Beyond the road: Modeling approaches to assess the impacts of large transport infrastructure

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1 Introduction

In the UK, the intensive use of transport networks has led to severe congestion and increased investments in infrastructure, including the HS2 project. This surge underscores the need to thoroughly investigate how transport infrastructure shapes economic outcomes. Traditionally, most governments have relied on cost–benefit analysis (CBA) for transport appraisal which measures travel-related costs and benefits but fails to account for indirect effects such as relocation and agglomeration [9, 6]. These indirect effects named Wider Economic Impacts (WEI) can exceed 20% of total benefits [12] and have attracted growing attention [2, 13, 5]. Recognizing these challenges, the UK Department for Transport (DfT) has proposed supplementary approaches for the evaluation of Wider Economic Impacts (WEI), such as Land Use and Transport Interaction (LUTI) models and Quantitative Spatial Economics (QSE) models [7]. The LUTI model adopts a geographical perspective, focusing on the simulation of spatial and behavioral dynamics, whereas the QSE model is rooted in economics and simulates market behavior. Although both models aim to assess similar outcomes, they rely on distinct mechanisms and theoretical foundations, and systematic comparisons of their results and applicability remain rare.

Therefore, in this study we apply both LUTI and QSE models to the same case study of transport infrastructure in the UK, with the aim of assessing their feasibility, complexity, and transferability for practical policy applications. At the same time, we extend both models to better capture local context and to address some of their original limitations. Specifically, the LUTI model is disaggregated by industry groups, while the QSE model is enhanced through a more detailed representation of travel behavior, incorporating transport model and transport competition behaviour. The findings are intended to provide government with a clearer evidence base and strategic guidance for shaping future approaches to transport appraisal and decision-making.

2 Methodology

2.1 Case Study

The case study area of this study is Cambridge-Milton Keynes-Oxford (CaMKOx) corridor (Figure 1), which is the region envisions becoming a global knowledge-intensive cluster but faces the challenges of poor transport connectivity and housing supply [3]. To address these issues, the National Infrastructure Commission has recommended completing the East West Railway (EWR) (Figure 2) connecting Oxford and Cambridge by 2030 [11]. Therefore, we will thoroughly examine the potential impacts of this transport infrastructure, offering the government clearer insights for more informed decision-making.



Figure 1: The Location of CaMKOx Corridor

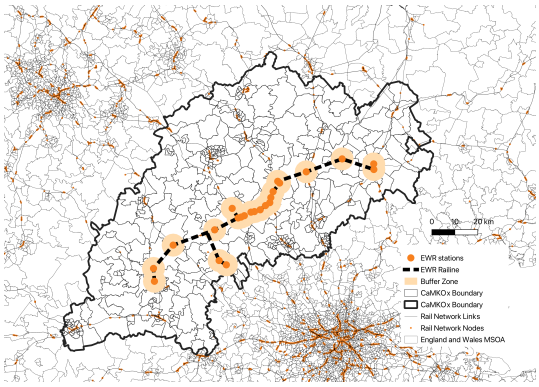


Figure 2: The Plan of East West Railway

2.2 Coupled LUTI Model

We employed a spatial interaction model based on a coupled LUTI gravity model, which achieves equilibrium through two singly constrained submodels—a rarely used but more flexible approach than traditional gravity models. This design allows interdependent variables to adjust dynamically, offering a more nuanced simulation of land use and transportation interactions [4]. While it captures population and employment reallocation across industries, along with agglomeration effects, it does not account for broader economic shifts such as housing prices, wage dynamics, or welfare impacts.

2.3 QSE Model with Integrated Transport Behaviour

To address these factors, we incorporated a Quantitative Spatial Economics (QSE) model to enable a more comprehensive appraisal. Informed by recent theoretical advances [1, 10, 8], we implement a basic QSE model and extend it by introducing competing transport modes into the structural gravity framework, as well as integrating a transport model with QSE for the scenario outputs in the CaMKOx region with a setting of open economy system.

3 Initial Results

3.1 Coupled LUTI Model

Results show notable shifts in population and employment, moving from the northern/western to the southern/eastern CaMKOx corridor and from peripheral zones toward the central EWR area (Figures 3 and 4). This effect is most evident around Milton Keynes, where a dense station network is expected to boost accessibility. Besides, the EWR significantly enhances agglomeration effects in the CaMKOx corridor, particularly benefiting the other industry like education, services etc (Figure 5). For retail and office sectors, the greatest increase in agglomeration effects is observed around Cambridge, at the terminal stations of EWR, likely influenced by the existing workforce distribution in the area. Meanwhile, industrial and other industry agglomeration effects intensify the most around Milton Keynes, near the central section of the EWR and also some northern parts in CaMKOx.

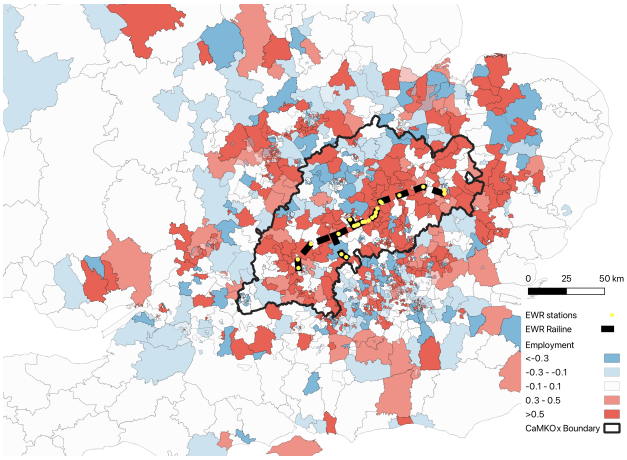


Figure 3: Employment change after expansion

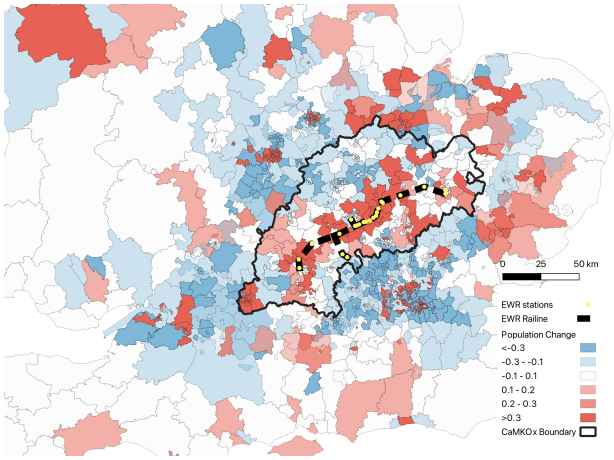
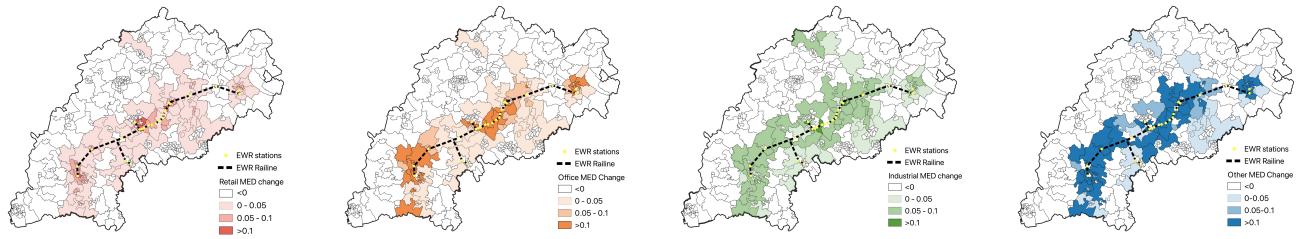


Figure 4: Population change after expansion



(a) Retail (b) Office (c) Industrial (d) Services

Figure 5: MED values across different industries after EWR construction

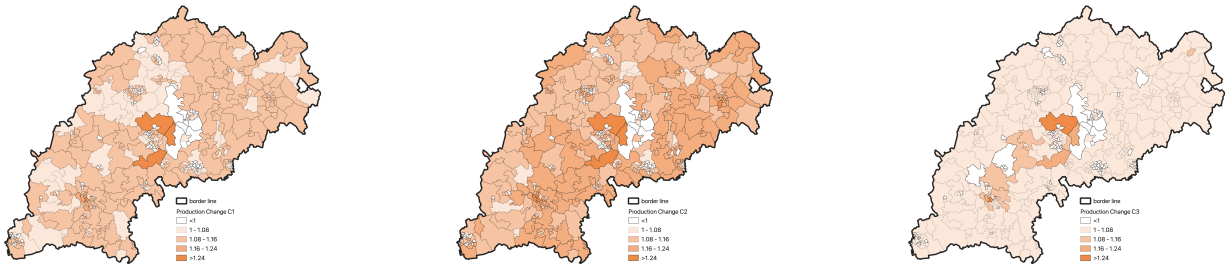
3.2 QSE Model with Integrated Transport Behaviour

We design four scenario settings to test the impacts of the East West Railway impacts to the region. C0 represents the baseline model, serving as the reference case. C1 captures real-world conditions derived from transport models. C2 introduces a high-frequency service scenario, while C3 reflects a low-frequency service scenario. Together, these settings allow for systematic comparison of baseline outcomes with alternative transport configurations under varying service assumptions. The general results indicate that, compared with the current planned train frequency, even a modest increase in service frequency could generate substantial economic benefits for the region, while also helping to mitigate inequality by

improving accessibility in peripheral areas (Figure 6 and Figure 7).

Description	c0	c1	c2	c3
Change in production	1.0	1.085324	1.149531	1.036836
Change in overall land rents	1.0	1.023978	1.038587	1.012935
Average floor space prices	1.0	1.001791	1.002528	1.001182
Average net wages	1.0	0.993364	0.992133	0.995107
Total floor space	1.0	1.015753	1.026377	1.007647

Figure 6: Summary table of QSE results



(a) C1: Production Change (b) C2: Production Change (c) C3: Production Change

Figure 7: Production change in CaMKOx for three scenarios.

4 Conclusion

This study applies both LUTI and QSE models, extending their mechanisms and implementing them in a UK case study. Further analyses and results, beyond the scope of this abstract, will be presented and discussed in the oral presentation if accepted.

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The opinions expressed in this abstract are the author's own and do not reflect the views of the DfT or East West Railway Company.

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