Experimental Design in Two-Sided Platforms: An Analysis of Bias

1 Settings

Figure 2 shows difference between estimator and GTE in steady state. We consider a market with homogeneous customers and homogeneous listings. We set $\epsilon = 1$, $\alpha = 1$, $a_C = a_L = 0.5$. Customers have utility $v = 0.315$ for control listings and $\widetilde{v} = 0.394$ for treatment listings.

2 GTE

$GTE = Q_{11}(\infty|1,1) - Q_{00}(\infty|0,0)$
Rate of booking: $Q_{ij}(\infty|a_C, a_L) = \lambda \sum_\theta \sum_\gamma \phi_{\gamma,i} p_{\gamma,i}(\theta, j|\mathbf{s}^*(a_C, a_L))$, where $\phi_{\gamma,0} = (1-a_c)\phi_\gamma$, $\phi_{\gamma,1} = a_c\phi_\gamma$, $\phi_\gamma = 1$.
Booking probabilities: $p_\gamma(\theta|\mathbf{s}) = \frac{\alpha_\gamma(\theta)v_\gamma(\theta)s(\theta)}{\epsilon_\gamma + \sum_{\theta'} \alpha_\gamma(\theta')v_\gamma(\theta')s(\theta')}$, where $v_{\gamma,0}(\theta,0) = v_{\gamma,1}(\theta,0) = v_{\gamma,0}(\theta,1) = v$, $v_{\gamma,1}(\theta,1) = \widetilde{v}$
Steady state: $s(\theta) = \text{argmin } \sum_\gamma(\lambda_\gamma \log(\epsilon_\gamma + \sum_\theta \alpha_\gamma(\theta)v_\gamma(\theta)s(\theta)) - \tau(\theta)\sum_\theta \rho(\theta)\log s(\theta) + \tau(\theta)\sum_\theta s(\theta)$, where $\lambda_{\gamma,1} = a_C\lambda$, $\lambda_{\gamma,0} = (1-a_C)\lambda$; $\rho(\theta,0) = (1-a_L)\rho(\theta)$, $\rho(\theta,1) = a_L\rho(\theta)$

3 CR, LR

$\hat{GTE}^{CR}(\infty|a_C) = Q_{11}(\infty|a_C,1)/a_C - Q_{01}(\infty|a_C,1)/(1-a_C)$
$\hat{GTE}^{LR}(\infty|a_L) = Q_{11}(\infty|1,a_L)/a_L - Q_{10}(\infty|1,a_L)/(1-a_L)$

4 TSRN, TSRI-1, TSRI-2

Choose a_C and a_L as functions of λ/τ to reduce bias in the regime of intermediate market balance.
$a_C(\lambda/\tau) = (1-e^{-\lambda/\tau}) + \tilde{a}_C e^{-\lambda/\tau}$, $a_L(\lambda/\tau) = \tilde{a}_L(1-e^{-\lambda/\tau}) + e^{-\lambda/\tau}$, $\beta = e^{-\lambda/\tau}$
$\hat{GTE}^{TSRN}(\infty|a_C,a_L) = \frac{Q_{11}(\infty|a_C,a_L)}{a_Ca_L} - \frac{Q_{01}(\infty|a_C,a_L)+Q_{10}(\infty|a_C,a_L)+Q_{00}(\infty|a_C,a_L)}{1-a_Ca_L}$
$\hat{GTE}^{TSRN-k}(\infty|a_C,a_L) = \beta[\frac{Q_{11}(\infty|a_C,a_L)}{a_Ca_L} - \frac{Q_{01}(\infty|a_C,a_L)}{(1-a_C)a_L} - k(1-\beta)(\frac{Q_{00}(\infty|a_C,a_L)}{(1-a_C)(1-a_L)} - \frac{Q_{01}(\infty|a_C,a_L)}{(1-a_C)a_L})] + (1-\beta)[\frac{Q_{11}(\infty|a_C,a_L)}{a_Ca_L} - \frac{Q_{10}(\infty|a_C,a_L)}{a_C(1-a_L)} - k\beta(\frac{Q_{00}(\infty|a_C,a_L)}{(1-a_C)(1-a_L)} - \frac{Q_{10}(\infty|a_C,a_L)}{a_C(1-a_L)})]$