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Estimating the marginal social costs of urban metro rail systems

Shane Canavan, Daniel J. Graham, Richard J. Anderson
Centre for Transport Studies
Railway and Transport Strategy Centre
Department of Civil and Environmental Engineering
Imperial College London
London SW7 2AZ

ABSTRACT

Amongst the more successful transport solutions to the population shift from rural to urban areas, has been high capacity and high frequency services provided by urban metro rail systems. However, the use of metro systems does also raise some contentious issues. Metro systems can use a great deal of public resources. Funds are often received from either government, or local authorities for compensation payments for reducing fares for certain socio-economic groups, contractual fees, as well as for a variety of subsidies such as operating and energy services. It is clear that discrepancy in the ability of metro operators to provide an efficient service in terms of their use of physical and labour assets and resources warrants closer investigation.

This research examines a panel data set of 34 metro systems across 20 countries, from a period of 1994 to present. The data used originates predominantly from two consortiums, namely the Community of Metros (CoMET) and the Nova Group (Nova), managed by the Railway and Transport Strategy Centre (RTSC) based at Imperial College London. The study also makes use of train movement and smart card transaction data from the London Underground.

Cost function econometric models are estimated and provide cost elasticities for the main cost drivers of metros, including both internal cost factors under control of the metro management and external factors. The regression model framework comprises of the following:

Independent variable:

- Cost of metro operation

Dependent variables:

- Output (car km, passenger journeys, train hours)
- Price (capital, labour, energy)
- Input (network length, energy use, staff hours)

The results from the cost functions reveal estimates for returns to scale (RTS) and returns to density (RTD) when producing different output types such as car kilometres, passenger journeys and train hours. From these, the study examines how costs change as scale and density change. This is achieved by reconciling the results with disaggregate data on train and passenger movements. As such, insight is provided for how costs of trips vary for different types of trips, over different parts of the metro network, as well as at different times of day.

In evaluating the disaggregate train and passenger data the study complements previous evidence on what determines metro operating costs, bridging the information gap between the public authorities and metro operator, which could lead to better rail regulation. In doing so, the results are beneficial to metro operators strategy in terms of capacity utilisation and provision given the improved understanding of how exactly the cost of service varies spatially and temporally.

Key words: metro rail, econometrics, cost efficiency, big data