Estimating the marginal maintenance cost of rail infrastructure usage in Sweden; does more data make a difference?

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ABSTRACT
This paper updates knowledge about the marginal cost of railway maintenance. Using a panel dataset comprising 16 years, we test whether more data makes a difference to conclusions. In contrast to previous estimates using a shorter panel, maintenance costs are now demonstrated to exhibit a positive dynamic effect; an increase in maintenance cost during one year indicates the need for more maintenance also the next year. Moreover, the marginal cost from the dynamic model is larger than its static counterpart. We conclude that the use of dynamic models on longer time series may have charging implications in several EU member states, considering that their track access charges are based on econometric studies that use static models and short panel datasets.

1. Introduction

The way in which railway infrastructure maintenance is affected by variations in train traffic comprises one component of the social marginal costs for using railways. The policy relevance of this relationship was formally established after the vertical separation of infrastructure management and train operations, introduced by the European Union in 1991 (Dir. 91/440). This directive required the introduction of track access charges. The charging principles of infrastructure use was further specified when Dir. 2001/14 established that track access charges should be based on the direct cost of running a vehicle on the tracks. This means that train operators (inter alia) should be charged for the impact of traffic on infrastructure maintenance.

Except for that the level of marginal cost of track use is a platform for EU’s infrastructure policy, the marginal cost pricing paradigm is also one of the pillars of a policy for efficient use of societies’ resources. Against this background, the purpose of this paper is to present new empirical evidence on the marginal cost for rail infrastructure maintenance, using more data than the existing literature.

Previous research has used different approaches for estimating the cost incurred by running one extra vehicle or vehicle ton on the tracks. There are examples of so-called bottom-up approaches that use engineering models to estimate track damage caused by traffic (see Booz Allen Hamilton, 2005; Oberg et al., 2007). Starting with Johansson and Nilsson (2004), most studies have, however, used econometric techniques to estimate the relationship between costs and traffic; this is referred to as a top-down approach. This line of research first estimates the cost elasticity with respect to traffic and then uses the average maintenance cost; the marginal cost is the product of these two components.

A survey of econometric rail cost studies made in Link et al. (2008) report cost elasticities in the interval 0.13–0.38. Cost elasticities between 0.2 and 0.45 are recommended by Wheat et al. (2009), based on research from several European countries. More recent evidence is provided in Wheat et al. (2015), where for example the Swiss case study have access to a panel data set comprising 10 years and reports elasticities at about 0.5. However, this value is not directly comparable to the other results since it includes a renewal cost component. Table 1 lists some results of previous studies on Swedish data which is the most direct benchmark for our analysis. It is obvious that these elasticities are within the overall range of cited observations for Europe.

Estimating a dynamic model to analyze rail infrastructure costs is rare, Andersson (2008) being one exception. He uses a difference

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Previous estimates on the marginal maintenance cost of rail infrastructure usage in Sweden.

<table>
<thead>
<tr>
<th>Model</th>
<th>Output variable</th>
<th>Cost elasticity</th>
<th>$\text{MC}^{2014}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johansson and Nilsson (2004)</td>
<td>Pooled OLS Gross ton</td>
<td>0.17</td>
<td>0.0012</td>
</tr>
<tr>
<td>Andersson (2006)</td>
<td>Pooled OLS Gross ton</td>
<td>0.21</td>
<td>0.0031</td>
</tr>
<tr>
<td>Andersson (2007)</td>
<td>Fixed Gross ton</td>
<td>0.27</td>
<td>0.0073</td>
</tr>
<tr>
<td>Andersson (2008)</td>
<td>Fixed Gross ton</td>
<td>0.26</td>
<td>0.0070</td>
</tr>
<tr>
<td></td>
<td>Effects GMM</td>
<td>0.26</td>
<td>0.0070</td>
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<tr>
<td></td>
<td>Difference Gross ton</td>
<td>0.34$^5$</td>
<td>0.0092$^5$</td>
</tr>
<tr>
<td></td>
<td>Box-Cox Freight gross ton</td>
<td>0.05</td>
<td>0.0014</td>
</tr>
<tr>
<td></td>
<td>Passenger gross ton</td>
<td>0.18</td>
<td>0.0108</td>
</tr>
</tbody>
</table>

1 Marginal cost.
2 Inflation adjusted using the Swedish consumer price index, $S$—short run, $L$—long-run.

2 The result in Eq. (1) assumes that $\frac{\partial C}{\partial \text{GTKM}} = 0$, i.e. an extra ton that runs on a track section will not change the length of that section. More explicitly, we consider $C = f(\text{GT} \cdot \text{KM})$, and $\frac{\partial C}{\partial \text{GTKM}} = f(\text{KM})$. If $\frac{\partial C}{\partial \text{GTKM}} = 0$, we have $\frac{\partial C}{\partial \text{GTKM}} = f(\text{KM})$, which implies that $\frac{\partial C}{\partial \text{GTKM}} = 0$. Note also that an interaction term between GT and track length can be added in the model estimation to allow for the cost elasticity with respect to GT to vary with track length.

3 As indicated in the introduction, $\text{GTKM}$ may also include spending on renewals. Since track sections often have zero resources spent on renewal, and there is a possible interdependence between the cost categories, adding renewals to maintenance does not contribute to our understanding of the latter cost category and its own (possible) dynamics.
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