Why does car traffic increase when public transport infrastructure is improved ?

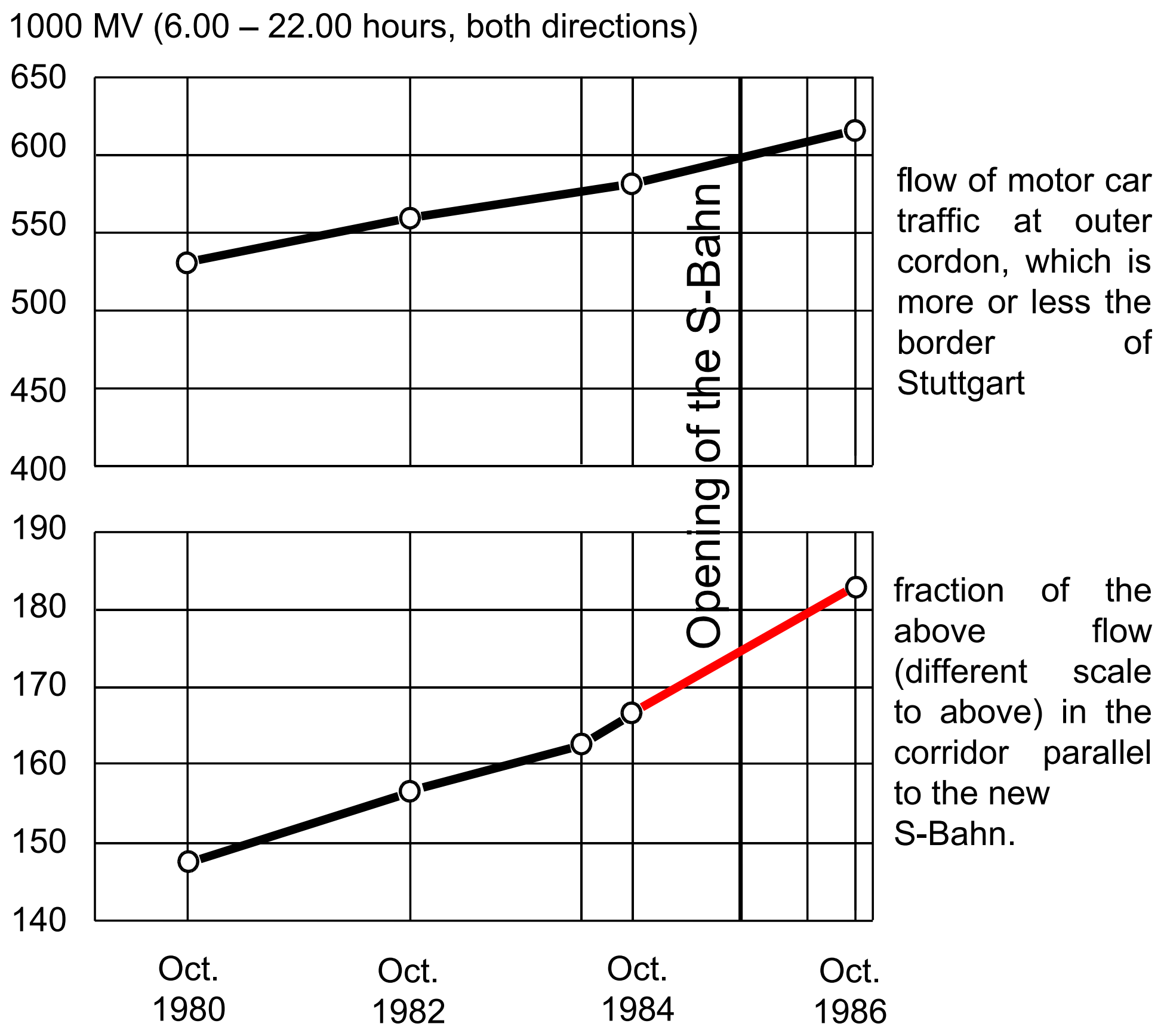
Rudolf Pfleiderer and Martin Dieterich

Introduction

In considering the significance of public transport in the political discussion relating to modal split, one would assume that there are numerous case studies proving that funds allocated to public transport infrastructure yield a reduction in car traffic. Surprisingly, few case studies have been published. In Stuttgart, Germany, a new light rail (S-Bahn) opened in 1985 linking the city with the industrialised region of Böblingen. The promise was reduced car traffic. The result was a substantial increase in car traffic along the corridor of the new S-Bahn.

The following quotation summarizes the result of the investigation (Younes 1990): The Stuttgart case study of a new S-Bahn linking the city of Stuttgart with the industrialized region of Böblingen has some surprising findings. Based on in depth surveys and studies carried out by both the city and the local public transport authority, it is clearly shown that the growth in motor vehicle traffic along the corridor of the new S-Bahn has increased substantially since it was opened and that this increase was significantly more than the increase in traffic for all roads in the city.

See fig. 1.



Source: Landeshauptstadt Stuttgart, Referat Städtebau: Vorher-Nachher-Untersuchung zur S-Bahn nach Böblingen (Auswirkungen auf den Individualverkehr)

Fig. 1. As a result of the opening of the S-Bahn from Stuttgart to Böblingen in 1985, the volume of motor car traffic rose substantially.

The simple model

Two basic laws describing traveller behaviour explain these findings.

1. The travel time budget is in the long run with good approximation constant (speed independent).
2. Non captive travellers choose the faster mode (Mogridge Conjecture, see Allard J., 1987). As long as travelling by car is faster, the car will be chosen. As soon as car travel becomes slower than public transport, motorists transfer and the speed of the two modes will approach equilibrium.

Take the case of a metropolitan area consisting of a densely built-up core zone, surrounded by less densely built-up outskirts. In the core zone car traffic equals capacity (saturated area) and there is a speed equilibrium. In the surrounding outskirts (unsaturated area) car traffic is faster than public transport.
See fig. 2.

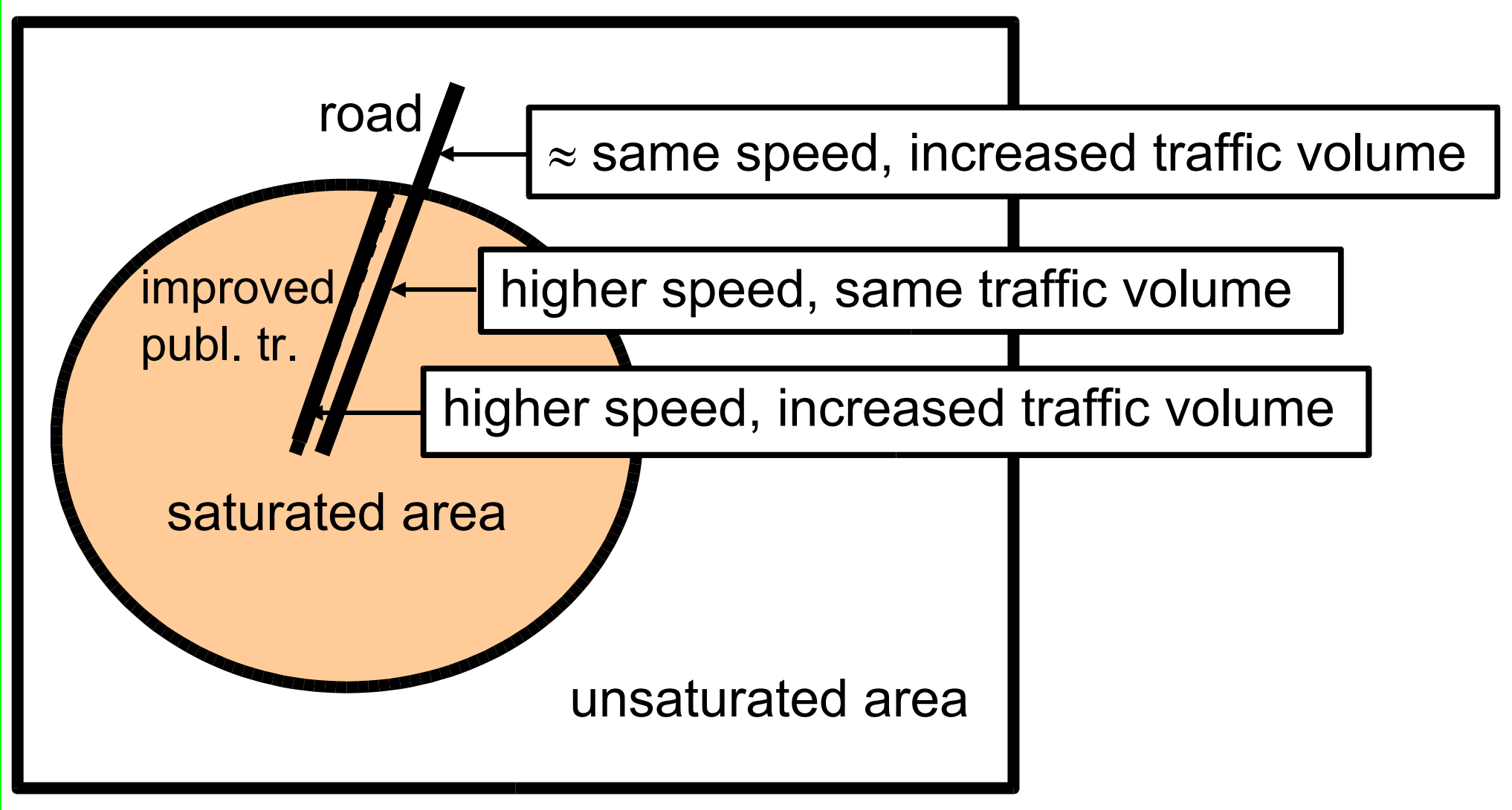


Fig. 2. Simple model with saturated and unsaturated area

If the speed of public transport is increased, some motorists in the core zone will transfer. Few motorists have to transfer in order to reduce congestion enough for the speed of the private traffic to catch up with the speed of the public transport. The flow of the car traffic remains the same. See fig. 3. But queues at traffic lights are shorter. According to the law of the speed independent time budget the time saved by motorists in the saturated area is transferred into additional private traffic. This is only possible in the unsaturated area. Therefore, the traffic volume in the unsaturated area rises. See fig. 4.

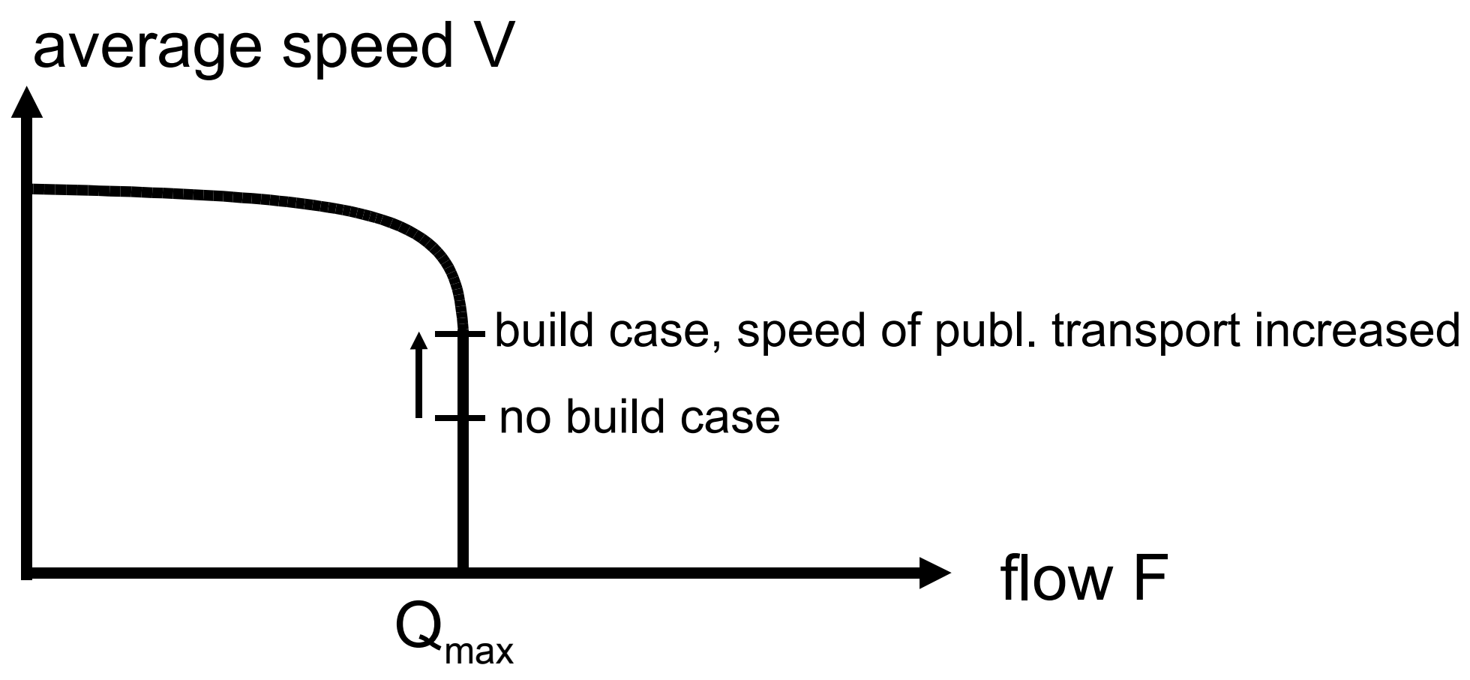


Fig. 3. Flow speed diagram in saturated area

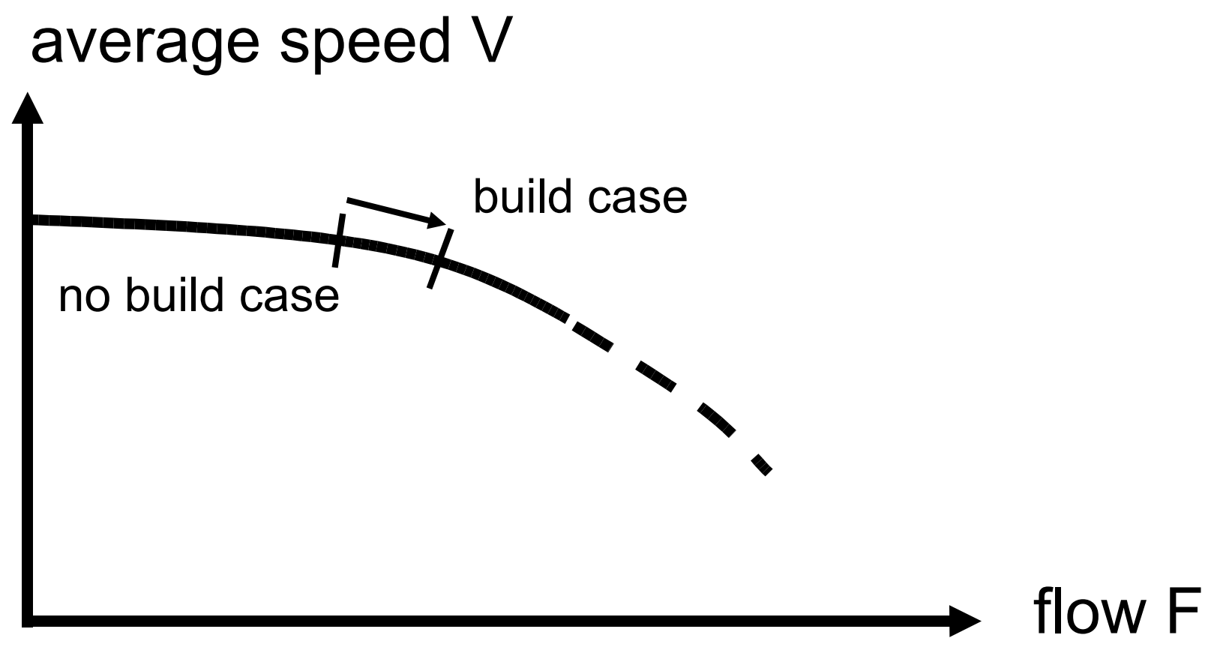


Fig. 4. Flow speed diagram in unsaturated area

The simple formula

It is assumed that in the core zone (saturated area) there is congestion (saturation) in the rush hour. The traffic flow is $F = Q_{max}$ (fig. 3). At the beginning of the rush hour the occupants of Z cars – typically cars driving between the edge and the centre of the core zone – transfer to the improved public transport. Assuming that the time these cars spent in traffic per journey (trip time) averages T_T, then the reduced total car travel time amounts to

$$T_1 = Z\ T_T$$

The total waiting time for the remaining car traffic at the traffic lights is reduced by the travellers who transferred to public transport by

$$T_W = Z/F$$

Assuming that the duration of the rush hour is T_R, then the total time savings of the car traffic in the core zone can be calculated as

$$T_2 = T_W\ F\ T_R = (Z/F)\ F\ T_R = Z\ T_R$$

This is a surprisingly simple relationship. T_2 is the total time which is – according to the law of the speed independent travel time budget – reinvested into the traffic and thus a measure for the induced traffic. The difference between the travel times of the transferred and the induced traffic is

$$T = T_2 - T_1 = Z\ (T_R - T_T)$$

The car mileage per rush hour induced by the improvement of public transport is thus:

$$N = V\ T = V\ Z\ (T_R - T_T)$$

V is the average speed in the unsaturated area.
T_T is typically 25 minutes. T_R can be for example 2 hours. Thus N is positive.

The more motorists transfer, the greater is the induced mileage N and of course N is proportional to the average speed V in the unsaturated area.

Final remark

Fig. 5. Result of improvement of public transport and car traffic

Source of the cartoon: Cerwenka (1996). Origin: Nebelspalter, Switzerland

The increase in motor car traffic can be avoided, if the acceleration of public transport is complemented by an appropriate deceleration of the parallel road traffic.

Literature

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Rudolf Pfleiderer, Florian-Geyer-Str. 8, D – 70499 Stuttgart, pfleiderer.stuttgart@t-online.de
Dr. Martin Dieterich, Röntgenstr. 17, D – 73230 Kirchheim, dieterim@fh-nuertingen.de

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