycling for leisure or dedicated fitness activities.

Set against these benefits are possible adverse impacts on health. Strak et al. (2010) report some adverse respiratory impacts among cyclists in the Netherlands due to exposure to particulates or soot on busy roads, although de Nazelle and Nieuwenhuijsen (2010) argue that cyclists' freedom to choose quieter routes exposes them to lower levels of pollutants than other road users. Consideration must also be given to the risk of traffic accidents. For PBS, there is the risk that some users will be less experienced or may not be using a protective helmet. However, new cycle infrastructure, including PBS, will increase cycle uptake and can heighten drivers' awareness of cyclists (Jacobsen, 2003). In a review of various health implications, de Hartog et al. (2010) find that, overall, the health benefits of physical exercise outweigh the risks from exposure to air pollution or traffic accidents.

If PBS was to result in a distinct modal shift from private vehicle use then the health benefits of greater cycling would also extend to the wider population through reduced emissions of particulates, nitrogen dioxide and sulphur dioxide. There would also be other

[1] As recommended by the Irish Heart Foundation (http://www.irishheart.ie/iopen24/physical-activity-t-7_19_73.html). Similar recommendations are made by the U.S. Dept. of Health and Human Services. *2008 Physical Activity Guidelines for Americans*. 2008 and the Centre for Disease Control and Prevention 2010 http://www.cdc.gov/transportation