Ecological Economics 113 (2015) 106–113

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

Transport transitions in Copenhagen: Comparing the cost of cars and bicycles

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ARTICLE INFO

Article history:
Received 24 June 2014
Received in revised form 24 November 2014
Accepted 10 March 2015
Available online 23 March 2015

Keywords:
Bicycles
Cars
Copenhagen
Cost–benefit analysis
Sustainable transport
Urban transport transition

ABSTRACT

In many cities of the world, bicycle infrastructure projects are implemented to foster more sustainable transportation systems. However, such projects have often raised questions regarding their public funding, as they entail considerable costs. This paper reviews cost–benefit analysis (CBA) frameworks as these are presently used to assess bicycle infrastructure projects. Specific focus is on the CBA framework developed in Copenhagen, Denmark, a self-declared "city of cyclists". In this framework, costs and benefits of car and bicycle, the two major urban transport modes, have been assessed and are compared across accidents, climate change, health, and travel time. The analysis reveals that each km travelled by car or bike incurs a cost to society, though the cost of car driving is more than six times higher (Euro 0.50/km) than cycling (Euro 0.08/km). Moreover, while the cost of car driving is likely to increase in the future, the cost of cycling appears to be declining. The paper concludes with a discussion of the applicability of the Copenhagen CBA framework to advance sustainable transport planning and to motivate and justify urban restructuring.

1. Introduction

Many cities in the world seek to change their transport systems in favour of buses, trams, trains, cycling, and walking, as a result of increasing levels of local air pollution, emissions of greenhouse gases, accidents, and congestion (e.g., EC, 2011). Policy makers seem particularly keen to increase the share of cyclists, as this transport mode incurs a wide range of benefits compared to vehicles with internal combustion engines, such as comparably high speeds, minimum area requirements both with regard to tracks and parking, as well as no pollution, fewer accidents, and considerable health benefits (Heinen et al., 2010; Horton et al., 2007; Pucher et al., 2010). While cities in Asia have seen a significant decline in cyclist numbers due to transport policies favouring cars (Zhang et al., 2014), bicycling has become a major component of visions of sustainable urban transport systems in Europe, supported by market-based instruments, command-and-control approaches, as well as soft policy measures (Heinen et al., 2010; Pucher et al., 2010). As outlined by Pucher et al. (2010), any measure to support bicycling is likely to result in some degree of transport mode change, but significant changes will depend on more fundamental shifts in transport cultures (Aldred, 2013; Heinen et al., 2010; Jones and Novo de Azevedo, 2013; Kenworthy, 2007).

Recent research indicates that urban transport transformations, i.e., profound changes in transport mode choices, ultimately require new urban transport cultures favouring bicyclist identities (Aldred, 2013; Kåstrup, 2009). However, bicycle cultures only evolve where the concerns and expectations of cyclists regarding notions of safety, speed, and comfort are taken into consideration (Aldred, 2013; Cycling Embassy of Denmark, 2012). To improve traffic safety, and to provide better and faster cycle conditions, a wide range of interventions in favour of cyclists have been implemented in cities, including measures as diverse as two-way travel on one-way streets, separated or elevated exclusive bicycle tracks, shared bus/bike lanes, signed bicycle routes, coloured lanes, bike boxes, bicycle phases/traffic signals, bicycle stations, or bike share programmes (for the whole spectrum of measures see e.g., Cycling Embassy of Denmark, 2012; Pucher et al., 2010; Fishman et al., 2013). Notably, the attractiveness of cycling is inversely linked to the attractiveness of car driving, and measures to re-designate car lanes and car parking are both psychologically important to support cyclist identities, and physically necessary to accommodate growing cyclist populations (Aldred, 2010, 2013; Kåstrup, 2009; Pucher and Buehler, 2008). As a consequence, interventions require substantial urban re-design (Forsyth and Krizek, 2011; Larsen et al., 2013), and considerable planning and building efforts incurring costs (Hutton, 2013).

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http://dx.doi.org/10.1016/j.ecolecon.2015.03.006
0921-8009/

Many cities face considerable difficulties in implementing new transport systems due to financial constraints (Hutton, 2013; Meschik, 2012). Various authors have thus sought to understand costs and benefits associated with cycling and car driving, indicating that progress has been made in the assessment of the social and private costs of different transport systems (Becker et al., 2012; CE Delft et al., 2011; Hopkinson and Wardman, 1996; Ortuzar et al., 2000; Krizek, 2007; Meschik, 2012; Rabl and de Nazelle, 2012; Rank et al., 2001). In Copenhagen, the implementation of sustainable transport infrastructure is part of the city's ambition to become a leading 'eco-metropolis' (City of Copenhagen, 2008). To achieve this, environmental economics are increasingly used in decision-making (City of Copenhagen, 2012a, 2012b), including the consideration of various externalities linked to the car and bicycle as the two major transport modes in Copenhagen. For this purpose, a cost–benefit analysis (CBA) methodology was developed and subsequently refined to assess infrastructure projects with regard to transport costs, security, comfort, branding effects & tourism, transport times and health (City of Copenhagen, 2009a). The analysis revealed that cycling entails considerably lower costs to society than car driving (COWI and Københavns Kommune, 2009), and is now used for assessments and the implementation of infrastructural change in favour of the bike.

In light of this, the paper has various objectives. First of all, it presents the various CBA approaches developed internationally in the context of cycling, as far as these have been reported in the literature, as well as the CBA and its underlying methods as currently used in Copenhagen. Secondly, it discusses whether the CBA used in Copenhagen is holistic, and which implications its use has had for urban transport planning and policy making in Copenhagen. The purpose of the paper is thus both the presentation of the CBA framework used in Copenhagen, as well as the discussion of the consequences of adopting complex CBA frameworks in urban re-design, i.e., weighing different transport modes' social and environmental costs in comparative assessment, rather than focusing on social benefits of new infrastructure alone, as is often the case in transport economics.

2. Cost–Benefit Analysis and Transport Policy Frameworks

The use of CBA in project assessments is widespread, guiding investment decisions in most public spending contexts (e.g., Boardman et al., 2010; Hanley and Spash, 1993). The use of CBA implicates that monetary value is assigned to the advantages and disadvantages of a project, which results in a net cost or benefit of the project to society. In practice, this is fraught with difficulties, as no market values may exist for many of the aspects to be included in the analysis, and in some cases, disadvantages may be incommensurable (Hanley and Spash, 1993). This has led to a widespread critique of CBA, both with regard to how economic value is derived in neoclassical economic frameworks, and specifically with regard to the valuation of the environment (for discussion see e.g., Bithas, 2011; Hutton, 2013; Parks and Gowdy, 2013). A persistent problem of CBA is thus the difficulty to identify all project impacts, both current and future, and to assign monetary value to these, considering principles of fairness and value incommensurability. As outlined by Hanley and Spash (1993), inputs to CBA models often depict "likely", rather than "actual" values. Yet, the use of CBA methodologies remains widespread.

Given the importance of CBA for transport projects (Annema et al., 2007; Hutton, 2013; Knudsen and Rich, 2013), there is a specific body of literature dealing explicitly with transport CBA-methodology. For instance, Grant-Muller et al. (2001) compare evaluation frameworks as used in different European countries, finding that there are considerable differences in the number of variables considered, as well as the economic values assigned to these variables. A number of European countries were also found to complement CBA with multicriteria analysis (MCA), indicating that there are diverse approaches in use. In recent years, extended CBA processes have gained importance in Europe as a result of various efforts to implement more sustainable transport systems and growing concerns about the significance of externalities to society. For instance, the European Environment Agency (2003) estimated the external costs of transport to be in the order of 8% of GDP in the EU plus Norway and Switzerland. More recently, CE Delft, Infras and Fraunhofer ISI (CE Delft et al., 2011) suggested that transport externalities amount to €500 billion in the EU27 plus Norway and Switzerland, or 4% of total GDP (value for 2008; CE Delft et al., 2011). The European Commission now uses a Handbook on the External Costs of Transport to assess externalities (EC, 2014). Irrespective of limitations, these assessments suggest that externalities, including accidents, noise, air pollution and climate change, are significant, deserving better integration in transport infrastructure planning, taxation and decision making frameworks (see EC, 2012).

While the European Union thus appears to regularly use CBA in transport assessments, there is a notable absence of any discussion of the cost or benefit of cycling. Krizek (2007) identified 25 journal articles and reports assessing bicycling from economic viewpoints, of which 7 relate to urban contexts. In chronological order, Nelson (1995) discusses the implementation of bicycle access ways, including the cost of air pollution, congestion, or noise. Sharples (1995) presents a framework for the evaluation of bicycle facilities. Litman (1999) examines cost savings from non-motorized transport. Buis (2000) provides cost–benefit calculations for cycling in Amsterdam, Bogotá, Delhi and Morogoro. Wittink (2001) investigates the effectiveness of non-motorized transport in relation to various parameters, such as economic growth, poverty reduction and quality of urban life in the Netherlands. Saelensminde (2002) discusses CBAs for walking and cycle-track networks in Hokksund, Hamar and Trondheim, Norway. Lindsey and Knaap (1999) examine a greenway system in Indianapolis, Indiana, providing an account of the different values of greenways and techniques to measure their value. Where ratios of benefits to costs of bicycling are presented (Buis, 2000; Saelensminde, 2002), these conclude that the benefits of bicycling far outweigh the costs.

However, only two of the studies attempt to provide frameworks of aspects to be considered in CBA. Specifically, Litman (2004), in focusing on walking, includes liveability, accessibility and transportation costs, health, external costs, efficient land use, economic development, and equity; while Lindsey (2003) suggests to include recreation, health/fitness, transportation, ecological biodiversity and services, amenity visual/aesthetic, and economic development. As Krizek (2007) concludes, methods and units are different in the studies, and considerable improvements in data collection and methodology need to be achieved in order for such frameworks to guide sound policy decisions for investments in cycling, as well as to make these comparable. Such improvements have been presented in various more recent papers (e.g., Börjesson et al., 2012; Börjesson and Eliasson, 2012; Tilahun et al., 2007) and summarized in policy documents (e.g., CE Delft et al., 2011). Studies by Meschik (2012) or Rabl and de Nazelle (2012) have used this data to present CBAs for the benefits incurred in switching from car driving to bicycling (per individual or km cycled).

The purpose of the following sections is to present a comparison of the social welfare associated with the use of cars and bicycles in Copenhagen (City of Copenhagen, 2009a). This includes a discussion of cycling and city planning in Copenhagen, and the CBA framework used to guide urban transport planning and the restructuring of urban space to implement more sustainable transport systems.

3. Cycling and City Planning in Copenhagen

The bicycle has been, particularly throughout Europe, the most important means of transport at the turn of the 20th century. In Copenhagen, it became a means of mass transportation that remained important throughout the World War II and to the 1950s, due to the rationing of oil, fuel and rubber in the post-war effort to rebuild European cities (Agervig Carstensen and Ebert, 2012; Gade Jeppesen, 2012). It was not before the 1960s that cars became more important than bicycles, but