Comments on “Crowding”, by Yizhen Gu, Qu Tang, Kai Wu, Ben Zou

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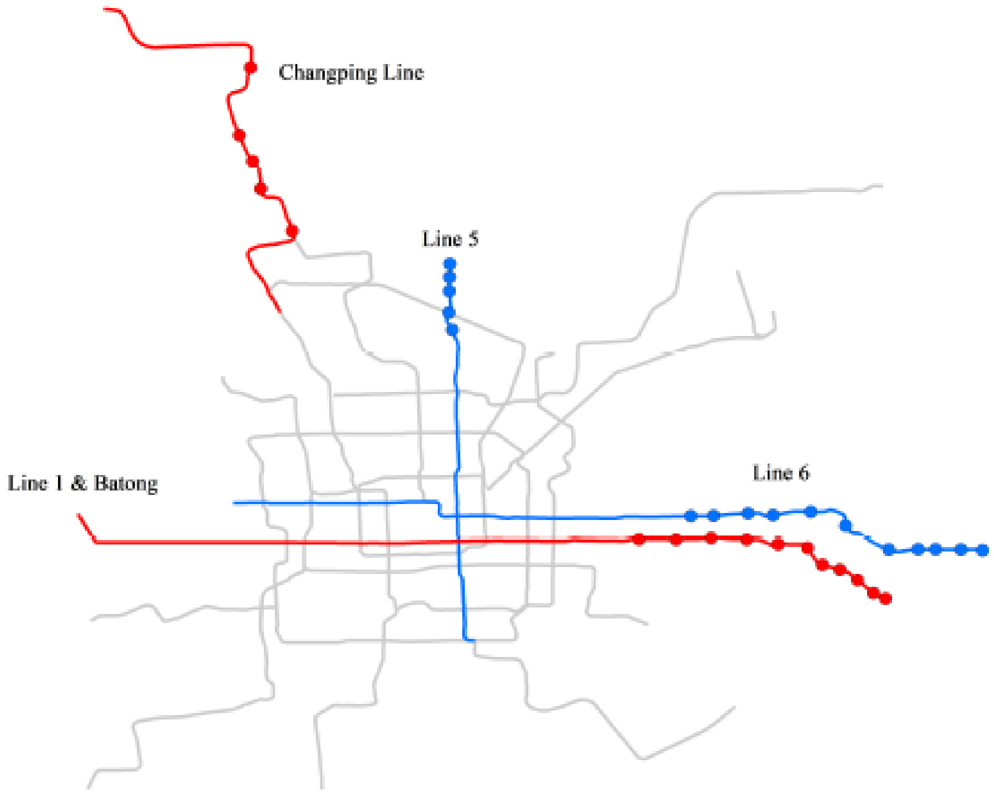
Off-Peak Transit Discount in Beijing

- Early Bird Discount on trips originating before 7:00 am from 16 suburban stations. Red.
- Implemented in December 2015.
- Discount is 30%.
- Prices vary by distance traveled: 0-6km, 6-12 km, 12-22km, 22-32km, and >32 km.

- Potential objectives for the study:
  - Travel origination times.
  - Number of passengers – crowding
  - Willingness to pay for reduced crowding and travel time for times near most preferred times.



Red = Treatment, Blue = Control

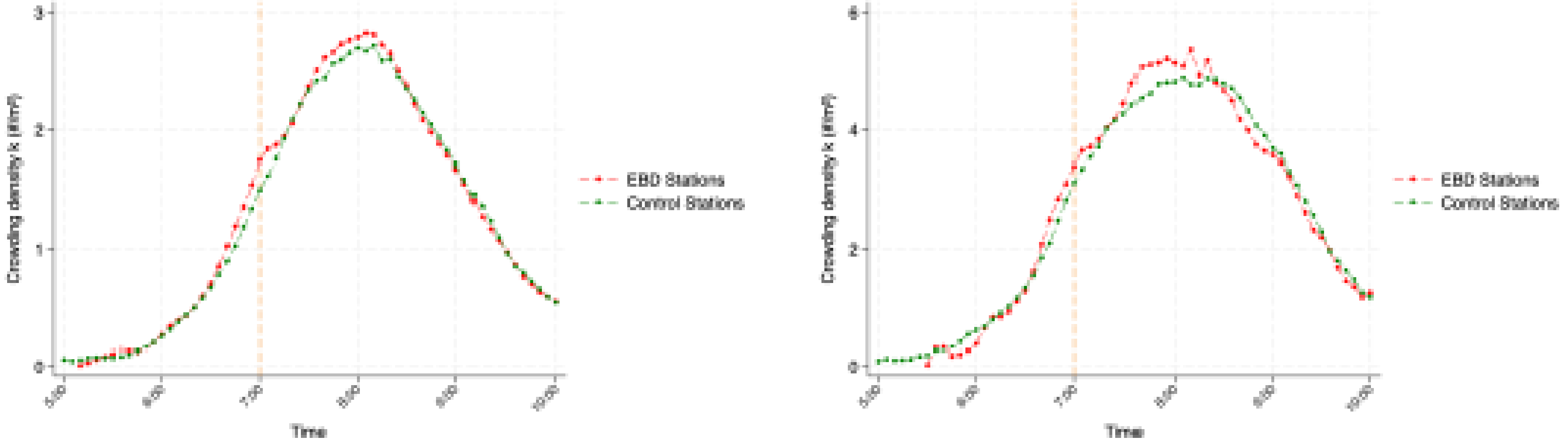
Data: Ideal v. Actual

- Ideal data set:
  - Data on individuals, before and after December 2015. Origin/Destination, times, demographic data, and work location and starting time.
  - Change in travel origination times for people who travel from EBD stations before and after December 2015.
  - Control could be blue stations, all non-EBD eligible stations, or remote non-EBD stations. The advantage of blue stations is that they became eligible for EBD later. *Potential issue: All stations are treated to some extent*.
- Actual data set:
  - Data on origination and destination times for 16 EBD stations and 16 (blue) control stations for 21 workdays in 2016. All post-policy change.
  - No direct information on income, demographic data, or work location and starting time.

Evidence of Switch Toward Travel Times Qualifying for Early-Bird Discount

Figure 2: In-Train Crowding Density

Downtown-Bound Trains over the Morning Hours



(a) Average across Stations

(b) The Most Downstream Stations

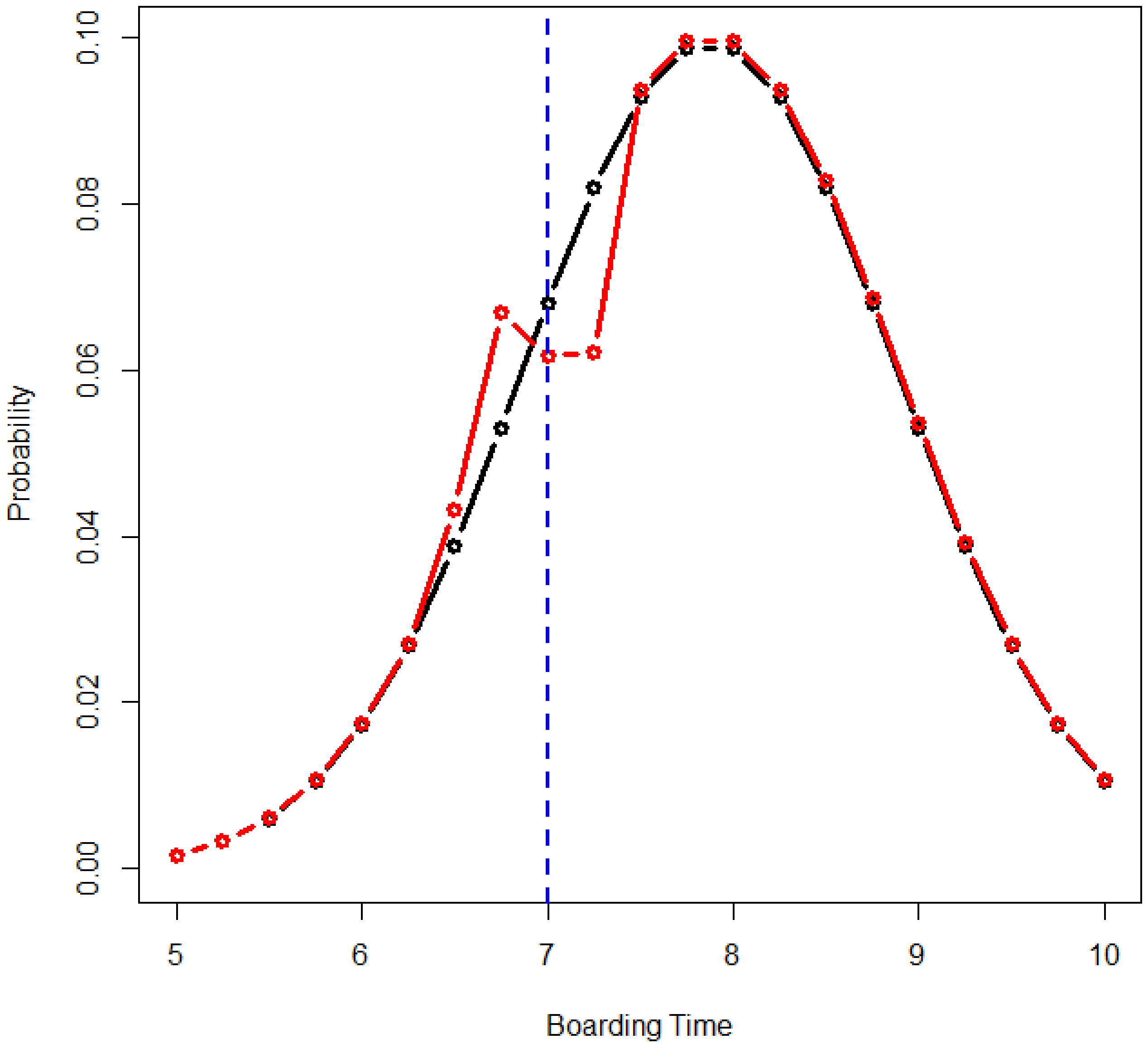
Simulations

- Base: Normal distribution, mean = 8:00, variance = 1. Close to actual distribution.

- 15-minute bins:

- Prob($T_{i-1} \leq t < T_i$) =

$$\Phi\left(\frac{T_i-\mu}{\sigma}\right) - \Phi\left(\frac{T_{i-1}-\mu}{\sigma}\right)$$



A Modification to Account for Bunching near 7:00

- 6:45 – 7:00, $P_j = \lambda_1 \left[\Phi\left(\frac{7-\mu}{\sigma}\right) - \Phi\left(\frac{6.75-\mu}{\sigma}\right)\right]$, where $\lambda_1 > 1$.
- 7:00 – 7:15, $P_{j+1} = \lambda_2 \left[\Phi\left(\frac{7.25-\mu}{\sigma}\right) - \Phi\left(\frac{7-\mu}{\sigma}\right)\right]$, where $\lambda_2 > 1$.
- Normalize the probabilities to assure they sum to 1 across all bins.
- Other intervals are not altered, except by normalization. Might allow for changes for the 6:30 – 6:45 and 7:15 – 7:30 bins also. λ_3 and λ_4.
- Test whether λ_1 and λ_2 differ from 1. Should be equal to 1 for control locations.
- McMillen and Singh, “Fair Market Rent and the Distribution of Rents in Los Angeles,” *Regional Science and Urban Economics* (2020)

Crowding / Number of Passengers Along a Network Segment

- Not directly observed. The authors estimate the number of passengers along a network segment by calculating optimal routes from the origin/destination data. Very convincing.
- If data from prior to the policy change had been available, it would have been very interesting to know which segments had increases in passengers at various times and which had decreases.
- Having more riders boarding distant locations at times before 7:00 must increase crowding downstream after 7:00. What is the net effect on crowding?
- Could try to infer the effect of crowding from the estimated distributions. Set λ_1 and λ_2 to 1 and compare the implied number of passengers at various network segments to the actual estimated values.

Willingness to Pay

- j = origination destination pair
- d = workday, between 6:30 and 8:30
- t = time of day
- P = price
- S_{jdt} = market share of time bin t in market (j,d).
- $t + \widehat{TT} - t_{jdt}^{OA}$= time of arrival minus optimal arrival time, assumed to be symmetric amount of disutility whether positive or negative.
- $logS_{jdt} = \alpha P_{jdt} + \beta \widehat{Crowd}_{jdt} + \rho \left| t + \widehat{TT} - t_{jdt}^{OA} \right| + \kappa_{jd} + \phi_t + \xi_{jdt}$

Measurement – A Significant Contribution!

- Price is given by origin/destination combination. Discrete with 25 combinations.
- Crowding: an aggregate of the number of passengers per square meter over the duration of a passenger's travel time. Clever calculation based on the number of passengers predicted to be traveling on the line segments, based on the authors' calculations of their optimal travel routes. (A possible check: does the number ever exceed the physical constraints?)
- Deviation of arrival time from optimum. Predict the optimum from the arrival times of passengers who arrive at the same time as a passenger from routes without the EBD. For example, the optimal arrival time for the EBD rider with the 25^{th} percentile arrival time is predicted to have the arrival time of the rider with the 25^{th} percentile arrival from the non-EBD distribution. Clever and probably reasonable.
- Income (to allow for heterogeneous preferences). Based on maps derived digital data for origin/destination combinations. Appears reasonable since the data are aggregated to line segments. Would be less reliable if the models were estimated using data for individuals.
- Conclusion: All of the major variables are measured reasonably accurately despite the lack of data on travel times, routes, income, etc.

Endogenous Crowding

- Spurious positive correlation between willingness to pay and crowding. (Nobody goes there anymore – it's too crowded!)
- Instead of counting the number of passengers per square meter over the duration of the trip, aggregate the number of passengers per square meter based on the number of passengers who share the same line segment but *do not qualify for the EBD*.
- Based on infrequent travelers – less than 3 rides per week. (Where does this variable come from? Calculations based on the 21 days in the sample?)
- Key is to remove EBD riders from the calculation. But other riders are subject to similar motivations. They take rides at peak times because they want to get to work at peak times. Riders who ride the trains during morning hours are likely knowledgeable of travel times too. Clever, but not as convincing as other calculations.

Policy Analysis

- Internalize the price of crowding through Pigouvian tax – first best. Incidence is regressive.
- "Capacity-Rationing Queuing": Limit the number of people who can enter a car. Adds to wait time.
- Two classes – 3 business class cars and 3 standard cars. Both groups gain: less crowding for business class and lower fares for standard cars.
- Other possibilities: More variety in work arrival times. Stay-at-home days.

Conclusion

- Very clever use of limited data.
- Convincing measurement of unobserved variables.
- Not fully convinced by the instrument for crowding.
- Would like to see more analysis of the distributions of arrival times.
- Also would like to know more about the effect of EBD riders on other parts of the network. Do early commuters downstream incur significantly more crowding than before?