Efficient transportation policies for sustainable cities

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Introduction

In the context of sustainability, many European cities try to downgrade the share of cars in the urban areas. Different cities have explored alternative ways to curb traffic. London charges a congestion fee for commuters who drive into the city center, Copenhagen is creating bicycle superhighways to connect the suburbs to the city, Hamburg is working on a plan "Green network" that would eliminate the need for cars within the city.

The aim of this paper is to evaluate the relative efficiency of car-reducing policies in a multi-user multi-period multimodal context. This paper studies this issue developing a stylized multimodal network in which the traffic authority can maximize social welfare by adjusting transit design variables and network pricing. The general model is applied to a medium-size city.

While most papers dealing with multimodal transportation focus only on "pure" modes of transport, such as private car mode or public transit mode, this paper considers combined trips as well as pure mode trips. Moreover, this paper takes a network approach whereas most papers focus on a single traffic corridor (e.g. Basso and Silva (2014), Tirachini et al. (2014)).

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Methodology

We work with a given origin destination matrix and a decomposition of the population in representative socio-economic user groups. The network consists of different modes that can be combined (bus-car, bus-bike, etc). The generalized cost of a link contains several components: a monetary cost, taxes levied by the government, and a time cost which can be a function of the number of users. The user preferences are represented by a nested CES utility function with three levels: choice between transport and consumption of a composite commodity (first nest), choice between peak and off-peak period (second nest), and choice between the transport alternatives (third nest). The elasticities of substitution at each level are parametrically given. The elasticity of substitution for every branching of the choice tree will determine the ease of substitution and the price elasticities between different transport alternatives.

Expected results

The model is applied to the conurbation of Leuven (Belgium). The network is defined by distinguishing between three zones: the city center, the suburban employment center and the outside region. The modes of transport between or within the different zones include combined trips such as train-bus as well as the pure modes: car, bus, walk. Users choose between the different alternatives based on the perceived generalized cost. We distinguish between three different classes of users: students, commuters and others. For each OD-pair and user type, we calibrate a nested utility function on the basis of observed travel patterns.

For the city of Leuven, 3 scenarios to reduce the use of cars in the city center are considered: introducing road pricing in the city center, raising parking fees in the center of Leuven and expanding public transport. In the first two scenarios we expect a decrease in the number of cars in the city center as travelers will switch modes, or refrain from travelling to the city center. The third scenario could result in an increase in cars travelling in the center as improved public transit to the suburban employment center could reduce congestion on the roads to the center and induce car traffic with as origin or destination the city center. We expect the two pricing scenarios to be welfare increasing as travelers will switch from a mode with a large congestion externality (car), to modes without externality (walk, bike) or
modes with a positive externality (transit). For the scenario in which transit
design is adapted the expected change in welfare is ambiguous. On the one
hand, commuters will switch towards positive externality modes, on the other
hand the capacity that has become available on the car links induces demand,
which implies large congestion externalities. Furthermore, the investments
needed to adapt the transit infrastructure will decrease welfare even more.

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