# Can transport models predict the effects of congestion charges?

**Jonas Eliasson ***
Centre for Transport Studies,
KTH Royal Institute of Technology, Stockholm, Sweden
**Dirk van Amelsfort[α], Maria Börjesson[β], Karin Brundell-Freij[α], Leonid Engelson[β]**
[α]WSP Analysis & Strategy, Stockholm, Sweden
[β]Centre for Transport Studies, KTH Royal Institute of Technology, Stockholm, Sweden
* Email: mailto:jonas.eliasson@abe.kth.se

## 1 First Section

Congestion pricing has long been advocated as probably the most efficient way to combat road congestion. Many cities around the world have considered it, and quite a few have introduced it, either as systems covering the city centre (London, Stockholm, Singapore) or as systems covering single links or lanes (Melbourne, Toronto, the “value pricing” systems in the US).

Designing congestion pricing systems is a delicate task, however. Even if the general principle of marginal cost pricing is simple enough, designing a system that is possible to implement in reality, with all the necessary pragmatic simplifications, is difficult. Since both investment costs and political stakes are usually high, one may perhaps only get one chance to get the system design “right”, at least in the sense that it delivers tangible benefits without creating too serious problems in the form of rerouted traffic or transit crowding. The complexity of the transport system and the large number of possible design variables makes the use of transports models essential.

However, transport models have limitations in many respects. For example, they only model some adaptation mechanisms (usually mode, destination, frequency and route choice) while leaving out others (large-scale models usually exclude some or all of such mechanisms as car-sharing, trip chaining, choice of departure time or day of the week); non-private road traffic is often modeled in a simplistic way; they are estimated on observations of a different population of travellers than the one it is applied for; static assignment models with their inherent inability to model dynamic queue propagation are often used. These potential limitations are well known by experienced model users and developers, and are (or should be) taken into account whenever questions are formulated, results are interpreted, and conclusions drawn. An experienced modeler will use the model in a way such that relevant policy conclusions can be drawn in spite of the model's limitations. But the question is: are our "advanced state-of-practice" transport models sufficiently reliable to be used as decision support? This is the question of this paper.

We explore this question by comparing predicted and actual effects of the Stockholm congestion charging system. We focus on whether the transport model used as decision support when designing the system was "good" enough to allow correct conclusions to be drawn regarding how the system should be designed and what complementing measures were needed (such as increased public transport capacity). The Stockholm congestion charging system is a particularly well suited case for model validation. First, we know precisely what questions the model was used to analyze, how the model was used, how results were interpreted and what conclusions were drawn. Second, we know the actual outcome with a fair degree of precision: the effects of the charges were measured in an extensive evaluation program gathering all sorts of data on traffic flows, travel times, travel patterns etc.

At its core, this paper is hence a model validation study, comparing a forecast with actual outcome. But our main focus is not just whether the forecast turned out to be accurate in some general sense: our central question is whether the forecast was correct in those respects that were crucial for the analysis at hand, or more precisely, whether it was sufficiently accurate to enable the planners and decision-makers to reach the right conclusions for the design and preparation of the charging scheme. Hence, the paper is structured according to the issues that were the main questions during the design and preparation process: whether the general reduction of car traffic would be in line with the target, whether there would be capacity problems in the public transport system, how the charges should be differentiated in time, whether congestion on the ring roads around the charging cordon would worsen etc. For each of these issues, we explore whether the model results were sufficiently accurate to enable planners to make correct decisions regarding the design of the charging system and the preparation of complementary measures. Our question can be phrased as "if planners had had access to a perfect model, able to perfectly predict the effects of the charges – had the system been designed differently in any respect, or had different preperations been made?". If not, then the model can reasonably be said to be "sufficiently good" for its purpose.

But the purpose of the paper goes beyond mere model validation. The important question from a policy perspective is whether the Stockholm experiences – where the charges resulted in a substantial congestion reduction – is  transferable to other cities. Obviously, introducing a copy of the Stockholm system in another city would not give precisely the same effects. But if transport models can be trusted to a reasonable extent, then a decent transport model for another city should be able to predict what effects congestion charges would have in that city. There are hosts of model-based analyses of congestion charging schemes for many cities around the world, but the results are often met with skepticism and arguments like "making driving more expensive won't reduce car traffic". The ulterior motive of this model validation exercise is to contribute to this debate, and to enable cities considering congestion charges to make an informed assessment of the potential benefits it might bring, and how the system should then be designed.

The paper also contributes to earlier literature by describing the effects of the charges in greater detail than any previous paper.

The planning and design of the charges were centered around the following questions. We compare modeling results with actual outcome for each of these questions.

- Would the charges reduce traffic across the charging cordon (where the main congestion problems are located)?
- How large, if any, would the traffic reduction be? How would it vary across time and space? This is essential for deciding charge levels.
- Would congestion problems decrease? By how much, in that case? Would the traffic reduction (if any) be sufficient, and located at such places and points in time, that travel times got appreciably shorter?
- Would congestion problems appear, or worsen, in other locations instead? Re-routing traffic may be a substantial problem. Even small increases in congestion on alternative routes may cause considerable political problems. To some extent, these problems may be alleviated by minor measures if they can be anticipated.
- How much would public transport trips increase? During some time periods and at some parts of the transit network this may cause considerable crowding problems. If these could be anticipated, they may be possible to alleviate through increased capacity.
- Would there be any positive environmental effects? The charges were marketed to a large extent as "environmental charges", and hence it was considered important to be able to quantify the environmental effects in advance.