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The importance of reducing hyper congestion

Advances in supply curve estimation and prediction using the FAST model

Martin Adler (economics@atadleradvisory.com)
Christiaan Behrens (c.behrens@seo.nl)

Introduction of the Flow AdjuSted Travel (FAST) model

We propose to apply a new model to measure the benefits of road transport policies. The Flow AdjuSted Travel (FAST) model has two major advantages compared with conventional measuring methods.[1]

First, FAST provides a better estimate of the high economic losses when the road is severely congested (hyper congestion), by accounting for the non-monotonic nature of road supply.[2] Ignoring non-monotonicity results in a substantial downward bias in the economic valuation of road congestion reduction policies. This bias might lead to incorrect policy advice. For example, the external cost can exceed the private cost by at least a factor 20 for the non-monotonic section of the road supply curve. This implies that congestion reduction policies might be more efficient from a welfare perspective.

Second, FAST is attractive because it can work with traffic data from a broad range of available traffic measurement sources and can be used both for highways and inner city locations. This is a major improvement as current empirical models have much stronger data requirements and cannot handle data about inner city locations.

The FAST model has already been successfully applied for the city of Rome. This example shows the potential of the model to support infrastructure planners and managers for day-to-day decisions and long-run infrastructure investment, from the calculation of optimal road expansion to the investment in rail infrastructure. After describing the methodology, we briefly show the results of the Rome application.

Methodology

The FAST model makes use of a combination of an instrumental variables (IV) estimation approach and theoretical considerations to arrive at non-monotonic supply function(s).[3] The FAST model can provide empirical support to the current simulation based approaches. The model has been developed to make use of time and location disaggregate data.

The model allows to directly arrive at the costs for the users as function of the intensity of infrastructure use. A basic optimization routine can be used to find optimal usage equilibria. Back-of-the-envelope and full-fledged welfare analysis are possible based on the estimations and using simulation.

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[1] Conventional and current standard methods include: i) the estimation of travel time as a function of vehicle flow; ii) the ratio between inflow and the maximum flow capacity; iii) travel time as a function of density. Other, less conventional methods require measurement of vehicles "floating" in traffic. Each of these methods has drawbacks and advantages in terms of data requirements, data collection effort, computational efficiency and economic interpretation.

[2] A non-monotonic function cannot be estimated using standard econometric techniques because one x-value will be associated with various y-values, see the backward-bending shape of Figure 1. Non-monotonicity is common for transport supply functions next to non-linearity.

[3] Full details are available in the research paper by Adler *et al.* (2017): *Road congestion and public transit*.

A FAST example of Rome

The FAST model has successfully been applied to the city Rome. In this application, we estimate the road supply curve using data from road sections across the city and on the highway ring-road. Figure 1 shows the example of one road, with the black dots the actual observations and the black curve the estimated road supply curve. In a second step, we assess the monetary and travel time losses from congestion given the current road infrastructure and report the deviation from optimal road use levels.

Figure 2 shows that the largest welfare benefits are from reducing hyper-congestion at the backward bending section of the road supply curve. As a result, vehicle flow increases and travel time cost decrease which renders the entire grey area DWL a welfare gain. This shows that transport policies which successfully remedy hyper congestion, can substantially reduce external costs in the range of 20 times the private cost. This implies a major economic benefit for society. The average welfare gain for a two-lane highway in Rome that is heavily congested can amount up to 700 euro per hour. The current conventional methods do not take into account hyper congestion, and hence underestimate the economic benefits of transport policy.

Figure 1 – Road supply curve

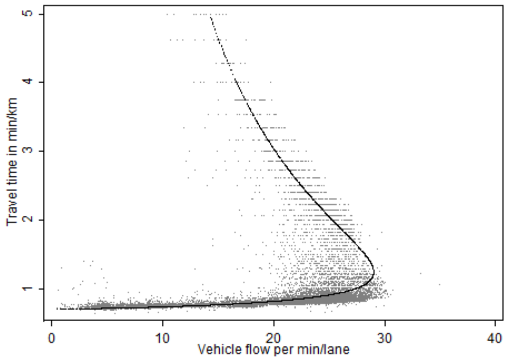
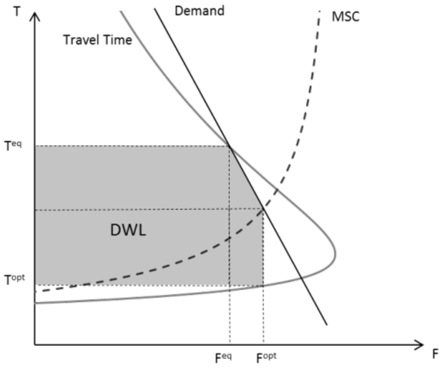


Figure 2 – Welfare considerations



There are welfare optimizing policies available. For the case of Rome, we use additional public transit data to show that public transit provision decreases travel time of car users in the city by 0.15 minutes per kilometer. This travel time benefit justifies about 60% of the current subsidies to public transit. We demonstrate with simulations that welfare optimizing subsidies that consider adjustments to transit supply and additional transit benefits, e.g. pollution reduction, could be used to reduce fare prices, improve transit quality and increase transit use. The benefits of a whole range of other transport policies can be studied with FAST, such as, for example, dedicated bus lanes, adding capacity at bottlenecks, bicycle paths, quantity restrictions, and pricing.

Applications, Variants and Extensions

The method can be applied to all congestible transport facilities, such as airports, ports, transit stations and roads. For the analysis, the presence of disruptions is helpful in the estimation. However, disruptions are not obligatory as their effects can be extrapolated from previous research. Together with demand or supply shocks in the transport system (e.g. disruptions due to strikes), the method also allows to study the resilience of transport networks, for example on vital roads such as the A2 or the A16 in the Netherlands.