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Superstitions, street traffic, and subjective well-being☆

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ABSTRACT

Congestion plays a central role in urban and transportation economics. Existing estimates of congestion costs rely on stated or revealed preferences studies. We explore a complementary measure of congestion costs based on self-reported happiness. Exploiting quasi-random variation in daily congestion in Beijing that arises because of superstitions about the number four, we estimate a strong effect of daily congestion on self-reported happiness. When benchmarking this effect against the relationship between income and self-reported happiness we compute implied congestion costs that are several times larger than conventional estimates. Several factors, including the value of reliability and externalities on non-travelers, can reconcile our alternative estimates with the existing literature.

1. Introduction

Traffic congestion is a leading quality-of-life issue in most urban areas. Conventional estimates of traffic congestion costs aggregate the value of lost time, wasted fuel, and increased pollution and accidents due to congestion. In the United States (US) these estimates total $121 billion per year (Schrank et al., 2012), and the costs are particularly large in urban areas. For example, the Los Angeles metro area accrued $10.8 billion of congestion costs in 2011, representing 3% of income or 14% of housing costs. Congestion costs in other countries may be larger as a share of income; Creutzig and He (2009) estimate that congestion costs in Beijing represent 4% to 7% of municipal gross domestic product (GDP).

A critical element in determining congestion costs is motorists' value of time. Most estimates set the value of time at a fraction of the hourly wage (Liu et al., 2009), with the fraction typically determined by results from stated preferences (SP) studies or, less often, revealed preferences (RP) studies. Two recurring patterns in the literature are that SP estimates are often smaller than RP estimates and that motorists report a higher value of time in congested conditions than in free-flow conditions. These patterns suggest that the costs of traffic congestion are highly salient – motorists may not fully appreciate them until they directly experience them – and that driving in traffic entails some degree of psychic disutility. A related literature on travel reliability finds that motorists value reliability improvements – typically measured in standard deviations or interquartile differences of travel time – as much as they value reductions in mean travel time (Small, 2012). These factors suggest that even reliable estimates of in-vehicle value of time are insufficient for calculating congestion costs.

In this work we estimate the effects of traffic congestion on subjective well-being in Beijing, China. In response to heavy congestion and pollution, Beijing restricts vehicle usage on the basis of license plate numbers. On any given weekday, private vehicles with plates ending in one of two digits may not drive within the 5th Ring Road from 7 am to 8 pm. As a result each vehicle is restricted one day per week. However, superstitions regarding the number four – which is homonymous with “death” in Chinese – dramatically reduce the proportion of vehicles with license plates ending in four. We thus expect, and find, large increases in traffic congestion on days on which plates ending in four are restricted. We combine data on congestion with data from the Chinese General Social Survey (CGSS) to estimate the effect of daily

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congestion levels – instrumented using a measure of the share of plates that are restricted each day – on self-reported happiness.

We use our estimates to apply an alternative method for valuing congestion costs. This method, based on self-reported levels of happiness, is novel to the transportation literature but has seen application in other contexts involving public goods or externalities. Our method compares the happiness effects of quasi-random daily changes in congestion levels to the happiness effects of additional income. If we treat happiness as a proxy for utility, this comparison reveals the utility-constant tradeoff between congestion and income. The method has both advantages and disadvantages vis-à-vis existing methods. It leverages quasi-random variation in congestion levels to estimate effects on subjective well-being. In this sense it avoids a frequent problem in RP studies, the potential confounding of travel-time differences with unobserved attributes. It measures subjective well-being for a random sample of the entire population, allowing inferences about the value of congestion costs for non-marginal individuals and individuals who are not travelers. It draws its outcome from a survey unrelated to transportation topics, avoiding SP-specific issues of framing bias, strategic response bias, or lack of information on the part of respondents.

There are natural disadvantages to the method as well. It treats subjective well-being as a proxy for utility. If it is a poor proxy – in particular if there is a systematic error term relating utility and subjective well-being – then our estimates will be biased. A related issue, endemic to many studies applying this method, is the lack of clearly exogenous wealth variation in our sample. Finally, to the extent that happiness is mean-reverting over the long run – i.e. individuals habituate to new life circumstances – comparisons between short-run changes in congestion and long-run changes in income may overstate the marginal rate of substitution between congestion and income. For these reasons we view our research design as complement to conventional approaches, and we note that shortcomings of the different approach are in general orthogonal to each other.

These caveats notwithstanding, we find that traffic congestion has a large negative effect on self-reported happiness. This "reduced form" result strongly suggests that congestion is a major determinant of quality-of-life, even in countries with moderate levels of GDP per capita. If we treat subjective well-being as a reasonable proxy for utility, our results imply that Beijing motorists' WTP to avoid an hour of congestion substantially exceeds the hourly wage rate. Although our WTP estimates are higher than those from the existing literature, several factors – including the value of reliability and potential external effects of congestion on non-travelers – can reconcile the two sets of estimates. Consistent with the large impact of congestion on quality-of-life, our estimates suggest significant potential welfare gains from congestion pricing.

2. Background

Congestion plays a central role in urban and transportation economics. The primary cost of congestion is lost time, and the value of travel time is a critical input in many transportation models. A rich literature – summarized in several meta-analyses and reviews – estimates this value across a variety of contexts (Zamparini and Reggiani, 2007; Shires and de Jong, 2009; Abrantes and Wardman, 2011). Two types of studies, stated preferences and revealed preferences, populate this literature. SP studies present respondents with hypothetical scenarios and poll their WTP for specific goods or attributes. These studies offer the researcher precise control over the good or attribute in question and are helpful for valuing goods that are not traded on an open market. Nevertheless, they are subject to several types of biases: strategic bias, in which a respondent misreports to advance his own agenda; framing bias, in which a respondent's answer depends on how the surveyor frames the question; and information bias, in which respondents may not understand a scenario's details and have no incentive to figure them out.

In contrast to SP studies, RP studies examine individuals' actual choices. For example, an RP study might observe that commuters choose a transport mode that costs $1 more than an alternative but is 0.1 h faster and conclude that commuters' value of time is at least $10 per hour. This methodology avoids biases specific to SP studies, but it can suffer from potential confounding of unobserved attributes with travel time differences. For example, if the faster transport mode is more comfortable, it is unclear how much of the observed WTP accrues from lower travel times and how much accrues from increased comfort. Alternatively, if the faster mode is less comfortable, the observed WTP will understate commuters' value of time. RP estimates are also challenging to generalize beyond individuals at the margin of choosing different modes.

Several patterns emerge in meta-analyses of the value of travel time. First, estimates from RP studies are consistently higher than estimates from SP studies. Shires and De Jong (2009), for example, analyze 1299 estimates of the value of time and find that estimates based off SP methods are significantly smaller. Second, estimates of the value of time in congested conditions are significantly higher than estimates of the value of time in free-flow conditions. This finding suggests that motorists dislike the higher workload associated with driving in congested conditions or find these conditions frustrating in general. Finally, the elasticity of value of time with respect to GDP per capita is <1, suggesting that congestion may be a larger problem (as a share of income) in less developed countries.[1] However, there are very few estimates of value of travel time in low- or middle-income countries (Shires and De Jong, for example, report that their sample includes "only a few" middle-income countries and no low-income countries).

Given the limitations of many SP and RP studies, some of the cleanest estimates of the value of travel time come from studies of tolled highway express lanes. These studies leverage RP designs that are unlikely to be confounded by unobserved attributes, because the only difference between an express lane and a regular lane is the speed of traffic. Small et al. (2005) study the California SR91 express lanes and find an average value of time and average "value of reliability" (with reliability defined as the 90th minus 50th percentile of the travel-time distribution) each approximately equal to the hourly wage, or almost double the average of most value of time studies. They also find evidence of considerable heterogeneity in value of time and value of reliability. Devarasetty et al. (2012) study toll lanes on Houston's I-10 and find a value of time savings of $51 per hour, or 1.5 times the hourly wage.[2] Bento et al. (2014) analyze express lane choices in a model that considers "urgency", or the desire to jump a queue in order to meet a schedule constraint, and find that failing to consider schedule constraints generates an implied a value of time exceeding $100 per hour for 30% of express lane users.

The overall picture that emerges from this literature is that individuals value travel time but find congestion costly along dimensions beyond simple loss of time. They appear to have trouble anticipating the additional costs in hypothetical scenarios, suggesting a high degree of salience to the costs. Furthermore, costs are heterogeneous and grow less rapidly than per capita income. These patterns suggest an incomplete picture of total congestion costs in highly congested cities, particularly in developing or middle-income countries. In this context we view our happiness-based approach as providing complementary evidence on the costs of congestion in one of the world's largest cities.

Two other strands of literature relate to our study. First, a series of papers use subjective well-being measures to estimate tradeoffs in the provision of non-market goods in other contexts. These goods include inflation (Di Tella et al., 2001), airport noise (Van Praag and Baarsma,

[1] Abrantes and Wardman (2011) report a GDP elasticity of 0.9, with a tight confidence interval.

[2] Devarasetty et al. note that some of this value may represent value placed on increased reliability.