

Costs of Congestion: Literature Based Review of Methodologies and Analytical Approaches

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Road congestion is seen as having increasing impacts on travellers, the environment and economy as a whole, but there is little evidence on what the full costs of congestion are. This research has involved an international literature review on the costs of road traffic congestion. Firstly, congestion in Scotland was summarised based upon analysis of the Scottish Household Survey data. Congestion is widely understood but rarely defined, so a summary was made of different definitions of congestion and how it has been measured. The main focus was to report on the different methods used to measure the costs of congestion. Finally an outline was given on the link between economic growth and congestion ('decoupling').

Main Findings

- Whilst at the national level for Scotland only 11.5% of trips are affected congestion, this figure varies substantially according to location, time of day and purpose of the journey. The impacts of congestion are greatest in Glasgow, Aberdeen and Edinburgh, where up to 42% of travellers in the morning peak experience congestion related delay
- The two main ways in which congestion is defined are firstly a traffic based perspective and secondly an economic view. Different ways of measuring congestion may be based on travel time (or speed), traffic volume, area affected and summary indices (or more complex model outputs). In practice, the simpler measures are more commonly used.
- There are three principal ways to measure the costs of congestion: the first defines it against a baseline where there is no congestion, the second measures the additional cost on the whole system of an additional trip or kilometre travelled by a vehicle, whilst the third measures it against a base where the price of travelling by car (including fuel tax and vehicle excise duty) is at a level that matches the additional costs to the system imposed by that trip. Congestion costs can include a wide range of items including costs to the environment, safety, maintenance etc.
- Some transport measures result in increased income and reduced costs (e.g. by reducing congestion). Where these are introduced, other measures are needed to either prevent more demand for travel or to reduce the need to travel. Some measures may be quite difficult to implement politically, such as road pricing.

Aims and Objectives

The main objective has been to conduct an international literature review on the costs of traffic congestion. This included the following sub tasks;

- to describe congestion within Scotland,
- to review definitions of congestion and how it has been measured
- to describe the methods used to measure congestion costs
- to provide an outline of the literature concerning the link between economic growth and congestion ('decoupling').

Methodology

There are few studies which use the same approach to measure congestion throughout Scotland. As a result, a summary of congestion was produced based upon delay calculated from the Scottish Household Survey (SHS) and congestion indicators produced by the Transport Model for Scotland (TMfS). The aim was to give a broad picture of the main areas in Scotland affected by congestion.

For the literature review, a search was made of academic and other databases for materials published within the last 10 years. Some slightly older key findings were also reported. The material covered includes the UK, USA, Europe and wider international field.

Findings

Current levels of congestion in Scotland

Limited literature exists on the locations of congestion in Scotland and this does not define congestion. The approach here was to use existing data on the impacts of congestion (delay, speed reductions and reliability problems) to describe the locations where the impacts of congestion are greatest. A broad picture emerges:

- Whilst at the national level only 11.5% of car driver trips are affected by congestion, this figure disguises large variation according to location, time of day and journey purpose.
- Congestion impacts are largest in the cities of Glasgow, Aberdeen and Edinburgh, where up to 42% of AM peak travellers experience congestion related delay.

- The trunk road network that experiences the most congestion is that in the vicinity of these cities, plus the approaches to the Forth estuarial crossings.
- Peak hours are more congested than the off-peak. Commuting and business related trips are more affected than trips for 'other' trip purposes. No data is available on congestion impacts for freight movements.
- Congestion related delays are reported throughout Scotland, beyond Aberdeen, Glasgow and Edinburgh and their vicinity. The frequency and incidence of delays is, however, higher in the large cities.

Definitions of congestion

Despite frequent use of the term, congestion is often understood but not formally defined. How people perceive congestion may be as important as the hard evidence in driving the need for measures to address congestion.

A traffic based definition given by the Highways Agency reflects a wide understanding of congestion and is summarised as follows: congestion occurs when hourly traffic demand is greater than the maximum amount of traffic that can normally travel along a particular section of road.

An alternative economic based definition is: Congestion is the hindrance vehicles impose on each other because of the relationship between speed and amount of traffic. It occurs in the situation where the traffic system is close to its full capacity.

These two definitions reflect the two basic approaches to interpreting congestion: firstly a traffic based view (which is related to many ways that congestion is measured in practice) and secondly an economic view (which is related to ways in which the costs of congestion can be calculated).

How congestion is measured

At the practical level of measuring congestion, different approaches are classed as follows: travel time (or speed) based measures, traffic volume based measures, area based measures and summary indices (or more complex model outputs). In practice, the simpler measures are more commonly applied. Some examples are as follows:

- One frequently used measure divides the 'total delay' by the 'volume of traffic' to give the 'average amount of delay' for a vehicle travelling one kilometre. This type of measure disregards factors such as the number of people in the vehicle, how valuable time is for each person and wider factors (e.g. environmental impacts resulting from congestion).

- Simple measures based on speed are used particularly for a motorway context (for example, 'a congested state exists when the traffic speed is below 50 mph').
- A more complex measure is the 'congestion reference flow' which is an index based on the capacity of the road, number of lanes and other traffic related variables
- The 'level of service' indicator is a basic congestion scale running from A to F and describes conditions using variables such as speed, travel time, disruption to flows and safety. It is widely used in the USA.

Calculating the costs of congestion

To estimate the costs of congestion, there are three main approaches that can be used and these are summarized below.

- The *Total Cost of Congestion* gives the cost of congestion compared to a state of zero congestion. A frequently quoted figure attributed to the CBI is that congestion costs the UK economy £20 billion/ year (but there is no supporting evidence for this). Research at the University of Leeds suggests that the total cost of congestion to the UK economy was £19.2 billion in 1998.
- The *Marginal External Cost of Congestion* refers to the change in the total cost of congestion as a result of a single additional trip or single additional kilometre travelled by a vehicle. It is possible to separate this into different cost categories e.g. road wear and tear, increased accident risk, environmental costs and delay to other road users. There is a wide variation in the marginal external cost of congestion between locations and time periods, with factors such as the local geography, historic development of the road network and the level of economic activity having influencing roles.
- The *Excess Burden of Congestion* gives the cost of congestion compared to a situation in which the prices drivers pay to use the road system (including fuel tax, vehicle excise duty) reflect the costs that they impose on the transport system and the environment. It differs from the Total Cost of Congestion as it is highly likely that even when the excess burden of congestion is zero congestion will be present on the transport network. It assumes there are no improvements to the road network to increase the amount of traffic that can use the road. There is a wide

range in estimates of the cost of the excess burden of congestion ranging from £2.6 billion per year to £11.7 billion per year.

The appropriate way to calculate the cost of congestion will vary according to the end use of the data. Where the aim has been to consider road pricing schemes, the Marginal External Cost of Congestion and the Excess Burden of Congestion is normally calculated. It is argued that the Total Cost of Congestion figure, in itself, has least policy relevance as there is always a cost associated with building sufficient roads to remove all congestion. Notwithstanding that, the difference between the total costs of congestion with and without a proposed transport improvement is an important input to the transport planning process.

Data needed to calculate Congestion costs

In terms of data requirements, all three approaches need a transport model. Different types of model already exist, but may require modification to represent the area to be studied. Estimates of the physical and cost impacts that congestion causes (e.g. pollution, accidents, etc.) are also needed. As with all modelling the results can be very sensitive to the assumptions made including the level of modelling detail and what the environmental costs are.

The link between transport and growth in the economy

There is strong empirical evidence that growth in travel is related to income, the cost of travel and the 'need to travel'. However, data collected at the EU level and internationally suggests that the link between transport demand and economic growth is not fixed over time (i.e. may be 'decoupled'), and may also vary between the passenger and freight sectors. Research has identified particular policies and transport measures which could be used to promote decoupling whilst maintaining economic activity and achieving sustainability goals.

Where transport policy increases income and reduces cost (e.g. by reducing congestion), other measures are needed to either prevent increased travel demand (for example road pricing to 'lock in' the benefits) or to reduce the need to travel. Some measures may be quite difficult to implement politically, such as road pricing.

The underlying relationships are, however, complex and further understanding of the demand for travel is needed before drawing firmer conclusions

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The full report, "Costs of Congestion: Literature Based Review of Methodologies and Analytical Approaches" which is summarised in this research findings is a web only document and is available on the publications page of the Scottish Executive website at:

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