Transportation Research Part D 63 (2018) 49–57

Contents lists available at ScienceDirect

Transportation Research Part D

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

Does the increase of public transit fares deteriorate air quality in Beijing?

Ziying Yang[a,*], Manping Tang[b]

[a] School of Finance, Southwestern University of Finance and Economics, Chengdu, Sichuan, China
[b] College of Management, Sichuan Agricultural University, Chengdu, Sichuan, China

ARTICLE INFO

Keywords:
Beijing public transit
Fare increase
Air pollution
Transit subsidies

Jel classification:
L62
Q53
Q58
R48

ABSTRACT

Since 2006, Beijing lowered its public transit fares as a way to improve air quality. However, Beijing increased public transportation fare prices from December 28, 2014, and commuters pay for the distance they traveled rather than a flat fare. This paper explores the effect of Beijing public transit fares increase on air quality. We collect daily data of air pollution and weather variables and use synthetic control method of Abadie and Gardeazabal (2003) to select control units. We then estimate a difference-in-differences model and assess the effect of the policy on air quality index (AQI). We find a 16.28% increase in air pollution in short run. However, we find no longer-run effect on air quality.

1. Introduction

The rapid economic growth and urbanization over the past decades have been accompanied by serious air pollution problem in China (Zheng and Kahn, 2013; Greenstone and Hanna, 2014; Xiao et al., 2017). This problem is particularly acute in big cities, such as Beijing, which was ranked the thirteenth "most polluted city" in the world in 2004.[1] High air pollution has adverse health consequences, such as cardiopulmonary diseases (EPA, 2004), premature deaths (Cropper, 2010; Chen et al., 2013; Wolff, 2014), and infant mortality (Chay and Greenstone, 2003; Currie and Neidell, 2005).

To improve air quality and prepare for the 2008 Olympic Games, the Beijing government reduced bus fare in 2006 and subway fare in 2007, respectively. Under the fare policy, bus fare was RMB 1 Yuan per trip, giving 60% discount to Yikatong riders and 80% discount to student card holders; and subway fare was RMB 2 Yuan per trip no matter what distance a commuter travels.[2] Such low public transportation fares were due to massive government subsidies.[3] However, Beijing increased public transportation fares since December 28, 2014, and commuters pay for the distance they traveled rather than a flat fare. Under the new pricing scheme, bus commuters pay at least 2 Yuan per trip and the cost of the average subway journey doubles from 2 Yuan to 4.3 Yuan per trip.[4] An increase in public transit fares is associated with ridership loss because of commuters' behavioral responses, such as switching to car travel (Paulley et al., 2006; Wang et al., 2015; Zhang et al., 2017). Since motor vehicles, specifically cars, are a major source of air pollution in China's big cities (Ministry of Environmental Protection, 2011; Chen and Zhu, 2013; Viard and Fu, 2015), how does this

* Corresponding author.
E-mail address: yziying1988@gmail.com (Z. Yang).

[1] "Beijing Pollution: Facts and Figures," BBC News, August 11, 2008.
[2] The exchange rate between US dollar and Chinese Yuan was 1–6.22 at the end of 2014.
[3] "Beijing subway fare hick weighs on commuters," BBC News, January 7, 2015.
[4] For bus, Yikatong card holders get 50% off a single-journey fare, and student card holders will get 75% off.

https://doi.org/10.1016/j.trd.2018.04.020

public transportation fares reform affect air quality in Beijing? And are long-run public transit subsidies necessary for environmental purpose?

With air pollution data from Chinese Ministry of Environmental Protection and weather data from China Meteorological Data Sharing Service System, we employ a difference-in-differences method to investigate both the short-run and longer-run effects of Beijing public transportation fares increase on air quality. We find that, in short run, the fares reform increases air pollution by 16.28%. However, we do not find evidence that the policy has a significant effect on air quality in the longer run. By comparing the effects in short run and longer run, we find that the policy does not have a consistent effect on air pollution over the time.

Related literature. Our paper is related to two strands of literature. First, several studies investigate the impacts of public transit fares on transit demand (e.g., Paulley et al., 2006; Gkritza et al., 2011; Wang et al., 2015; Zhang et al., 2017) and riders' attitude (Zhang et al., 2017). Specifically, Zhang et al. (2017) find that the Beijing subway's fare increase lowers riders' satisfaction degree and that ridership decreased immediately after the policy but recovered to previous level four months later.[5] Second, our study also relates to literature on various emission-reduction policies, such as fuel tax (Parry and Small, 2005; Fullerton and Gan, 2005; Bento et al., 2009; Xiao and Ju, 2014), vehicle consumption tax (Xiao and Ju, 2014), congestion fees and road pricing (Small et al., 2005; Eliasson et al., 2009; Gibson and Carnovale, 2015), driving restrictions (Davis, 2008; Viard and Fu, 2015), Low Emission Zones (Wolff, 2014), and vehicle quota system (Xiao et al., 2017; Yang et al., 2017). However, few empirical studies have examined the environmental effects of public transit fares changes. Thus, our analysis contributes to the above two strands of literature by investigating how the increase of Beijing public transportation fare affects air quality. It enables comparisons of these emission-reduction policies and helps both policymakers and researchers better understand China's transportation policies.

In addition, this study contributes to the literature on public transit subsidies (e.g., Parry and Small, 2009; Drevs et al., 2014; Basso and Silva, 2014). For example, Parry and Small (2009) investigate whether urban transit subsidies are warranted and find that the current fare subsidies in Washington (DC), Los Angeles, and London are welfare improving. This strand of literature mainly focuses on congestion, while our study discusses the efficiency of public transit subsidies from the perspective of air pollution. In Beijing, public transportation fares were heavily subsidized since 2007, imposing a heavy fiscal burden on the government. On December 28, 2014, the increase of transit fares reduced such fiscal burden. Our analysis examines the environmental effect of public transit fares increase, rather than fares reduction. It is found that the fares reform does not affect air quality in the longer run. Thus, continuous public transit subsidies to improve air quality may not be warranted.

The rest of the paper is organized as follows. Section 2 briefly reviews Beijing public transportation fares background, and introduces the data. Section 3 describes the empirical model and the identification strategy. Section 4 reports our estimation results. Section 5 concludes.

2. Beijing public transportation fares background and data description

2.1. Beijing public transportation fares background

As the capital of the People's Republic of China, Beijing has one of the biggest and busiest public transit system in the world. The Beijing's public transportation system mainly consists of subway and buses. We briefly introduce the fares background for subway and buses, separately.

The Beijing subway has experienced rapid expansion since 2002 after the city won the bid to host the 2008 Summer Olympics. From 2000 to October 7, 2007, Beijing subway fares ranged from RMB 3 Yuan to 7 Yuan, depending on the line and number of transfers. To encourage mass transit use, and reduce traffic congestion and air pollution, Beijing municipal government introduced a flat fare of RMB 2 Yuan with unlimited transfers for all lines on October 7, 2007, except the Airport Express, which costs RMB 25 Yuan. Such lower fare policy was due to a massive government subsidy. For example, the governments subsidized the bus and rail transit agency in Beijing about RMB 20 billion Yuan in 2013.[6]

On December 28, 2014, the Beijing subway replaced the fixed-fare with a distance-based fare schedule for all lines except the Airport Express. The Beijing subway system charges users by travel mileage. Fares start at RMB 3 Yuan for a trip up to 6 km in distance. The fare for a trip between 6 and 12 km is 4 Yuan. Beyond that, 1 Yuan will be added for every 10 km thereafter until the trip distance reaches 32 km. If the distance of a single subway trip goes beyond 32 km, 1 additional Yuan for every 20 km will be charged.[7] Such change implies that the cost of the average journey will double from 2 Yuan to 4.3 Yuan.[8]

Prior to the December 28, 2014, the Beijing bus system adopted a flat-fare rate of RMB 1 Yuan per trip since 2006, giving 60% discount to Yikatong riders and 80% discount to student card holders.[9] Beijing's municipal government also increased the price for buses on 28 December 2014. The price starts at 2 Yuan for the first 10 km. 1 more Yuan will be charged for every 5 km beyond 10 km. When traveling by bus, Public transportation card holders get 50% off a single-journey fare, while student carrying transportation cards will get 75% off bus fare for a single trip.

[5] Zhang et al. (2017) use augmented Dickey-Fuller test to identify the effect of the new fare policy on passenger volume. Confounding factors, such as weather condition and heating system, may make the result invalid.

[6] Finance Bureau of Beijing. Report on Budget Execution of 2013 and Budget Draft of 2014 of Beijing. Available online: http://www.mof.gov.cn/zhuantihuigu/2014yshb/201402/t20140219_1044590.html. The total operating cost of public transport in Beijing was about 31 billion Yuan in 2013.

[7] Data source: http://english.cri.cn/12394/2014/11/27/3781s854098.htm.

[8] Data source: http://www.bbc.com/news/world-asia-30595286.

[9] Data source: https://en.wikipedia.org/wiki/Beijing_Bus.