“Railroads of the Raj: Estimating the Impact of Transportation Infrastructure.”

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Overview

- Among the youngest of international trade research papers
- Among the papers about the estimations of large infrastructure projects
- During the increase in India’s economy, the construction of the “Raj”
- Effect on the trade cost and social welfare

Overview

- Economic situation before and after the expansion
- New data set
- Between 1853 to 1930
- Based on data from the British Government
- Obtention of 4 results

4 results

- Inter-district price differences are equal to trade costs
- Bilateral trade flows take the “gravity equation” form
- Railroads increase real income levels
- There exists a sufficient statistic for the welfare gains from railroads

Related literature and contribution

- Jonathan Eaton, Samuel Kortum .2002. “Technology, Geography, and Trade”
- Ricardian trade model with many commodities.
- “Railroads and American Economic Growth: A “Market Access” Approach” (2016)
- “What Goods Do Countries Trade? A Quantitative Exploration of Ricardo's Ideas.” (2012)
- The preliminaries of the paper and papers cited

New data set

- 235 Indian districts
- 5 categories: prices, output, daily rainfall, inter regional and international trade in India, digital map of India's railroad network
- Agricultural economics
- Based on Eaton and Kortum (2002) model
- Settings for the Ricardian trade model are: many regions, many commodities

Steps before the empirical study

- Consumer preferences (1): $U_o = \sum_{k=1}^{K} \left(\frac{\mu_k}{\varepsilon_k}\right) \ln \int_0^1 (C_o^k(j))^{\varepsilon k}\, dj,$

- Production side (2): $F_o^k(z) \doteq \Pr\left(Z_o^k \leq z\right) = \exp\left(-A_o^k z^{-\theta_k}\right),$

- Price distribution for varieties of commodity k produced in region o (3):

$$G_{od}^k(p) \doteq \Pr\left(P_{od}^k \leq p\right) = 1 - \exp\left[-A_o^k \left(r_o T_{od}^k\right)^{-\theta_k} p^{\theta_k}\right]$$

Steps before the empirical study

- Expected value of the equilibrium price (4):

$$E\left[p_d^k(j)\right] \doteq p_d^k = \lambda_1^k \left[\sum_{o=1}^{D} A_o^k \left(r_o T_{od}^k\right)^{-\theta_k}\right]^{-1/\theta_k},$$

- total expenditure in region d on commodities of type k (5):

$$\frac{X_{od}^k}{X_d^k} = \pi_{od}^k = \lambda_3^k A_o^k \left(r_o T_{od}^k\right)^{-\theta_k} \left(p_d^k\right)^{\theta_k},$$

- Last condition (6): $r_o L_o = \sum_d \sum_k X_{od}^k = \sum_d \sum_k \pi_{od}^k \mu_k r_d L_d,$

4 results: Theory

- Price differences between the region d and o measure the trade cost (7): $$\ln p_d^o - \ln p_o^o = \ln T_{od}^o,$$

- Bilateral trade flows take “gravity equation” form for bilateral trade flows conditional on importer- and exporter specific terms (8):

$$\ln X_{od}^k = \ln \lambda_k + \ln A_o^k - \theta_k \ln r_o - \theta_k \ln T_{od}^k + \theta_k \ln p_d^k + \ln X_d^k.$$

- Increase in real income levels which is equal to the welfare in the district o (9):

$$W_o = \frac{r_o}{\prod_{k=1}^{K} \left(\tilde{p}_o^k\right)^{\mu_k}} \doteq \frac{r_o}{\tilde{P}_o}. \qquad \frac{dW_X}{dT_{YX}} < 0.$$

- Real income per unit of land (11): $$\ln W_o = \Omega + \sum_k \frac{\mu_k}{\theta_k} \ln A_o^k - \sum_k \frac{\mu_k}{\theta_k} \ln \pi_{oo}^k,$$

Empirical steps

- Assumptions about: goods, inter regional relation, stochastic production process
- From (7) we have (12): $$\ln p^o_{dt} = \underbrace{\beta^o_{ot}}_{=\ln p^o_{ot}} + \underbrace{\beta^o_{od} + \delta \ln LCRED(\mathbf{R}_t, \boldsymbol{\alpha})_{odt} + \varepsilon^o_{odt}}_{=\ln T^o_{odt}}.$$
- From (8) and (12), we have (13): $$\ln X^k_{odt} = \beta^k_{od} + \ln A^k_{ot} - \theta_k \ln r_{ot} - \theta_k \hat{\delta} \ln LCRED(\mathbf{R}_t, \hat{\boldsymbol{\alpha}})_{odt} + \theta_k \ln p^k_{dt} + \ln X^k_{dt} + \varepsilon^k_{odt}.$$
- Estimating the unknown parameters: θ_k and A_{ot}^k (14): $$\ln X^k_{odt} = \beta^k_{ot} + \beta^k_{dt} + \beta^k_{od} - \theta_k \hat{\delta} \ln LCRED(\mathbf{R}_t, \hat{\boldsymbol{\alpha}})_{odt} + \varepsilon^k_{odt}.$$

Empirical steps

- Relationship between productivity (A_{ot}^k) and rainfall ($RAIN_{ot}^k$) (15):

$$\ln \tilde{X}_{odt}^k = \beta_{od}^k + \beta_{dt}^k + \beta_{ot} + \kappa RAIN_{ot}^k + \varepsilon_{odt}^k.$$

- From the result 3 of the model (16): $\ln\left(\frac{r_{ot}}{\tilde{P}_{ot}}\right) = \beta_o + \beta_t + \gamma RAIL_{ot} + \varepsilon_{ot}.$

- From (14): $\ln\left(\frac{r_{ot}}{\tilde{P}_{ot}}\right) = \Omega + \sum_k \frac{\mu_k}{\theta_k} \ln A_{ot}^k - \sum_k \frac{\mu_k}{\theta_k} \ln \pi_{oot}^k.$

- From (16) :

$$\ln\left(\frac{r_{ot}}{\tilde{P}_{ot}}\right) - \left[\sum_k \frac{\hat{\mu}_k}{\hat{\theta}_k} \hat{\kappa} RAIN_{ot}^k\right] = \beta_o + \beta_t + \gamma RAIL_{ot} + \psi\left[\sum_k \frac{\hat{\mu}_k}{\hat{\theta}_k} \ln \pi_{oot}^k(\hat{\Theta}, \mathbf{RAIN}_t, \mathbf{R}_t, \mathbf{L})\right] + \varepsilon_{ot}.$$

Summary

- More enlightenment on transportation infrastructure improvements effect
- Reduction of inter-regional price gaps, and increased trade volumes
- Increase of real agricultural income by approximately 16 percent
- Identification of the prediction of the evolution of real income in Indian districts over time

Critical discussion

- Time limitation: increase in the level of real incomes in India
  - about the volatility of real incomes over time
  - 1930: increase in trade due to railroads network
  - Around 1930: may be some construction of roads too
  - After 1930: constructions of road have greater effect on the trade?

Critical discussion

- May have some hidden costs: social welfare
  - costs of the railroads network construction
  - Payback to the British government in form of long term loans
  - Creation of taxes
  - Not discussed in the paper

Critical discussion

- Agriculture sectors:
  - The only sector that may have comparative advantage between regions
  - After the end of construction, more knowledge shared between the population
  - Price of products other than specific for the region may decrease after 1930
  - Progress of technology through time so decrease of agriculture sector share on GDP
  - Big companies are only in big cities so not often use railroads network

Questions?