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Can Hong Kong price-manage its cross-harbor-tunnel congestion?

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ABSTRACT

Hong Kong drivers face daily congestion, especially at the Cross Harbor Tunnel (CHT) whose tolls are substantially lower than those of the drivers' other two tunnel options: the Eastern Harbor Crossing (EHC) and the Western Harbor Crossing (WHC). In 2013, the Hong Kong Special Administrative Region (HKSAR) Government issued a consultation paper, seeking public comments on three toll-change proposals that would raise the CHT's tolls and lower the EHC's tolls. The WHC's tolls would remain unchanged due to its congested connecting roads. Using monthly crossing data available from the HKSAR's Transport Department for 2000–2012, this paper uses a Generalized Leontief demand system to document that the usage patterns of the three tunnels is price-responsive. Hence, we conclude that the proposed toll changes are likely to be effective in transportation demand management, by shifting a portion of the CHT's usage to the EHC and WHC, thereby relieving the CHT's congestion.

1. Introduction

Hong Kong is densely populated, with a geographic size of approximately 1100 km^2 and a population of some 7.2 million. It is prone to severe traffic jams, as is true of most major cities (e.g., Rio de Janeiro, Mexico City, New York City, Los Angeles, London, Paris, Tokyo, Singapore, Beijing, and Shanghai). With 329 licensed vehicles for every km of road,[1] Hong Kong would become one big parking lot if most of these vehicles were on the road, under the assumption that each licensed vehicle's average length is about three meters. Hong Kong drivers experience daily congestion delays, especially at the Cross Harbor Tunnel (CHT), as shown in Fig. 1. In contrast, traffic is relatively light at the Eastern Harbor Crossing (EHC) and the Western Harbor Crossing (WHC).

Each cross-harbor tunnel has nine vehicle-specific tolls,[2] applicable to private cars, taxis, motorcycles, light buses, single-decked buses, double-decked buses, light goods vehicles, medium goods vehicles, and heavy goods vehicles. To reduce the CHT's congestion, the Hong Kong Special Administrative Region (HKSAR) Government has recently issued a consultation paper (Transport and Housing Bureau, 2013) seeking public comments on three toll-change proposals that aim to implement

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[1] See http://www.gov.hk/en/about/abouthk/factsheets/docs/transport.pdf.

[2] See http://www.td.gov.hk/en/transport_in_hong_kong/tunnels_and_bridges/toll_rates_of_road_tunnels_and_lantau_link/index.html.

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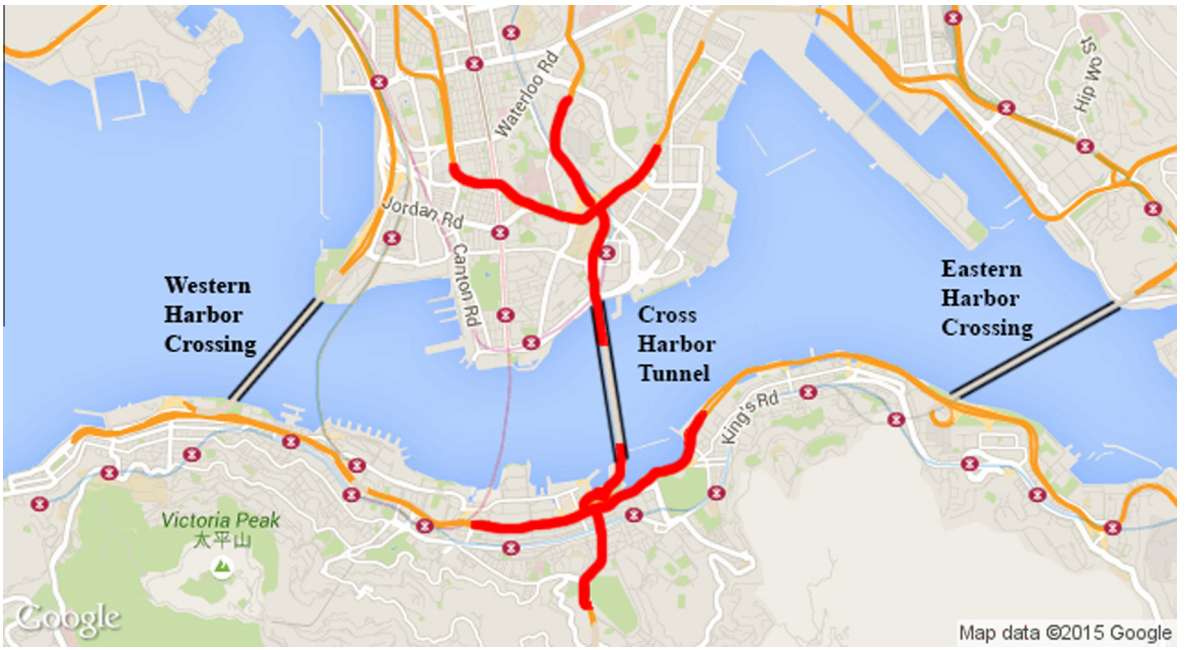

Fig. 1. Congestion problem of the Hong Kong Cross Harbor Tunnel, with the red line denoting the queue observed during daily rush hours on the tunnel's connecting roads (Wilbur Smith Associates Limited, 2010). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

transportation demand management (Vickrey, 1967, 1969; Pretty, 1988; Meyer, 1999; May and Milne, 2000). The implied premise of the proposed toll changes is that the three tunnels are substitutes with discernible price responsiveness.

There have been two prior studies on the price responsiveness of Hong Kong's three cross-harbor tunnels, the first of which was by Hau et al. (2011). Based on a sample of 426 respondents to a route-choice survey conducted in 1999 (p. 471), their discrete-choice (multinomial logit) analysis yields *disaggregate* price elasticity estimates by vehicle type: (a) private cars' own-price elasticity estimates of −0.30 to −0.43 and cross-price elasticity estimates of 0.10–0.25; (b) taxis' own-price elasticity estimates of −0.55 to −0.82 and cross-price elasticity estimates of 0.18–0.54; (c) light goods vehicles' own-price elasticity estimates of −0.83 to −1.02 and cross-price elasticity estimates of 0.39–0.57; and (d) medium and heavy goods vehicles' own-price elasticity estimates of −0.90 to −1.06 and cross-price elasticity estimates of 0.38–0.56 (Hau et al., 2011, pp. 475–476). These estimates suggest that the tunnel demands by vehicle type are price-inelastic and that the tunnels are substitutes with positive cross-price elasticities.

Hau et al. (2011), however, do not estimate the price responsiveness of motorcycles, light buses, single-decked buses, and double-decked buses. Unless these unstudied vehicles are totally price-insensitive, their study does not provide sufficient information to enable one to assess the potential effectiveness of the HKSAR Government's toll-change proposals. To be sure, the price elasticity estimates for the unstudied vehicles would be unnecessary if their total harbor crossings were close to zero. This, however, is not the case for buses; see Fig. 2.

The second study is due to Loo (2003). Using monthly aggregate data on tunnel usage by all vehicle types, from January 1979 to September 2000, this study estimates six tunnel-specific double-log regressions to examine the monthly tunnel traffic of six major toll tunnels in Hong Kong. The explanatory variables of each cross-harbor tunnel's regression only include the natural-log of the tunnel's own average toll, thus yielding the tunnel's own-price elasticity estimate, while assuming its cross-price elasticities to be zero. These own-price elasticity estimates are *aggregate* estimates that measure the price responsiveness of the total harbor crossings via a given tunnel made by all vehicle types. The own-price elasticity estimate for the CHT is −0.291, and the estimates for the EHC and WHC are positive though statistically insignificant ($p > 0.05$) (Loo, 2003, Table 3). As the study assumes zero cross-price responsiveness for all six tunnels, it lacks the complete information necessary to assess the potential effectiveness of the toll-change proposals for the three cross-harbor tunnels.

Notwithstanding their incomplete information on price responsiveness, these two studies apparently say "yes" to the substantive policy question: Can Hong Kong price-manage its cross-harbor-tunnel congestion? The vast difference in the two studies' elasticity estimates, however, motivates us to seek additional evidence on the price responsiveness of harbor-tunnel crossings. Moreover, both studies are based on data that are over 10 years old, highlighting the need for updated elasticity estimates to answer the policy question posited above.

Our estimates are based on 156 monthly observations during the 13-year period of 2000–2012 on harbor-tunnel crossings described in Appendix A. Using this updated data sample, we estimate *nine* vehicle-specific Generalized Leontief (GL) demand systems to quantify the price responsiveness of monthly harbor crossings made by the *nine* vehicle types. Our