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Research article

Urban residents' response to and evaluation of low-carbon travel policies: Evidence from a survey of five eastern cities in China

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ABSTRACT

To address the problems of excessive energy consumption and global climate change, the Chinese government has issued numerous policies to guide urban residents' low-carbon travel behavior. To evaluate the validity of these policies from the perspective of public opinion, this study summarizes 22 policies from the four vantage points of economics, administration, technology, and public information and then measures residents' response to and evaluation of policies based on survey data on 1977 urban residents using stratified random sampling in five cities in eastern China. The results indicate that from the viewpoint of policy response, administrative policies for promoting public transport show the highest degree of response, followed by public information, technological, and economic policies. Specifically, the responses to parking and congestion fee policies are relatively stronger than those to vehicle purchase tax, vehicle and vessel tax, and fuel surcharge policies. Moreover, the responses to fuel surcharge policy are even weaker than car-restriction policies, including license-plate number restriction, license-plate lottery, and license-plate auction policies. From the viewpoint of policy evaluation, administrative policies for promoting public transport obtain the highest evaluations, followed by economic and technological policies. Residents' evaluations of car-restriction and public information policies are the lowest. In addition, a four-paradigm model is introduced to illustrate residents' reactions to each policy in terms of response and evaluation. Finally, several implementation strategies, including the anterior, concurrent, optional, core, supporting, and assisting policy options are proposed to guide urban residents' low-carbon travel behavior.

1. Introduction

The ongoing trend of urbanization has led to the accommodation of more than half of the world's population in urban areas, and this growing population will in turn have great impact on urban transportation. According to International Energy Agency (IEA) forecasts, the global CO_2 emissions from urban transportation will be increasing at a 1.7% annual growth rate by 2030, and in developing countries at higher rates of 3.4% (IEA, 2010). In recent years, CO_2 emissions from urban transportation have increased significantly in developing countries, especially in China. China's CO_2 emissions in the transportation sector increased by about 9.7 times at an average annual growth rate of 7.4% from 1980 to 2012 (Xu and Lin, 2015). For example, during the period from 2000 to 2011, CO_2 emissions from urban residents' travel have increased by 328% and 205% in Beijing and Shanghai, respectively, with private cars accounting for 84% and 61% of this, respectively (Wang and Liu, 2015).

Many developed countries have come to believe that the car-oriented development mode should be transitioned to the transit-oriented development mode to achieve sustainable urban transportation. A shift from personal transport to public transport (PT), walking, and cycling is vital to avoid sprawl and car-related pollution, and to achieve the Paris agreement's two-degree scenario (IEA, 2016). Hence, travel demand management (TMD), which involves strategies and policies to reduce travel demand or to redistribute this demand from personal cars to walking, bicycling, or PT, is urgently required. Many opportunities exist in cities to curb transport-related carbon emissions by reducing trips and trip distances (e.g., car restrictions and taxes), shifting activity to walking, bicycling, or PT (e.g., investments and subsidies), and progressively

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adopting more efficient vehicles (e.g., technology upgrades) (Lah, 2017). “Reduce” and “shift” options in urban areas would deliver 36%–39% of the required emissions reduction in urban transport, which highlights the strategic relevance of urban planning and TDM policies (IEA, 2016). Based on the experience of developed countries, China's central and local governments have issued a series of taxes, subsidies, investments, and regulations to stimulate the PT development and restrict car uses. However, traffic congestion and pollution problems are still serious, with growing car ownerships and low PT utilizations.

Sustainable transport policy encompasses many related but distinct aspects, such as air quality, health, social justice and welfare. Hence, enough evaluation of the humanity, fairness, and effectiveness of policies from the vantage point of policy implementers should be seriously considered. However, at present, most studies involve econometric analyses that evaluate the impact of a certain policy on a city's economy, well-being, and pollution. The research methods are over-reliant on economic data without sufficient considerations to the public's attitude/acceptance of policy. Because car restrictions may deprive people of their right to “pleasant driving”, people may passively cooperate with these mandatory policies, but express low satisfaction with them, leading to cognitive dissonance and policy resistance. The worst situation is that people find ways to get around a policy or become indifferent to it, resulting in greatly reduced policy effectiveness and sustainability (Schade and Schlag, 2003; Aklin and Urpelainen, 2014; Zhang et al., 2015). For example, car owners may drove “illegally” without obeying the driving restriction rules (Wang et al., 2014), and wealthy people are incline to buy second cars with a different license plate (Eskeland and Feyzioglu, 1997). Therefore, awareness, attitude, acceptance, and response of policy (Khademi and Timmermans, 2014; Liu et al., 2016a; b; Chen et al., 2017) are successively introduced to evaluate the policy effectiveness from the public's subjective perspective. This paper adopted the policy response and policy evaluation, whereas a policy response is defined as the degree of people's behavioral reactions to policy adjustments, i.e., whether or not to perform a specific action due to certain policy adjustments, and a policy evaluation is defined as people's subjective judgment of the importance of various policies.

Under these circumstances, this paper focuses on the low-carbon development, starts from the worldwide issue of urban transportation, and discusses the sustainability of related transport policies. The topic is important in the carbon emission abatement of urban residents' travel and the improvement of social welfare. We discuss what the reasons might be for the widespread advocacy or adoption of policies that may be largely ineffective. These would be very important for policy-maker, not only for carbon emission reduction, but also for atmospheric pollution mitigation of transportation sector in cities. The proposed policy suggestions are helpful for policy-makers to address or adjust the emphasis or priority of transport policy according to their specific development settings and goals.

2. Literature review

Earlier studies about low-carbon travel policies mainly focused on two aspects: promotion of PT systems and restriction to private cars.

In terms of promoting PT systems, most studies state that improving PT infrastructure and management services can promote PT use. For example, local governments need to construct bus rapid transit (BRT) and optimize PT structure, distribution, density, frequency, time, and routes (Van Vugt et al., 1996; Schwanen et al., 2001; Yang et al., 2013; Zhang et al., 2017). Some researchers present that urban transport problems are resulting from unreasonable urban planning, so the governments should attach importance to spatial structural planning, land use and multilevel roads planning, which are proved to significantly affects traffic volume, mobility, and energy consumption. (Nakamura and Hayashi, 2013; Vos and Witlox, 2013; Yang et al., 2013; Bento et al., 2016; Cai et al., 2018). In addition, a decrease of PT fare is demonstrated to have a positive effect in increasing the number of residents willing to use transit for daily travel (Hunecke et al., 2001; Sharaby and Shiftan, 2012; Eliasson and Proost, 2015; Qiang et al., 2017). In the case of restricting private cars, increasing the fuel surcharge has long been advocated by economists as an effective measure to address road congestion and air pollution (Barla and Proost, 2012). Except for fuel surcharges, other taxes and fees such as vehicle purchase taxes, vehicle tonnage taxes, road pricing, road maintenance fees, and parking fees are advantageous in reducing traffic congestion and car-related pollution (Lam and Toan, 2006; Vos and Witlox, 2013; Eliasson and Proost, 2015). Congestion charge, though remains disputed, has been successfully applied by cities and countries, e.g. London, Stockholm, and Singapore, and proved to effectively reduce congestion and air pollution (Button, 2004; Schmöcker et al., 2006; Zheng et al., 2014). In addition, some researchers believe that mandatory car restrictions, e.g. driving restrictions, are conducive to increasing PT use, alleviating traffic congestion, and reducing hazardous pollution. (Lu, 2016; Liu et al., 2016a; b).

Currently, the TDM scheme has been designed and a “soft” management is put forward. In addition to those mandatory regulations, a “soft” TDM scheme aims to provide moderate encouragement to people to adopt cleaner ways of travel by means of technological upgrades and persuasion.

Some researchers believe that low-carbon transport policy must transition from the “reduce” and “shift” strategies to the “improve” options (Lah, 2017), such as from reduction of conventional fuel vehicle (CFV) and shift to non-motorized modes to the improvement of alternative fuel vehicle (AFV) (Dender, 2009; Hickman et al., 2010; Barla and Proost, 2012). With the development of Internet technologies, intelligent transport systems (ITS) and ride-sharing services can reduce the unloaded rate and the exhaust emissions, and induce people's low-carbon travel behavior (Corman et al., 2009; Fagnant and Kockelman, 2014; Chen et al., 2016; Fan et al., 2017). Park-and-ride (P&R), a mode of transferring private vehicles to PT, is helpful in alleviating car-use problems of congestion, parking, and pollution (Lam et al., 2001; Islam et al., 2015; Song et al., 2017). Furthermore, individuals tend to adjust their focus, attitudes, and actions actively to perceived expectations, pressures, and norms derived from surroundings. (Avineri and Waygood, 2013). Therefore, information, advertising, and a low-carbon social atmosphere are conducive to people's low-carbon travel behavior (Anable, 2005; Ahmed et al., 2008; Chen et al., 2014; Geng et al., 2016).

According to existing research, this study summarizes and subdivides these low-carbon travel policies into four categories: economics, administration, technology, and public information (see Table 1). Economic policies refer to measures that aim to affect behavior by adjusting transport-related prices and costs. Administrative policies refer to mandatory orders, instructions, and regulations promulgated by state departments to regulate traffic. Technological policies refer to a new measure or mode based on technical progress in energy, Internet, and other fields. Public information policies, a group of persuasive measures including information, advertising, social opinion, and social culture, aim to strengthen individuals' environmental awareness, norms, motivations, and actions. Accordingly, the study introduced a four-paradigm model, collected empirical data from surveys in