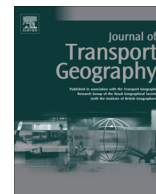




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Inequalities in the London bicycle sharing system revisited: impacts of extending the scheme to poorer areas but then doubling prices

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ABSTRACT

Cycling confers transport, health and environmental benefits, and bicycle sharing systems are an increasingly popular means of promoting urban cycling. Following the launch of the London bicycle sharing system (LBSS) in 2010, women and residents of deprived areas were under-represented among initial users. This paper examines how the profile of users has changed across the scheme's first 3 years, using total-population registration and usage data. We find that women still make fewer than 20% of all 'registered-use' LBSS trips, although evidence from elsewhere suggests that the introduction of 'casual' use has encouraged a higher overall female share of trips. The proportion of trips by registered users from 'highly-deprived areas' (in the top tenth nationally for income deprivation) rose from 6% to 12%. This was due not only to the 2012 LBSS extension to some of London's poorest areas, but also to a steadily increasing share of trips by residents of highly-deprived areas in the original LBSS zone. Indirect evidence suggests, however, that the twofold increase in LBSS prices in January 2013 has disproportionately discouraged casual-use trips among residents of poorer areas. We conclude that residents in deprived areas can and do use bicycle sharing systems if these are built in their local areas, and may do so progressively more over time, but only if the schemes remain affordable relative to other modes.

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1. Introduction

Successfully promoting cycling is expected to confer important transport, health and environmental benefits (de Hartog et al., 2010; Maizlish et al., 2013; Woodcock et al., 2013). Cycling for transport is one way to integrate physical activity into daily life (WHO, 2002), and can also reduce pollution and ease congestion by displacing journeys that would otherwise have been made by motorised modes. Creating opportunities for such active travel has therefore been identified as one central feature of a 'healthy city' (Rydin et al., 2012). Similarly, cycling for recreation can also provide an important source of physical activity, and appears less likely than other forms of recreational physical activity to involve motorised travel (e.g. due to driving to a walking route or sports centre) (Goodman et al., 2012).

The growing number of bicycle sharing systems (BSS) around the world provide increased urban opportunities for both cycling for transport and cycling for recreation (Fishman et al., 2013;

O'Brien et al., 2014). For example, the London bicycle sharing system (LBSS) is particularly well-used for commuting trips (Transport for London, 2011a), including multi-modal trips starting from major train stations (O'Brien et al., 2014; Wood et al., 2011; Zaltz Austwick et al., 2013). Using LBSS is also popular as a leisure activity, with operational and observational research both indicating comparatively high level of use around London's large parks (Goodman et al., 2014; Zaltz Austwick et al., 2013). By increasing access to bicycles for such trips, LBSS and other such schemes facilitate cycling directly, and health impact modelling confirms the net health benefits that this confers upon BSS users (Rojas-Rueda et al., 2011; Woodcock et al., 2014). Moreover, because BSS users are much less likely than personal-bicycle users to wear helmets or 'cycling' clothes, BSS may indirectly encourage cycling by normalising the image of cycling as an everyday activity (Fischer et al., 2012; Fishman et al., 2013; Goodman et al., 2014).

The introduction of a BSS in London might therefore seem one promising intervention to achieve the Mayor of London's vision of making cycling "something anyone feels comfortable doing, [including people] of all ages, races and backgrounds, and in all parts of London" (Greater London Authority, 2013, p.9). In practice, however, LBSS did not initially seem likely to reduce the gender and socio-economic inequalities in cycling participation which

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have been raised as a cause of concern (Marmot, 2010; Steinbach et al., 2011). Instead in the first 7 months of the scheme's operation (July 2010 to February 2011), LBSS use was even more male-dominated than cycling in London in general, with 82% of LBSS trips made by men (Ogilvie and Goodman, 2012). Individuals living in income-deprived areas were also underrepresented, a pattern in line with the general tendency for London's cyclists to be drawn from more affluent households or neighbourhoods (Goodman, 2013; Steinbach et al., 2011). Similar findings with respect to the socio-economic advantage of BSS users have also been reported in Washington DC (LDA Consulting, 2012; Virginia Tech, 2012) and Montreal (Fuller et al., 2011), although the overrepresentation of males was only observed in Washington.

One interesting finding in London, however, was that trip rates among registered users were in fact higher among residents in poorer areas after one adjusted for the fact that these poorer areas were less likely to be near an LBSS docking station (Ogilvie and Goodman, 2012). This raised the possibility that the share of trips made by residents from more deprived areas would increase following the (then future) extension of LBSS in March 2012 to some of the poorest parts of London. On the other hand, in January 2013 LBSS doubled its prices, making the cost of a single cycle trip (£2) more expensive than a single bus trip (£1.40 with a pre-paid card). This development might plausibly be expected to operate in the opposite direction, and disproportionately discourage LBSS use among those living in more deprived areas.

This paper therefore revisits the important question of how far LBSS is contributing to the realisation of the wider policy aim to encourage cycling among a broad variety of Londoners. Specifically, it examines how the gender and, in particular, the socio-economic profile of LBSS users has been affected by (1) the geographic extension of LBSS to East London and (2) the doubling of LBSS prices. To contextualise these findings, this paper also provides a broader update of usage of LBSS over its first 3 years. Besides addressing a question of local policy relevance, this paper contributes to the international BSS evidence base by providing (to our knowledge) the first examination of the effect of changes in spatial extent or pricing upon the profile of BSS users in any city. Such evidence is of value since many of the other 600 BSS in operation globally may in the future also wish to consider making such changes, particularly since most of these schemes have been completed only in the past 5 years (Meddin and DeMaio, 2013).

2. Methods and context

2.1. The London bicycle sharing system (LBSS)

LBSS was launched by the public body Transport for London on 30th July 2010. The scheme's bicycles can be taken from any docking station and returned to any other docking station, with the scheme operating 24 h a day, 365 days a year. To hire a bicycle, users can either register online for an access key using a UK credit/debit card ('registered use', minimum age 18), or else pay by at docking stations by a UK or international credit/debit card ('casual use', available since 3rd December 2010). Users initially pay for access to LBSS bicycles, after which trips of under 30 min are free but longer trips incur additional usage charges at a progressively faster rate. Access originally cost £1 for 1 day, £5 for 7 days, and £45 for 1 year: from 1st January 2013, these prices doubled.

The scheme initially comprised 5000 bicycles located across 315 docking stations, spread at approximately 300 m intervals across 45 km² of central London. This original zone included the entertainment centre of the West End, the business district of the City of London, and the leisure areas of Hyde Park and Regent's

park. It also included some more affluent residential areas to the west and some more deprived residential areas to the east. On 8th March 2012 the scheme extended east to cover a larger area and incorporate 8000 bicycles at 575 docking stations across 65 km² (Fig. 1). The expanded scheme now encompasses the prosperity of the Canary Wharf business district in Docklands, characterised by city commuters working in financial services. It also encompasses much more of London's relatively deprived East End, including the poor-quality, high-density housing of London's poorest borough, Tower Hamlets. An expansion in any other direction would not have incorporated a potential user base with such contrasting socio-economic characteristics, and this eastern extension therefore presents an interesting 'natural experiment' in terms of examining the type of users attracted by this newly-expanded BSS.

Still more recently, on 13th December 2013, LBSS expanded again to include additional areas of southwest London. This, however, occurred after the time period considered in this paper.

2.2. Operational registration and usage data

Transport for London provided operational usage data for all trips made between 30th July 2010 and 31st July 2013. Of these, we excluded 0.1% that were missing data on the date on which the trip took place. For all remaining trips, the start date was available plus a unique ID number linking trips made by registered users on the same LBSS access key or made by casual users on the same debit/credit card. For registered users, this unique ID was also linked to anonymised operational registration data. In this registration data, individuals' titles and/or first names were used to assign gender, and home postcodes (mean population 50 individuals) were used to assign area of residence. No individual-level data was available on the characteristics of casual users. From 1st April 2011 onwards, the available trip-level information additionally included the start and end docking station of the trip, and the start and end time of the trip (to the nearest second). We excluded from our analyses the 0.4% of trips with the same start and end station and lasting less than 2 min, assuming that no trip had in fact been made. For all trips, we identified whether the trip started or ended (i) in London's large Hyde Park or Regent's Park, or (ii) serving one of London's ten largest railway stations. For each registered-use trip, we also calculated the minimum crow-flies distance from the centroid of the home postcode to the start or end docking station (whichever was nearest). Ethical approval for the study was granted by LSHTM ethics committee (reference 6474).

2.3. Small-area income deprivation of individuals and of docking stations

We assigned small-area deprivation at the level of Lower Super Output Areas (LSOA) using the 2010 English Indices of Multiple Deprivation (DCLG, 2011). These widely-used geodemographic measures rank each LSOA (representing a population of approximately 1500) according to 38 different indicators grouped into seven domains of deprivation, including income, employment, education and crime. Each LSOA is thus assigned an overall deprivation rank and also a rank for each of these seven domains. Following official publications (DCLG, 2011), we defined 'highly-deprived' areas as being those ranked in the top tenth nationally for overall deprivation, and also created a second measure of those ranking in the top tenth for income deprivation. These two deprivation measures yielded very similar patterns of results, and so we present results for the income deprivation score to maximise comparability with previous research (Ogilvie and Goodman, 2012).

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