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Evaluating the impact of a workplace parking levy on local traffic congestion: The case of Nottingham UK

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ABSTRACT

A Workplace Parking Levy (WPL) scheme raises a levy on private non-domestic off street parking provided by employers. In April 2012 Nottingham became the first UK City to implement such a scheme with the revenue generated hypothecated for funding transport improvements.

The lag between the introduction of the WPL and the opening of related public transport improvements represents an opportunity to study the impact of a WPL on congestion as a standalone measure. In order to achieve this it is necessary to consider changes to variables external to the WPL, which also impact on congestion, which may obscure any beneficial impact of the scheme. An autoregressive time series model which accounts for the impact of these exogenous variables is used to evaluate the impact of the introduction of the WPL on congestion. Delay per Vehicle Mile is used as the dependent variable to represent congestion while the number of Liable Workplace Parking Places (LWPP) is used as a continuous intervention variable representing the introduction of the WPL. The model also contains a number of economic, transportation and climatic control variables.

The results indicate that the introduction of the WPL as measured by the number of LWPP has a statistically significant impact on traffic congestion in Nottingham. Additionally, external explanatory variables are also shown to impact on congestion, suggesting that these may be masking the true impact of the scheme. This research represents the first statistical analysis of the link between the introduction of a WPL and a reduction in congestion.

1. Introduction

In April 2012 Nottingham City Council introduced a Workplace Parking Levy (WPL) which levied a charge on occupied private non-domestic off street parking places. These are termed Workplace Parking Places (WPPs) and are defined as places occupied by vehicles used by employees, regular business visitors or students/pupils. It is the first charge of its type in the UK and indeed, in Europe.

The WPL has a dual role; firstly to act as a transport demand management measure and secondly to raise hypothecated funds for transport improvements. The money raised by the WPL is funding two new tram lines (NET Phase 2), improvements to Nottingham Railway Station and quality enhancements to the LinkBus services. The WPL scheme and the above mentioned public transport improvements comprise the overall "WPL package" and are intended to complement each other to enhance the transport demand management effect. For the 2016/17 financial year the charge per WPP is £379.

The aim of this paper is to report, *for the first time*, on a statistical evaluation of the impact of the introduction of the WPL on levels of peak period traffic congestion in Nottingham. Hamer et al. (2009) noted that such schemes are seldom introduced in isolation which makes it difficult to isolate the impact of the charging scheme from that of other transport improvements or traffic restraint measures. However, the research detailed in this paper takes advantage of the opportunity to study the stand alone impact of the WPL by examining the time period from 2010, when employers started to take pre-emptive action to reduce their liability for the provision of WPPs, up to 2015 when the principal public transport intervention of the WPL package, NET Phase 2, was completed.

The paper explores the relationship between City wide levels of congestion, the introduction of the WPL and important explanatory

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variables, including the key contextual factors that may obscure any impact of the introduction of the WPL. In order to achieve the above aim this research utilises a statistical approach to compare relevant time series data which provides an assessment of the relative impact on congestion of these variables.

The paper is structured as follows. A literature review is followed by the methodology section which details the application of a statistical approach to assess the impact of the supply of workplace parking on traffic delay. The results of this research are then presented and discussed. Finally, the conclusions are presented, including limitations and a suggested direction for further research.

2. Literature review

In order to meet the above research aim it is necessary to understand how to define and measure congestion, what factors drive congestion, the impact that existing parking space levies have had on congestion and finally what statistical approaches have been used successfully for achieving similar research aims.

2.1. Defining and measuring traffic congestion

Traffic congestion is inherently difficult to define; it often has different meanings or definitions depending on the individual or organisation (Wang, 2010). The UK Department for Transport (DfT) (2016), notes that congestion can be said to have both physical and relative dimensions. In a rural setting any queue at a junction may be unexpected and thus be considered as congestion whilst commuters in a more urban setting consider this the norm even though the actual time spent queuing would be much greater. In this urban setting only an excessive delay at that junction may be considered as congestion by a commuter. Thus perceptions of congestion are relative (DfT, 2016). Its physical characteristics occur when vehicles interact with other vehicles and road users to produce a slower speed than would be expected if only one vehicle was using the road (DfT, 2016).

Various academic sources attempt to provide a definition based on the physical dimension. For example Goodwin (2004) defined congestion as “the impedance vehicles impose on each other, in conditions where, due to the speed flow relationship the use of transport system approaches its capacity” while Brownfield et al. (2003) defined congestion as “An urban or peri-urban link is defined as being congested where the point average speed taken over 3 min is below 50% of the speed limit”.

Additionally various researchers, for example, Skabardonnis et al. (2003) and Dowling et al. (2004), divide congestion into recurrent and non-recurrent types. Recurrent congestion is that caused by regular events such as times of high demand for travel whilst non-recurrent congestion is that caused by one off events such as accidents.

For this research it is necessary to quantify congestion in order to assess change over time therefore it will be the physical dimension that must be the focus. As most measures of congestion utilise journey times averaged over a period of time they inevitably contain elements of both recurrent and non-recurrent congestion as it is difficult to separate out the two components from the data sets.

In the UK the consensus amongst Local Authorities and the DfT is that traffic congestion can be defined as a state where the speed on a given stretch of road falls below the free flow speed. The DfT (2009) defines congestion on UK major roads as vehicle delay which is the difference between the actual travel time and a reference travel time i.e. the journey time possible under free-flow conditions.

Having arrived at a suitable definition of traffic congestion it is now necessary to review the available literature to understand the metrics which have been used to measure levels of traffic congestion. The advent of data generated from GPS from satellite navigation systems has enabled the use of time based metrics thus rendering the use of flow as a proxy for congestion as obsolete. A number of such physical, time based metrics are discussed below.

Taylor et al. (2000) outlined a measure he termed the Congestion Index (CI), this is a measure that is often quoted in academic papers, for example Wang (2010). This compares total travel time on a link as a proportion of expected free flow travel time. A CI of 1 would indicate zero congestion whilst an index close to zero would indicate high levels of congestion. Wang (2010) observes that as this metric is dimensionless and thus not dependent on link length it can be used for comparison across segments, corridors or even large networks. This has a disadvantage as the figure it produces is essentially abstract in that it does not relate to a real unit of measurement i.e. time lost.

The UK Commission for Integrated Transport recommended that a measure of congestion be based on the difference between free flow speed and actual speed (DfT, 2000a). This indicator was more fully defined in the follow up report “A measure of road traffic congestion in England” (DfT, 2000b). This concept has become known as delay and was used by the DfT as a congestion metric for UK Major Roads (the Strategic Road Network) until 2010 (DfT, 2009). The US Department of Transport Guidance for measuring effectiveness for highway schemes defines a similar measure which calculates delay per vehicle mile travelled (US DoT, 2013).

Grant-Muller and Laird (2006) have note that there are 2 main draw backs to these delay based indicators:

1. They fail to take into account the impact of journey time variability
2. Where they are expressed per vehicle, no allowance is made for vehicle occupancy.

The latter has obvious ramifications for urban congestion monitoring as it is possible for delay per vehicle to increase while delay per person is falling due to the prioritisation of public transport.

Journey time variability is a different concept to all the measures of congestion discussed so far in that it quantifies the amount of uncertainty or variability faced by a traveller considering a journey. It does not quantify absolute delay, therefore, a traveller may experience a great deal of delay but provided that the overall journey time doesn't vary much from day today this metric would have a relatively low value (DfT, 2016). Because of this Journey Time variability is not suitable for this research problem as the aim of this research is to assess change in congestion over time.

Given that there is a general preponderance of metrics described in this literature review based on the concept of delay it would seem reasonable to use a delay based metric. Although the benefits of assessing congestion on the “person” level rather than vehicle level is recognised, there is currently no local data set available that would enable the calculation of this metric.

Therefore, average delay per vehicle mile was chosen as the metric for quantifying congestion in this research.

2.2. Drivers of congestion

In Nottingham, the reality has been that, since 2010, congestion levels have increased and similar increases are observed in other UK Core Cities (Dale et al., 2013). Despite a fall in the supply of WPP and other positive changes in employer behaviour, it has not been possible to observe any impact the introduction of the WPL has had on congestion in Nottingham. It is therefore important to identify the key factors or ‘drivers’ which are likely to impact on traffic congestion and may obscure any beneficial impact arising from the introduction of the WPL. These contextual factors can then be taken into account within any potential research methodology.

Tanner (1983) presented research that examined factors that contributed to congestion; he demonstrated the importance of income levels, fuel price and economic output in determining the demand for travel. More recently, and specific to the UK context, Transport for London carried out a detailed review of factors which contribute to traffic