



Identifying strategies for increasing efficiencies in bus transport in India by estimating a cost function

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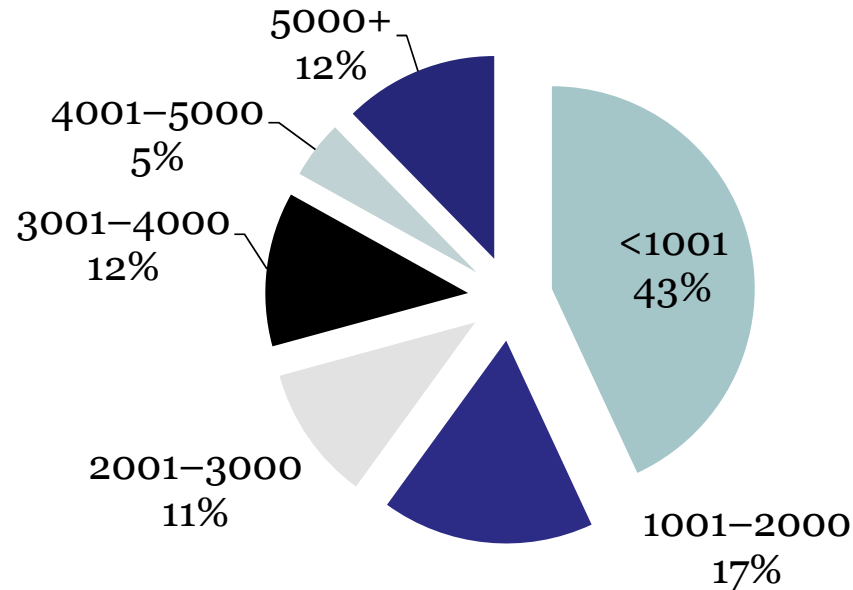


Motivation



- Rapid economic development in India → increasing mobility demand → Rising share of personal vehicles
 - Lower share of public transport
 - Higher energy consumption, emissions, noise, waste, etc.
 - Social & political impact
- Strategy: increase share of public bus transport in passenger transport
- Need for investments → financial viability
 - Cost savings → Optimal organization of production to obtain savings
 - Economies of Density and Scale
 - Impact of management form of firms on the cost structure

Density and Scale Economies



- Large number of ‘small’ firms
 - Smallest firm: 32 buses
- Some very large firms
 - Largest firm: 19000+ buses



Density and Scale Economies

- Hedonic approach:
 - Specify cost function of aggregated output measure and hedonic measures of output mix $C = f(\mathbf{w}, \varphi(\mathbf{y}, \mathbf{N}))$ and $\varphi(\mathbf{y}, \mathbf{N}) = \mathbf{y} \phi(\mathbf{N})$
 - More generally, $C = f(\mathbf{w}, \mathbf{y}, \mathbf{N})$

- Implication:

$$C = f(\mathbf{w}, \mathbf{y}) \longrightarrow ES(\mathbf{w}, \mathbf{y}) = \frac{1}{e_{cy}(\mathbf{w}, \mathbf{y})}$$

$$C = f(\mathbf{w}, \mathbf{y}, \mathbf{N}) \begin{cases} \longrightarrow ED(\mathbf{w}, \mathbf{y}, \mathbf{N}) = \frac{1}{e_{cy}(\mathbf{w}, \mathbf{y}, \mathbf{N})} \\ \longrightarrow ES(\mathbf{w}, \mathbf{y}, \mathbf{N}) = \frac{1}{e_{cy}(\mathbf{w}, \mathbf{y}, \mathbf{N}) + e_{cN}(\mathbf{w}, \mathbf{y}, \mathbf{N})} \end{cases}$$

$$ES(\mathbf{w}, \mathbf{y}, \mathbf{N}) = \frac{1}{e_{cy}(\mathbf{w}, \mathbf{y}, \mathbf{N}) + e_{cN}(\mathbf{w}, \mathbf{y}, \mathbf{N})}$$



Cost characteristics of public bus transit in



$$C = f(pkm, P_l, P_f, P_k, t, LF, NL, AR_i, MG_i)$$

- Specification issues
 - Dummy variables for Management Structure, Area of Operation (urban, mixed, hilly)
 - Translog, normalized at median. Homogeneity imposed with capital price
- Dataset
 - All public bus companies in India
 - NL data available only for 8 years, Model with NL allows distinction between Density and Scale
 - Unbalanced panel: 51 firms over 8 years



Estimation methods

- Fixed Effects

$$C_{it} = \alpha_0 + \mathbf{X}_{it} \boldsymbol{\alpha}_1 + \nu_i + \varepsilon_{it}$$

$$\varepsilon_{it} \square (0, \sigma_\varepsilon^2)$$

- Random Effects

$$C_{it} = \alpha_0 + \mathbf{X}_{it} \boldsymbol{\alpha}_1 + \nu_i + \varepsilon_{it}$$

$$\nu_i \square (0, \sigma_\nu^2) \mid \varepsilon_{it} \square (0, \sigma_\varepsilon^2)$$

$$\text{Cov}(\nu_i + \varepsilon_{it}, \nu_j + \varepsilon_{js}) = \begin{cases} \sigma_\nu^2 + \sigma_\varepsilon^2 & \text{if } i = j \text{ and } s = t \\ \sigma_\varepsilon^2 & \text{if } i \neq j \text{ or } s \neq t \end{cases}$$

- SUR

$$C_{it} = \alpha_0 + \mathbf{X}_{it} \boldsymbol{\alpha}_1 + \varepsilon_{it}$$

$$S_{it} = \beta_0 + \mathbf{x}_{it} \boldsymbol{\alpha}'_1 + \varepsilon'_{it}$$



Environmental variables

Variable	Coefficient
Load factor	-0.36**
Network Length	0.13***
Mixed operations	-0.59***
Hilly Areas	-1.32***
Company	0.61*
Municipal Undertaking	0.62*
Corporation	0.88***

- Combining rural & urban operations leads to lower costs
- Impact of management structure is ambiguous
 - Road transport corporations are most expensive

Economies of Density and Scale



Economies of Scale	
Small	2.087
Medium	1.450
Large	1.155
Very large	0.953
Economies of Density	
Small	9.583
Medium	2.150
Large	1.293
Very large	0.842

- Significant Scale Economies for median firms
 - Fall as output increases
- After including NL, 30% of the largest firms show Economies
 - Density & Scale
- Potential for cost reduction from mergers

Policy directions



For India:

- Potential for cost savings from mergers
 - Especially small firms
 - Firms operating in neighbouring areas
 - Combine rural and urban operations
- Side by side competition on the same network not useful for cost savings

In general:

- Research on the best production structure, don't go by 'best practice' approach.
- If it's a monopoly, regulate; don't force competition in the market.