Transportation Research Part A 46 (2012) 310–321

Contents lists available at SciVerse ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Labour market effects in assessing the costs and benefits of road pricing ☆

D.P. McArthur [a,*], I. Thorsen [a], J. Ubøe [b]

[a] Stord/Haugesund University College, Bjørnsonsgate 45, 5528 Haugesund, Norway
[b] NHH Norwegian School of Economics, Helleveien 30, 5045 Bergen, Norway

ARTICLE INFO

Article history:
Received 1 December 2009
Received in revised form 9 September 2011
Accepted 11 October 2011

Keywords:
Labour market mobility
Congestion
Transport infrastructure
Road pricing

ABSTRACT

Traffic congestion and the policies used to combat it have been studied extensively. One area which has received less attention is the secondary impacts of such policies. This paper uses a micro-simulation framework to study the effect on labour markets of road pricing. The key benefit of our chosen methodology is that it allows a simultaneous consideration of both commuting and migration decisions. We show that while welfare gains can be achieved through optimal charging, this may come at the price of decreased integration. This may manifest through either greater centralisation tendencies in population, or through unemployment disparities between regions.

1. Introduction

With the global growth in car use, infrastructure is becoming an increasingly scarce commodity. For example, Schrank et al. (2010) of the Texas Transportation Institute estimated that the annual cost of congestion to the US economy in 2009 was around US$115 bn. This presents a significant challenge to policy makers. A number of options are available. Supply can be increased, although this can be costly and may induce fresh demand (Small and Verhoef, 2007, p.176), or demand can be managed. The introduction of full marginal cost road pricing is one way to reduce demand. The principal is well understood theoretically and has been studied extensively empirically (Winston and Langer, 2006).

The problem of traffic congestion has many dimensions. Policy makers must consider distributional, environmental, efficiency and political factors. All of these aspects have received attention in the literature. However, one area which is usually neglected is the effect on the labour market. Transport infrastructure and policy can have serious effects on flows of commuters, migrants and on the distribution of unemployment. For example, in a study of highway investment Winston and Langer (2006) choose to ignore what they call 'second order effects', by which they mean labour market outcomes. Eliasson (2009) conducts a cost benefit analysis of congestion charging in Sweden but makes no reference to labour market effects. Graham and Glaister (2006) consider the spatial impacts of congestion pricing but also neglect the implications for regional disparities.

The reason for the lack of attention given to labour markets by the road pricing literature is not lack of importance, but rather difficulties in modelling and quantifying labour market outcomes. This paper considers what happens to commuters when they are priced off the road by the introduction of a congestion toll, people who might be termed 'displaced commuters'. An individual's response will be determined, at least in part, by labour market conditions and will, in turn, affect the labour market outcome observed. To model this, simultaneous consideration must be given to labour market participation, migration and commuting decisions. Such models quickly become intractable within an analytical framework.

☆ This research is a part of the Research Programme 182639/V10 which is financially supported by The Research Council of Norway.
* Corresponding author.
E-mail addresses: david.mcarthur@hsh.no (D.P. McArthur), inge.thorsen@hsh.no (I. Thorsen), jan.uboe@nhh.no (J. Ubøe).

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doi:10.1016/j.tra.2011.10.001

This paper will adopt a micro-simulation approach to modelling the actions of displaced commuters. A scenario where two towns or regions are linked by infrastructure which suffers from congestion will be considered. This can be thought of as a single road or a road network which suffers from a bottleneck. It would also correspond to a situation where towns are linked by a bridge or tunnel. Demand for commuting on this infrastructure will increase due to an exogenous shock which changes the spatial distribution of employment opportunities. This could represent a process of sub-urbanisation or of jobs being relocated from rural to urban areas. The actions of commuters who are priced off the road can then be examined and some insight gained as to how these actions affect aggregate social welfare.

In looking at the actions of these commuters, the effect of different policy options on the distribution of the population and unemployed workers will be considered. Although it is hard to place a value on such disparities, they are of policy interest. As a congestion charge actively relies on creating some kind of disparity by reducing the accessibility of the regions affected by the shock, it would seem that a goal of eliminating regional disparities may be, at least to some degree, incongruous with road pricing.

The paper is structured as follows. Section 2 outlines some of the relevant literature. Section 3 gives a summary of the micro-simulation model which is used to generate the results presented in Section 4. Section 5 will discuss possible policy options. One of the options considered is investment in new transport infrastructure. The model will be used to explore the effects of this on the labour market adjustment process. The effect of different financing options will also be explored. Section 6 closes with some concluding remarks.

2. The literature

We begin by reviewing the standard economic theory of optimal pricing (see Rouwendal and Verhoef (2006) for a review). This will also determine how we model congestion and road pricing in our micro-simulation model. One common form of a time-independent congestion model (Button and Hensher, 2001) is a speed–density relationship. The form presented here can be found in Noland (1997, p. 383):

$$T_{ij} = d_{ij} * \left[T_0 + T_1 \left(\frac{F_{ij}}{\omega} \right)^{\varepsilon} \right] \tag{1}$$

where T_{ij} is the total time taken to make the journey from i to j, T_0 is the time taken to travel 1 km when there is no congestion, T_1 and ε measure how quickly the journey time rises as the ratio of traffic volume to capacity changes, F_{ij} is the flow of commuters from i to j, and ω is the designed capacity of the infrastructure. Castillo and Benitez (1995) provide a discussion of the history of the speed–density relationship as well as the various functional forms which have been used.

An individual facing such a situation will, in principle, be willing to commute so long as the cost of commuting is lower than the wage rate i.e. so long as $\eta T_{ij} < W$ where W is the wage and η is the implied wage rate per minute. This is optimal from the individual's perspective but not from society's. The marginal social cost of a commuting journey is given by:

$$F_{ij} \frac{\partial T_{ij}}{\partial F_{ij}} = F_{ij} T_1 \varepsilon \eta \left[\frac{(F_{ij}/\omega)^{(\varepsilon-1)}}{\omega} \right] \tag{2}$$

For a socially optimal outcome, commuting should increase until $F_{ij} \frac{\partial T_{ij}}{\partial F_{ij}}$ is equal to the wage rate. This can be achieved by imposing a toll equal to the marginal social cost given in Eq. (2). It is clear there are some commuters for whom the marginal social cost is greater than the marginal benefit. Pricing these commuters off the road will lead to a benefit if and only if the wage rate represents the total marginal social benefit and Eq. (2) represents the total marginal social cost. There are reasons why this might not be the case.

In order to understand if a seemingly optimal charge will be optimal, we must consider the way in which it interacts with other distortions in the economy. Such interactions are the reason why a seemingly optimal charge may in fact be suboptimal. Parry and Bento (2001) provide a review of studies looking at such issues. These issues include congestion on unpriced routes (Liu and McDonald, 1998; Verhoef et al., 1996), accident rates (Newbery, 1988), pollution externalities (Small and Kazimi, 1995), public transport subsidies (Glaister and Lewis, 1997), and petrol taxes.

Parry and Bento (2001) extend this literature by looking at how distortions in markets other than the transport market affect the welfare gains from congestion charging. More recent studies include Larsen et al. (2004), who use a numerical simulation model to show that when moving taxes are present, the 'naive' optimal toll lies substantially below the true optimum. De Borger (2009) shows how transport taxation can interact with wages in a wage bargaining model, and how congestion charges can reduce employment by increasing union wage demands. De Borger and Wuyts (2009) examine the interaction between congestion charging and parking subsidies. They found that the presence of parking subsidies increased the welfare gain from the introduction of a charge.

A related issue, and one considered in this current work, is how the revenue raised from road pricing is used. Parry and Bento (2001) provide a review of the literature related to 'revenue recycling'. In their model, they find that lump sum transfers are not the best way to return the revenue to the economy and that it should instead be used to reduce other distortionary taxes in the economy. For instance, a reduction in taxes on labour will increase the labour supply. They found that under certain assumptions, this can double the welfare gain from a congestion charge.