1 INTRODUCTION

1.1 Context

This paper is concerned with some recent developments in the design and application of land-use/transport interaction (LUTI) models, particularly as illustrated in the work carried out by the author and colleagues for Leicestershire County Council and Leicester City Council in the development and use of the latest version of the Leicester and Leicestershire Integrated Transport Model (LLITM2014).

LUTI models are forecasting systems which combine land-use and transport modelling in such a way that

- future land-uses determine (most of) the demands for transport – in particular by defining where residents will live, and where jobs and services will be located
- the future performance of the transport system – given those demands – influences (some aspects of) future land-uses, not only in terms of changes to the physical use of land but more importantly in terms of where households and firms locate.

The way in which land-use and transport interact in forecasting can vary, with some models iterating land-use and transport forecasts to equilibrium in a given year (just as transport demand and supply are more commonly iterated to equilibrium); but the most common approach is the “time-marching” framework in which land-use change is modelled over time, gradually responding to changes in transport, and transport is modelled as responding to the land-use pattern at particular points in time.

Figure 1 below illustrates the interactions of the land-use and transport model in a time marching sequence.
The objective in using LUTI models, as with stand-alone transport models, is of course not just to make forecasts of what will happen in future, but to test how those forecasts respond to different assumptions or plans. This is illustrated in figure 2 below which shows

- across the middle of the diagram, the model itself, with the interaction of land-use and transport now shown as a loop (in practice, it works in the time-marching sequence just mentioned)
- entering the model from above, “top-down” economic and demographic scenarios which define the overall context for the model (and may in some cases be modified by the model response to policy inputs)
- entering the model from below, “bottom-up” planning and transport interventions which need to be tested. (In practice these may include economic development or regeneration measures, as well as those which are strictly “planning” interventions; all of the interventions can in general involve investment, regulation or pricing (e.g. taxation), either singly or in combination.
Individual schemes or programmes of investment and other interventions are therefore tested by running the model first to produce a “reference case” or “do-minimum” without those interventions; then running the model with “do-something” inputs; and comparing the results. Different ways of running these models were discussed in the presentation by Tom Simpson to TPM 2016 (Bosredon et al, 2016).

**1.2 Purpose**

The use of Land-use and Transport interactive (LUTI) model results in the formal appraisal of transport schemes has changed over time and continues to evolve. During the 1990s, if LUTI models were used at all, their output was used to inform discussion of whether the LUTI feedbacks would support other policies (for example, for the regeneration of inner cities) and of whether they would give rise to negative or positive feedbacks.

From around 2000, following the responses to the 1999 SACTRA report on *Transport and the economy*, this was formalised in terms of assessing impacts on regeneration areas (in England) and of “economic activity and location impacts” (EALIs) in Scotland. In the further follow-up to SACTRA that resulted in the 2005 draft guidance on wider economic benefits (WEBs), there was a further role for LUTI models to contribute to estimating “move to more productive job” effects – the one part of WEBs which required forecasts of land-use (employment) change. In both cases there was an expectation that total employment in the modelled area would not change, i.e. that the LUTI model used would redistribute a given total of employment in each sector, but would not change the number of jobs or their mixture across sectors. This ignored some significant developments in LUTI modelling, to which we return below.

In the present (draft) WebTAG guidance, the role of land-use change in the economic (value for money) analysis remains limited, in most cases, to estimating the productivity effects of changes in job location, though LUTI modelling is now referred to as one of the potential forms of “supplementary economic modelling” which might produce those estimates. Other aspects of analysis may however appear in the strategic case; in
addition, whilst WebTAG is still written almost exclusively in terms of assessing net national benefits, the key review behind the latest version of WebTAG, the recent report on *Transport Investment and Economic Performance* (Venables, Laird and Overman, 2014) emphasises that the spatial impacts of transport investment are a significant and genuine issue in decision-making, particularly of course for local decision-makers.

Another issue around appraisal is that WebTAG (and government appraisal guidance in general, i.e. the Treasury “Green Book”) sets out to measure benefits in “economic welfare” terms, that is, including not only costs and benefits which individuals, firms or government experience in money terms, but also all the other costs and benefits to which it is possible to attach money values – including, of course, time savings in leisure travel, and reductions in carbon emissions. There is however an argument (see for example Volterra Partners, 2014) that transport scheme appraisal should be more focussed, or exclusively about, cost and benefits in “the real economy”, i.e. those that result in real money costs or benefits. In this context, benefits in terms of changes in Gross Value Added (GVA, mainly wages and firms’ profits) are highly important. GVA is also a key metric in economic development planning and the works of the Local and Strategic Economic Partnerships. In so far as transport planning is intended to integrate with LEP/SEP objectives, the assessment of local GVA impacts is an essential part of transport appraisal, even if it does not feature in the main “value of money” analysis.

1.3 Structure

Given this context, this paper is therefore structured in terms of
- a description of the LLITM2014 model, with particular reference to the model mechanisms that are most important to the GVA calculations,
- an outline of the method used in the GVA calculations themselves, and
- some example results based upon analysis carried out using LLITM2014.

2 DESCRIPTION OF THE LLITM2014 MODEL

2.1 Overview

The LLITM2014 land-use model is an application of the DELTA land-use/economic modelling package. This is run in conjunction with the LLITM2014 transport model, which itself is an EMME application developed and maintained by AECOM. The modelling approach follows the tradition of dynamic land-use/transport interaction (LUTI) modelling, i.e. modelling which forecasts in steps through time, and where the central feature of the modelling is to forecast the changing location of households and employment. LLITM2014 forecasts change in land-use and all the activities that occupy that land-use across the model area. The Fully Modelled Area includes the Leicester and Leicestershire and other surrounding districts.
This model will serve as a tool to aid the preparation of business cases for new potential schemes and also be used in assessing the impacts of major developments. It can be used to inform the process of scheme prioritisation.

2.2 Geographic structure – Model zone system

The LLITM2014 has a Fully Modelled Area (FMA) that covers the Midlands extending north to Newark and Sherwood and downside to Daventry. The boundary stretches from the west around Tamworth and Lichfield right to the Peterborough area in the east. This follows the convention that the modelled area in land-use modelling should be significantly larger than the “study area” within which policies are to be tested, so as to allow for policies to induce households and jobs to move into (or out of) the “study area” in response to policies and their consequences.

There are 1347 zones which are more detailed in the Leicester and Leicestershire area and becomes wider as you move towards the outer boundary. This Fully Modelled Area is surrounded by a Buffer Area of larger zones and less detailed modelling. The rest of Great Britain is treated as a set of External Zones.

The figure below shows the geographic boundaries of the Model area.
2.3 Base land-use data

The model starts from the base year 2014 database and forecasts a new database containing the same variables, at the same level of detail, for each future year. There can be long time-lags within the model dynamics, but after the first few years, most of the data inputs to the model are themselves the forecasts produced for earlier years.

The base year database was created using the 2011 Census data for the households, population and employment and the Valuation office data for other variables including commercial floor and rents. This was then rolled forward to 2014 using the more limited data available for the subsequent years.
2.4 **Transport data**

The transport data in terms of generalised costs of travel for all origin and destination zone pairs consists of matrices of generalised costs by mode and purpose, for the base year 2014 and for the 8 model forecast years from 2016 at 5 year intervals.

2.5 **Planning policy inputs**

Planning policy inputs describe the scale and distribution of future planned development. These are typically locally sourced inputs from the relevant planning authorities. These inputs constrain development processes within the model and subsequently influence location of households and firms.

2.6 **The model components**

For the purposes of this paper, a selected few of the Model components that are relevant to the inputs for calculating GVA are described briefly in the following sections.

The accessibility component takes the most recent generalised costs supplied by the transport model and the most current pattern of land-uses and calculates measures of accessibility for each activity. These measure how difficult it is (in generalised cost units) for households to reach the range of destinations they are likely to require, or for businesses to be reached by the range of people and firms (workers, suppliers, clients) who are likely need to reach them.

The development model used for LLITM2014 has been made up of two components,

- Floorspace development model used to forecasts change in residential and non-commercial space categories (*education and health*)
- Land development model used to forecast change in commercial space. (*office, retail, warehouse, Industry, leisure and distribution*).

The development component, which is the first sub model in any new year, is different for residential and employment land-uses. In residential development, the three main components of change are demolitions, exogenous developments (developments which will happen or are input for the purpose of what-if tests, specified by the user), and permissible development - development forecast by the model as occurring in response to the economic conditions, within the limits of the input planning policy measures. Land Development Model\(^{10}\) is a model of developers’ choices of how much to invest, in what types of development built in what forms, in which zones.

The investment component is used in LLITM2014 land-use model to implement the economic scenario. The economic scenario has been calibrated such the employment by sector at the regional level is consistent with the TEMPRO7.2 projections. The investment model forecast capacities that drive the growth or decline of employment by sector in response to changes in wider accessibility and rents and also changes to local incomes and population demands.

The income component calculates expected incomes based on household type and the previous number of workers per household, for each household type in each zone. The
incomes calculated are estimates of net household incomes after tax, National Insurance and money benefits.

The car ownership component forecasts the proportions of households of each type, in each zone, which will own a car or cars. Growth in real incomes is usually the main driver of growth in car ownership, but other variables are also considered; in a no-growth situation, growth in car ownership may stop or decline.

The household location component assigns mobile households to zones. The key influences on location choice are availability of housing, cost of location, accessibility, housing quality, and environment. The cost of location is determined mainly by the rent in each zone, which the household location component adjusts to balance supply and demand, up to a certain equilibrium point.

The employment location model is similar to the household location model. It assigns employment (jobs) to zones, and forecasts the changes in the rent and occupancy of employment floorspace. The key influences on location choice are accessibility, availability of commercial floorspace and the cost of location.

The employment status component has three main functions. It calculates the forecast employment and categorises these into the applicable socio-economic level. The adjustment of labour supply to meet labour demand is worked out in this component. The other non-adult working age groups (children and retired) are also computed at this stage of the model. Based on all of these newly forecast activities, newly estimated travel to work matrices are derived.

The processes described above, in one way or the other, influence each other to produce a set of forecast planning data on numbers of households and people that live in these households and their car ownership and economic status. Future forecasts of jobs and where they are located are also an output from the model.

3 GVA CALCULATIONS

3.1 Approach

The approach taken for GVA calculation in LLITM2014 is that the GVA measure is based on changes in jobs multiplied by GVA per job (or simply wages per job if GVA per job is not available), adjusted for changes in productivity plus savings in transport costs.

As is usual in transport appraisal (but less usual in other fields), changes will be assessed for each Alternative scheme or package relative to a Base Case. The “changes in jobs” mentioned above will therefore be the number of jobs in Leicester and Leicestershire in a given year of the Alternative forecast compared with the equivalent number in the same year of the Base Case forecast. The change in jobs is disaggregated by sector (activity, in LLITM2014 terms).
LLITM2014 model can both relocate jobs from adjoining regions into Leicester and Leicestershire, or vice versa, and it can forecast higher (or lower) employment growth overall, and these impacts may vary by sector. The impacts of a scheme being assessed are forecast as a stream of impacts over time, not just as a single year value. The changes in jobs going into the GVA calculation are therefore sets of numbers, not just a single value.

Changes in productivity per job will stem from agglomeration effects (using the DfT methodology) and changes in transport costs accruing directly to Leicester and Leicestershire businesses (ie the costs, including staff time, of business travel and goods deliveries).

The agglomeration effects are applied as changes in earnings per job, but for all jobs, not just for the gains or losses resulting from the scheme being assessed.

The approach adopted in taking account of the transport cost savings from the intervention is simply to take the net saving in such costs accruing to Leicester and Leicestershire businesses and adding them to the total GVA gain resulting from changes in jobs and in agglomeration. This approach applies the cost savings per trip (for business travel and for goods movement) multiplied by the numbers of trips in the reference case.

Note that if a package of investments is effective in attracting additional economic activity (and hence attracting/retaining additional population) relative to the Base Case, then the extra activity and people (and income effects such as increased car ownership) are likely to generate additional congestion. This will become apparent if LLITM2014 is run in full (ie land-use and transport models combined). It is therefore quite possible that the GVA appraisal of such a package will show initial gains from reduced transport costs, followed by gains due to additional jobs that increase over time, offset by decreasing gains (and conceivably losses) due to worsening congestion. The inclusion of such feedback effects may reduce the apparent benefits but it is, we believe, the correct way to carry out such appraisals. It makes the analysis proof against the criticism that we are double-counting transport and economic benefits.

3.2 Implementation

The overall scheme for implementation of the required calculations is shown in Figure 4.

The top block of the diagram shows the various groups of outputs from LLITM2014 – outputs for each forecast year from the land-use/economic model (implemented in DELTA) and for each transport model forecast year from the transport model (implemented in EMME) (only a couple of years of the sequence are shown).

The middle block shows the required processing.

On the DELTA side (red outlines), changes in productivity due to changes in agglomeration have to be calculated for each year. Note that this uses transport cost data already incorporated into the DELTA application from the transport model. These changes are calculated in two steps: first the changes in agglomeration (based on measures of effective density), then the actual changes in productivity. These calculations are further described in sections below.
In parallel, on the transport model side (blue outline), the changes in transport costs are calculated for each transport model year.

These results, and the original DELTA forecasts of employment change, then go into a “GVA appraisal” tool which combines the different types of results for multiple years, and assembles the results into different components of GVA change for each forecast year and for chosen groups of zones (e.g. for the whole of Leicester and Leicestershire or for its component local authorities).

The Net Present Value NPV of the stream of GVA impacts can be worked out in relation to the cost of a scheme if the objective is to get a measure of GVA gained per £ spent. This is useful in scheme prioritisation or competitive fund bidding processes for different schemes or packages of schemes.

### 3.3 Productivity changes due to agglomeration effects

Agglomeration effects are those which arise from concentrations of economic activities and of the workers performing those activities. Three different mechanisms are usually identified which contribute to these effects:

- concentrations of jobs and workers with good transport links increase the probability that employers can find the best worker for each job, and that each worker can find the job which is most appropriate to his or her abilities (the labour market effect);
- similarly, concentrations of activities increase the probability that firms can find competitive suppliers who provide exactly the inputs they need (for example, to...
supply components, or to maintain specialised manufacturing equipment), and that specialist suppliers can find customers (the supplier market effect);

- concentration of activities also enhances productivity through the informal exchange of knowledge and information outside market relationships – for example by the exchange of ideas between people in different lines of business who can all take advantage of developments in information technologies.

The importance of such effects within particular clusters of particular industries has long been recognized. More recent research has put more emphasis on the value of concentrations of economic activity in general, and not just of particular industries.

A method for calculating the economic value of agglomeration effects due to more effective concentration of activities was introduced by DfT in 2005. “More effective concentration” can come about either through improvements in transport providing better linkages between activities, or through changes in the locations of jobs bringing them closer together. The approach to calculating productivity changes due to agglomeration effects in the present project is to use the DfT method to calculate changes in productivity per job for the four broad sectors in which the DfT’s research has found agglomeration effects, ie manufacturing, construction, producer services and consumer services; to apply those relative changes in productivity to base case assumptions on GVA/job.

The DfT method forecasts that productivity changes as a function of changes in “effective density”. The DfT measure of “effective density” is in effect a measure of accessibility to jobs. Employment density is calculated as the sum of jobs in the destination zone $j$ weighted by the generalised cost of travel to those zones from the origin zone $i$ for which the effective density is being calculated. The generalised cost of travel is adjusted by a decay function defined by DfT for the employment sector.

This is done for the Base and Alternative cases, and the results are used to calculate the Alternative case level of productivity (increase in GVA/job) using the assumption that the GVA per job for any of the DfT sectors in a zone $i$ in the Base Case is proportional to the corresponding effective density for that sector in that zone. The GVA per job in DfT sector $r$ in zone $i$ in the alternative case is therefore the ratio of the Alternative effective density to the Base case effective density multiplied by the GVA per job in DfT sector $r$ in the Base case.

These calculations which are run using the usual DELTA programs give us the change in productivity by sector. For LLITM2014 purposes, these calculations are run at the level of the four DfT-defined sectors, but the results are applied to all the corresponding employment activities and to each of the socio-economic levels of workers within those activities.

The GVA calculations for LLITM2014 are based on the assumption that in the Base Case, productivity will be spatially uniform across Leicester and Leicestershire for workers of each socio-economic level in each individual employment activity. Spatial differences in productivity within each SEL and activity will therefore arise solely from the agglomeration effects considered here. The Base Case values of productivity by industry for Leicester and Leicestershire have been taken from 2016 Experian Economic forecasts,
and the SEL (socio-economic level) differentials from the LLITM2014 calibration. The calculation required in the GVA appraisal for a given Alternative (i.e. a scheme or package) is then to adjust those Base values, in each zone, industry and SEL, in line with the agglomeration effects estimated using the DfT method described above.

3.4 Transport cost savings

The transport cost saving calculations are a standard rule-of-a-half calculation for each zone pair, mode, vehicle type and time of day, applied to the generalized cost in money units. Only business cars (home- and non-home-based) and goods vehicles are considered. All other purposes are ignored in these calculations.

The use of generalised cost implies that we are counting time savings as well as money savings. This has been adopted for consistency with standard TEE appraisal and hence on the argument that saving business travel time is a real gain to the economy.

3.5 GVA Appraisal

The GVA appraisal tool reads the numbers of jobs by sector and socio-economic level for each year of the Base and Alternative cases and works out the changes in jobs. It also reads the GVA/per job by sector in the base and alternative cases. The transport cost savings calculated by the transport model are also read.

Using these it calculates

- change in GVA due to changes in number/mix of jobs (GVA/job unchanged);
- change in GVA due to productivity changes (number/mix of jobs unchanged);
- change of GVA due to combined changes in number, mix and productivity of jobs

The change in GVA due to changes in number/mix of jobs is worked out as the overall sum of change in employment due to the intervention multiplied by the corresponding Base case GVA per job across all the sectors and zones.

The change in GVA due to productivity changes is worked out as the overall sum of the change in GVA per job due to the intervention multiplied by the employment by sector in the alternative case.

The change in GVA due to combined changes in number, mix and productivity of jobs is the change in total GVA by sector across all the zones.

The total change in GVA due to job and productivity changes plus transport cost savings is the combined GVA benefit accruing from the transport intervention.

Transport cost savings are provided from the transport model for the transport years. The periods in between the transport years are extrapolated and all these are converted into the right units for the GVA appraisal.
4 DEMONSTRATION TEST

4.1 Introduction
To be able to demonstrate the LLITM2014 model's ability to capture GVA benefits of transport interventions, we have run hypothetical schemes, which includes land-use and transport interventions, and analysed the impacts on the economy using the methodology described in the previous sections.

The land-use component in parts of the Leicestershire county involves providing extra space and the corresponding households and office employment that occupy that space. The transport intervention is an improved connectivity for motorised transportation by way of introducing an extra link to the road network into the south-eastern parts of the County around Harborough.

This exercise looks at the impacts of the scheme on the County and assumes that any extra jobs into this area is a benefit. This eliminates the variable productivity index element which is considered when estimating the wider economic benefits of schemes on the UK wide economy.

In this exercise, we have assumed that there is uniform productivity across the whole of the county so whatever benefits accruing from changes in job locations within the County are solely from agglomeration effects.

4.2 Impacts of scheme on employment
The land-use demonstration policy on its own results in an additional 400 jobs by 2035 in the policy area and a net gain of almost 200 jobs in the County. In the combined transport intervention and land-use test, the impacts on employment is an excess of around 450 jobs in the policy area and about 260 jobs net gain to the county.

Table 1 below shows the impacts of the land-use policy introduced within the model period from 2026 to 2035. This is represented as absolute changes in jobs between the Base case and the Alternative case.

Table 1 Impacts on jobs due to the land-use policy in the Harborough area

<table>
<thead>
<tr>
<th>Districts</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
<th>2031</th>
<th>2032</th>
<th>2033</th>
<th>2034</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blaby</td>
<td>-21</td>
<td>-6</td>
<td>-60</td>
<td>-19</td>
<td>-9</td>
<td>-23</td>
<td>-1</td>
<td>-25</td>
<td>-43</td>
<td>20</td>
</tr>
<tr>
<td>Harborough</td>
<td>168</td>
<td>162</td>
<td>204</td>
<td>248</td>
<td>200</td>
<td>249</td>
<td>286</td>
<td>372</td>
<td>462</td>
<td>402</td>
</tr>
<tr>
<td>Hinckley and Bosworth</td>
<td>-19</td>
<td>-31</td>
<td>23</td>
<td>24</td>
<td>36</td>
<td>-4</td>
<td>54</td>
<td>36</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Melton</td>
<td>-13</td>
<td>-15</td>
<td>-2</td>
<td>8</td>
<td>17</td>
<td>5</td>
<td>-23</td>
<td>-7</td>
<td>6</td>
<td>-9</td>
</tr>
<tr>
<td>North West Leicestershire</td>
<td>-24</td>
<td>1</td>
<td>-1</td>
<td>-6</td>
<td>-37</td>
<td>-5</td>
<td>-29</td>
<td>-61</td>
<td>-96</td>
<td>-15</td>
</tr>
<tr>
<td>Oadby and Wigston</td>
<td>-6</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>16</td>
<td>8</td>
<td>29</td>
<td>21</td>
<td>18</td>
<td>51</td>
</tr>
<tr>
<td>Leicestershire</td>
<td>7</td>
<td>54</td>
<td>66</td>
<td>149</td>
<td>136</td>
<td>149</td>
<td>174</td>
<td>173</td>
<td>170</td>
<td>197</td>
</tr>
</tbody>
</table>
4.3 GVA impacts

The GVA benefits due to the land-use policy in the Harborough area is presented below in table 3 in £/million for the various components of the GVA

Table 3 Impacts on GVA due to the land-use policy in the Harborough area

<table>
<thead>
<tr>
<th>Impact of the Land Use Policy (No Transport intervention)</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit due to change in jobs</td>
<td>0.32</td>
<td>3.24</td>
<td>4.51</td>
<td>10.83</td>
<td>9.66</td>
<td>11.06</td>
</tr>
<tr>
<td>Benefit due to productivity changes</td>
<td>-0.14</td>
<td>-0.14</td>
<td>-0.04</td>
<td>0.12</td>
<td>0.04</td>
<td>0.21</td>
</tr>
<tr>
<td>Combined benefit from change in jobs and productivity changes</td>
<td>0.18</td>
<td>3.10</td>
<td>4.47</td>
<td>10.95</td>
<td>9.69</td>
<td>11.27</td>
</tr>
<tr>
<td>Benefit due to changes in business transport costs</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total Modelled Benefit</td>
<td>0.18</td>
<td>3.10</td>
<td>4.47</td>
<td>10.95</td>
<td>9.69</td>
<td>11.27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact of the Land Use Policy and the Transport Intervention</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit due to change in jobs</td>
<td>0.32</td>
<td>3.92</td>
<td>6.20</td>
<td>13.18</td>
<td>14.38</td>
<td>17.01</td>
</tr>
<tr>
<td>Benefit due to productivity changes</td>
<td>-1.26</td>
<td>-1.12</td>
<td>-0.86</td>
<td>-0.58</td>
<td>-0.70</td>
<td>-0.11</td>
</tr>
<tr>
<td>Combined benefit from change in jobs and productivity changes</td>
<td>-0.93</td>
<td>2.79</td>
<td>5.34</td>
<td>12.60</td>
<td>13.68</td>
<td>16.90</td>
</tr>
<tr>
<td>Benefit due to changes in business transport costs</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Total Modelled Benefit</td>
<td>-0.93</td>
<td>2.79</td>
<td>5.34</td>
<td>12.60</td>
<td>13.68</td>
<td>16.90</td>
</tr>
</tbody>
</table>

The GVA benefits due to the Land policy and improved connectivity to the Harborough area is presented below in table 4 in £/million for the various components of the GVA

Table 4 Impacts on GVA due to the land-use policy and improved connectivity to Harborough area

<table>
<thead>
<tr>
<th>Impact of the Land Use Policy and the Transport Intervention</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit due to change in jobs</td>
<td>19.17</td>
<td>19.75</td>
<td>21.21</td>
<td>18.90</td>
<td>18.90</td>
<td>18.90</td>
</tr>
<tr>
<td>Benefit due to productivity changes</td>
<td>-0.02</td>
<td>0.09</td>
<td>0.04</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
</tr>
<tr>
<td>Combined benefit from change in jobs and productivity changes</td>
<td>19.14</td>
<td>19.85</td>
<td>21.25</td>
<td>18.78</td>
<td>18.78</td>
<td>18.78</td>
</tr>
<tr>
<td>Benefit due to changes in business transport costs</td>
<td>0.002</td>
<td>0.002</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
</tr>
<tr>
<td>Total Modelled Benefit</td>
<td>19.15</td>
<td>19.85</td>
<td>21.25</td>
<td>18.78</td>
<td>18.78</td>
<td>18.78</td>
</tr>
</tbody>
</table>
4.4 Calculating present value

The total modelled benefit is extrapolated so that a 50 year present value of benefits can be calculated. As part of applying discount rates\textsuperscript{vii} to estimate the GVA benefits for all future years, the unmodelled years beyond 2035 have been adjusted for Webtag income growth\textsuperscript{viii}.

The improved connectivity and the Land policy have a 50 year present value benefit to Leicester and Leicestershire of £528.62m.

The land-use policy and improved connectivity scheme have a 50 year combined present value benefit to Leicester and Leicestershire of £341.57m.

Present Value of GVA benefits are at 2010 prices and counted from the implementation year 2026.

5 CONCLUSION

The modelling and appraisal system we have described provides a powerful method of estimating the impacts and economic consequences of local planning and transport policies, both individually and in packages. We believe that this kind of analysis, measuring benefits in the formal (money) economy, will be of increasing importance in future policy appraisal, in addition to more conventional appraisal in economic welfare terms.

One of the merits of using full land-use and transport integrated model outputs for GVA impact calculations is to ensure there is no double counting of benefits due to transport and economic benefits.

6 ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support of Leicestershire County Council for the work described here, and in particular Dr Sonny Tolofari for his guidance throughout the LLITM project. They also acknowledge the input of their colleagues within the project, both at AECOM and at DSC, especially Emma Revill who carried out much of the development of the GVA calculations and Nikos Patias for his work on LLITM2014 implementation. The authors remain responsible for any errors of commission or omission.
REFERENCES


End Notes

1. The original LLITM is described in Revill and Simmonds (2011). A description of work using the very similar FLUTE (Sheffield City Region) model can be found in Revill et al (2014).

2. This Land development model is a new functionality introduced in LLITM2014 and was designed to avoid the user making estimations about proportions of land-use categories that would come out of land allocated for mixed use developments.

3. For the purposes of calculating the alternative GVA/job for LLITM2014 applications, we have assumed that the GVA/job for the DfT sectors are all set to 1. In this way the output GVA/job calculated in the alternative case for DfT sectors is solely due to the relative change in productivity per worker from agglomeration adjusted by DfT decay parameters by sector. The decay parameters adjustments mean that jobs that are very easily reached contribute a lot to “effective density”, and jobs that are difficult to reach contribute little or nothing. The “decay parameter” determines how rapidly jobs become irrelevant to “effective density”. The “decay parameter” is highest for consumer services, and lowest for manufacturing, meaning that in terms of productivity it is important for consumer service jobs to be near (in terms of generalised cost) to other jobs, whilst for manufacturing it is rather less important.

4. All mathematical formulae for the GVA calculations are all available and can be produced on request.

5. Note that in the DELTA-based calculations here, the benefit we measure is the change in total GVA. The transport cost saving is a rule-of-a-half calculation, ie the change in transport cost for a specific journey multiplied by the average of the Base and Alternative trips. The reasoning for this (which needs to be set out more formally) is that any change in GVA is good, whether it is due to changing the number/mix of jobs or the GVA per job; a reduction in total transport costs due to improved transport would be good, a reduction due to reduced demand would not.

6. In standard wider impact calculations, jobs locating from a lower productivity area to a higher productive area represents a gain to the national economy. Likewise when jobs locate from higher productive areas to low productive areas then this is considered as a lose to the economy.

7. The discount rate is taken from The Green Book table 6.1 which suggests a discount rate of 3.5% for years 0 to 30 and a rate of 3% for years 31 to 75.

8. Income growth is taken from the Wider Impacts Economic Dataset (WEBTAG 3.5.14, table “Forecast growth in GDP per workers”).