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Who will be affected by a congestion pricing scheme in Beijing?

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ABSTRACT

Equity concerns have been an important obstacle to adopting congestion pricing, in both developed and developing countries. However, the existing evidence on the equity effects of congestion pricing has come only from developed countries. In this paper, we shed light on the distributional consequences of a congestion pricing scheme currently under consideration in Beijing. We find that under this scheme, which covers the areas within the city's third ring road, a very small proportion of motorized trips would be subject to the full congestion charge. The directly affected individuals typically have higher household incomes and are wealthier than individuals who are not directly affected by the congestion pricing scheme. This finding reflects the fact that individuals who drive to work in Beijing are relatively wealthy. More important, we find that the Suits index for the congestion charge is 0.027, indicating that the congestion charge is slightly progressive.

1. Introduction

Transportation experts strongly recommend congestion pricing for reducing traffic congestion, and experiences in London, Singapore, and Stockholm have demonstrated its efficacy (e.g., Leape, 2006; Olszewski and Xie, 2005; Börjesson et al., 2012). By reducing automobile use, congestion pricing can also generate environmental benefits (e.g., Anas and Lindsey, 2011). Despite these benefits, however, only a few cities in developed countries, and no cities in developing countries, have adopted this policy. In contrast, a considerable number of cities in developing countries have implemented driving restrictions, under which certain vehicles cannot be used at certain times (Wang et al., 2014). Cities adopt driving restrictions instead of congestion pricing largely because rationing is considered more equitable and thus more politically acceptable (Rouwendal and Verhoef, 2006; De Grange and Troncoso, 2011). Indeed, Karlström and Franklin (2009, 283) write that equity effects have long been recognized as the Achilles heel of congestion pricing "because the rich or otherwise privileged are likely to be more able to cope with the toll than the poor or those who are otherwise disadvantaged, either by paying the toll or by adjusting behavior". Studies of the equity effects of congestion pricing have focused on cities in developed countries. See Eliasson and Mattsson (2006, Section 2) for a summary of the literature.

Largely because of equity concerns, the Beijing municipal government has also been using rationing policies, including driving restrictions (Viard and Fu, 2015; Wang et al., 2014) and vehicle purchase restrictions (Yang et al., 2014) instead of congestion pricing. However, a congestion pricing scheme in Beijing may not be regressive in practice. In fact, private car owners in China are relatively wealthy, and Cao (2011) finds that taxing motor fuels in China is quite progressive. In this paper, we analyze the potential equity effects of congestion pricing by characterizing the Beijing residents who will be directly affected by a possible congestion pricing scheme and by using the Suits index to measure the progressivity of the congestion charge.

The extraordinarily high air pollution levels that often occur in Beijing have recently prompted the Beijing municipal government to explore the possibility of using congestion pricing to reduce driving (Beijing Municipal Government, 2013). In particular, the Beijing government is considering the following scheme. Beijing has a set of concentric ring roads around the city center and the charging zone would be within the third ring road. Vehicles driving into this zone at any time are charged 8 Renminbi (RMB; roughly $1.25) each time they enter. Private and government- or company-owned automobiles, shuttles, and taxis will all be charged, but buses will be exempt. Residents living within the third ring are eligible for a 90% discount.

To investigate the distributional effects of this congestion charge scheme, we characterize the economic and social characteristics of the individuals who would be directly affected by the congestion pricing scheme. We also study the percentage of motorized travel that would be directly affected by the congestion

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pricing scheme. Our analysis covers commuting trips, school trips, and discretionary trips. Consistent with our focus on the characteristics of the directly affected individuals, Eliasson and Mattsson (2006) conclude that, in the case of Stockholm, the two most important factors for determining the equity effects of congestion pricing are who is directly affected by the charge (i.e., the first-order vertical equity) and how revenues are used. In this paper, we focus on the first-order vertical equity impacts of the congestion charge, and we leave the second-order or horizontal equity impacts for future research.[1]

Using household survey data from 2010, we find that only about 5% of motorized trips in Beijing will be directly affected by the congestion pricing scheme. More important, the directly affected individuals tend to be wealthier than those who are not directly affected. The directly affected individuals tend to live in households that have higher annual income and more living space per household member, and they tend to be better educated and more likely to be male. We find similar results for school trips: individuals who use cars or taxis to go to school inside the third ring road tend to come from wealthier households. We also find that regardless of where they live in Beijing, individuals who drive to work have higher household income, live in larger residences, are better educated, and are more likely to be male than individuals who are employed but do not drive to work. Thus, our evidence suggests that congestion pricing in Beijing will affect the rich or the privileged more than others. In addition, we find that the Suits index of the congestion charge scheme is 0.027, indicating that it is slightly progressive. The distributional effects reflect the distinct income distribution of Beijing residents; policy makers in any city considering a congestion charge or other type of transportation fee will need to consider the income distribution in the city when assessing the distributional consequences of the policy.

2. Data

Our analysis is based on the 2010 Beijing Household Travel Survey conducted by the Beijing Transportation Research Center (BTRC), an agency of the Beijing municipal government. The BTRC has conducted annual household travel surveys for many years, and the Beijing municipal government uses these surveys to understand Beijing residents' travel behavior and to inform transportation policies. Academic researchers have also used the survey data to analyze transportation in Beijing (e.g., Wang et al., 2014).

We focus on the 2010 survey because of its large sample size. The 2010 survey adopts a multistage sampling strategy with the target of a 1% sampling rate. The BTRC randomly selects 642 traffic analysis zones (TAZs) of the 1911 in the entire city. TAZs are geocoded areas defined by the BTRC for traffic analysis. Each of the administrative districts in Beijing has 16–238 TAZs, based on the size of the area and the population of the district. TAZs are smaller in districts with higher population densities. The average TAZ is about 1.5 km^2. In the inner eight districts, on which the sampling focuses, TAZs range from 0.21 to 16 km^2. On average, about 75 households in each TAZ are randomly selected for in-person interviews to collect data on trips taken during a designated 24-h period (the household's travel day). Fig. 1 shows the sampled and unsampled TAZs in Beijing; the surveyed TAZs are distributed evenly within each ring road.

The survey gathers (1) information about each segment of a trip taken by each member of a household during the household's travel day, including travel purpose (e.g., going to work), travel mode (e.g., automobile), time when the travel began and ended, and the TAZ codes of the origin and the destination; (2) household information, including the TAZ code of the residence, vehicle ownership, household income, whether renting or owning the housing, and if owning, the size and building type of the housing; and (3) household member information, including gender, age, occupation, whether possessing a driver's license, whether employed, and if employed, the TAZ code of the workplace.

3. Findings

We focus on the directly affected individuals because they must either pay the congestion charge or switch to other transport modes, at least in the short run. We consider whether the directly affected individuals tend to have low income or wealth. To provide context for this analysis, we first estimate the fraction of trips that will be directly affected by the congestion charge.

3.1. A small share of Beijing commuters would be directly affected

The full sample includes 140,395 trips[2] made by 88,304 individuals from 43,772 households.[3] Of the full sample of trips, 43% are motorized trips. Of these, only 5% involve driving (or taking a taxi) into the third ring road and thus will be directly affected by the congestion charge. Of these directly affected trips, 48% are work trips,[4] 5% are business trips, 5% are school trips, and the other 42% are discretionary, including trips to stores, restaurants, gyms, parks, banks, or hospitals, and trips to visit friends or relatives.

To provide further context for commuters, we estimate the percentage of employed individuals who will be directly affected by the congestion charge. Of the 41,078 employed individuals in our sample,[5] only 3.1% live outside but drive to work within the third ring. Since 6.4% of these 1276 individuals have access to government- or company-owned cars, and many of them can avoid the congestion charge, just 2.9% of employed individuals will be directly affected by the congestion pricing scheme. In our sample, 11% of the employed population live outside and work inside the third ring but do not drive to work. That is, 14% of the employed live outside but work inside the third ring, and 23% of these individuals drive (or take a taxi) to work. For comparison, 20% of our sample live and work within the third ring, 57% both live and work outside the third ring, and 10% live inside but work outside the third ring. This last group needs to pay 10% of the congestion charge when they drive home from work.

3.2. Directly affected commuters tend to be wealthy

We compare the characteristics of the directly affected commuters with those of two comparison groups of individuals: (1) those who live outside and work within the third ring but do not drive to work; and (2) the full sample of employed individuals minus the directly affected group. The congestion charge does not

[1] Second-order impacts refer to changed traffic flow and individuals' adjustment of their travel behavior. Horizontal equity refers to the extent to which individuals within a class (e.g., income, gender, ability, and race) are treated similarly (Levinson, 2010).

[2] These trips do not include the return leg of a round trip. The purpose of the return leg is often missing in the survey.

[3] The survey covered 116,142 individuals from 46,900 households. Some individuals did not make any trips in the designated 24 h.

[4] Our classification of trips is based on the answers to the following question: what is the purpose of your trip? “Working” and “business trips” are two options listed in the survey answers. It is possible that some survey subjects may have chosen the answer of “working” for both commuting and business trips.

[5] The survey covers 49,634 employed individuals. Some individuals did not make work trips on the survey day.