NeTIRail

Needs Tailored Interoperable Railway Infrastructure

Deliverable D1.5

Wider economic effects intermediate report

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Executive Summary

Task 1.4 (Wider Economic Benefits) in NeTIRail-INFRA is concerned with the development of tools required to estimate the wider economic impacts of the case study rail lines.

Before wider economic impacts can be valued in a cost benefit analysis it is necessary to predict the scale of the impacts on the economy – e.g. in terms of productivity, employment and output. The estimation and valuation of these impacts will form part of the business case for the innovations developed in work packages 2, 3 and 4 and will where possible be incorporated into the decision support tools being developed in WP6.

The purpose of this deliverable is to identify the evaluation studies and the econometric methods to be used in estimating the relationship between historic rail investment and changes in employment. The results from evaluation studies will be used to support the estimation of the wider economic impacts of the case study lines in WP1.

The literature is developed in the context of changes in productivity and output and chosen supporting models for economic output, productivity and the valuation methods for all the economy impacts will be described in the subsequent deliverable associated with this task.

However, the literature remains fairly embryonic in terms of estimating employment impacts from changes in transport quality. This task addresses this evidence gap and involves the development of a model regarding the relationship between rail infrastructure and employment–focused around the NeTIRail-INFRA interests (busy commuter line, low trafficked line and freight line in the East European countries Slovenia, Romania and Turkey). Having reviewed data availability and historic rail investments, we find there to be insufficient potential evaluation studies in the three case study countries and here we describe the methods used to create a long list including additional historic investments in Sweden and the UK. We then describe how we have whittled these down to a short list of seven evaluation studies covering the three NeTIRail-INFRA line types (busy commuter, low trafficked and freight).

We explain how the effect of these investments on employment will be evaluated using a "Differences in Differences" evaluation method and the reasons underlining this choice of approach.

Finally, we set out the remaining steps of Task 1.4.

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Abbreviations and acronyms

Abbreviation / Acronym	Description
DID	Difference in Difference
GDP	Gross Domestic Product
IV	Instrumental Variables
SMS	Scientific Maryland Scale
GVA	Gross Value Added
NUTS1/2/3	EUROSTAT Nomenclature of Territorial Units for Statistics NUTS1 – Major socio-economic regions NUTS2 – Basic regions for the application of regional policies NUTS3 – Small regions for specific diagnoses

1. Introduction

1.1 Wider economic impacts

Wider Economic Impacts are the economic impacts of transport (e.g. on labour, product and land markets) that are additional to the transport user benefits. Under conditions of perfect competition for both the transport and transport-using sectors, a properly specified appraisal of a transport scheme would accurately estimate all welfare impacts through the first order effects e.g. consumer surplus. These first order effects are estimated in Task 1.3.2. In practice, most markets are not perfectly competitive. If only direct user impacts are appraised, some economic impacts would be missing. In some contexts, these impacts can be a large part of the overall appraisal of a rail scheme.

The development of methodology for estimating wider impacts and incorporating them into project appraisal is still an emerging field. A consensus has developed regarding the market failures and distortions that lead to "additionality". In standard cost benefit analysis, transport user benefits (eg time savings) capture the value to society from the investment. However, where market failures exist, transport investment yields impacts which are additional to changes in user benefits. These include productivity increases due to changes in agglomeration, changes in employment where labour taxes exist and where structural unemployment exists and increased output (GDP) in imperfectly competitive markets. At the research frontier include the debate on the relevance of regional specialisation effects on productivity and of distortions in the land market.

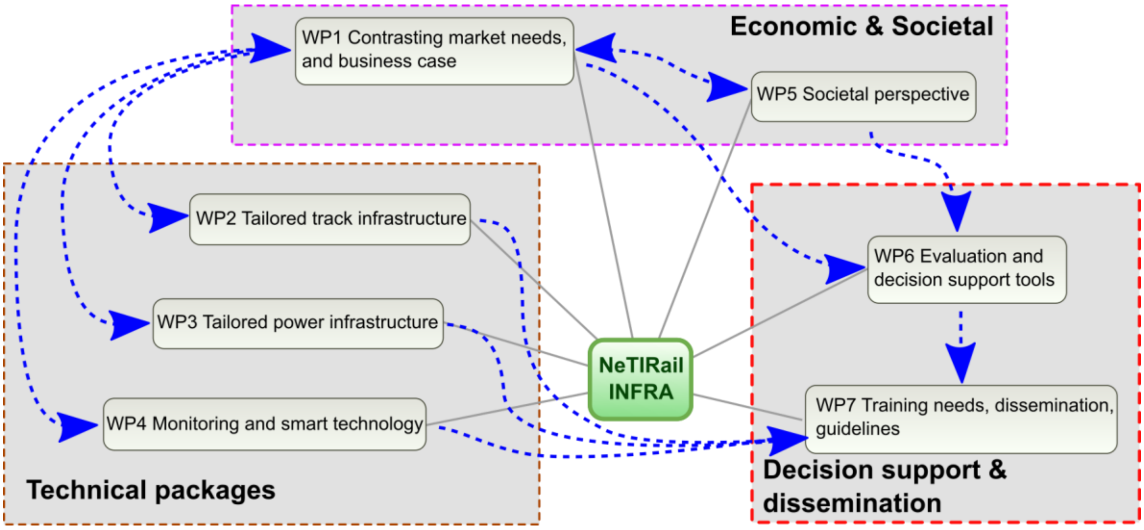
Improvements in links between cities for passenger and freight can potentially yield all of the identified impacts. However, agglomeration impacts are more likely when the links between two large cities can be improved, facilitating economies from larger labour and supplier pools and larger consumer markets. It is less likely that an improved feeder line from a rural area to a city will yield significant agglomeration impacts but could lead to wider economic benefits through increases in labour supply, better skills matching and increased output. If the remoter area also suffers from high levels of unemployment then this will also be a source of additional benefit. Thus the context of the case studies is important in determining the appropriate forms of wider impacts which need to be considered. The case study lines have been described in D1.1.

1.2 Scope of Task 1.4

1.2.1 Relationship to other tasks in NeTIRail-INFRA

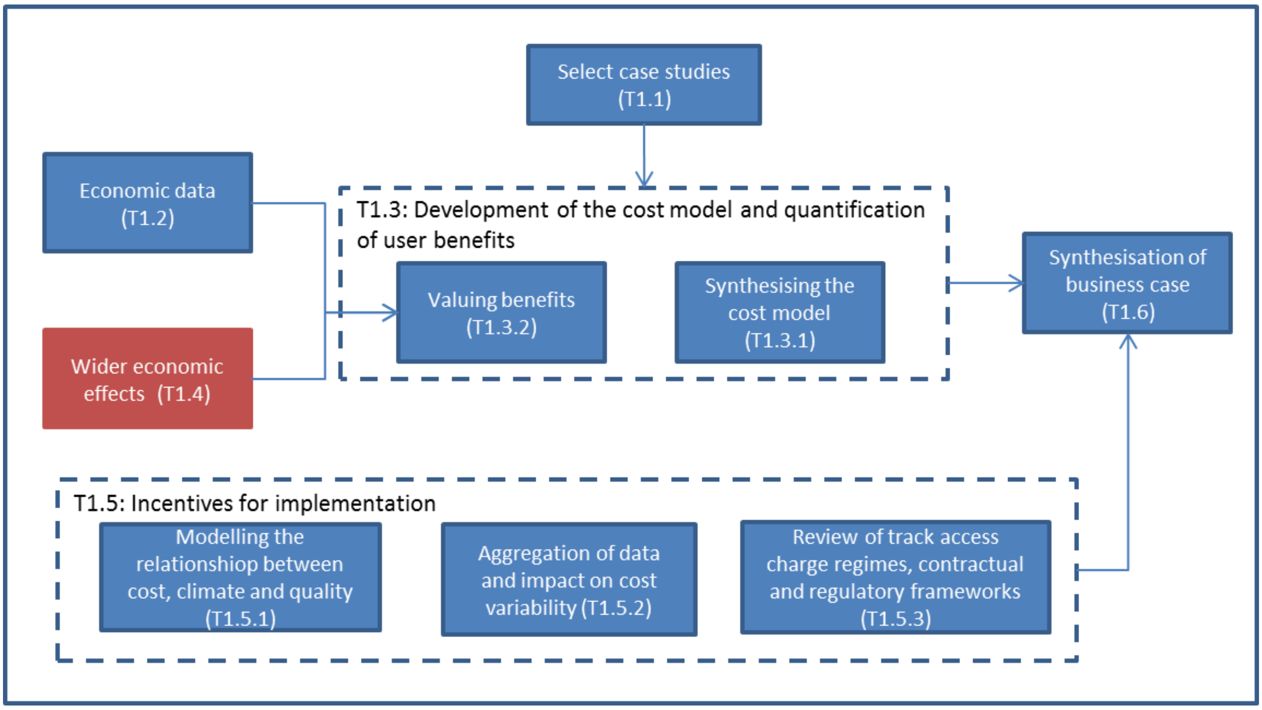
Task 1.4 (Wider Economic Benefits) in NeTIRail-INFRA is concerned with the development of the tools required to estimate the wider economic impacts of the case study rail lines. These estimations will form part of the business case for the innovations developed in work packages 2, 3 and 4 and will where possible be incorporated into the decision support tools being developed in WP6. The tools themselves will be applied as part of Task 1.3 (Valuation of Benefits) and will sit alongside the analysis of societal impacts (Work Package 5) and will ultimately be incorporated in the decision support tools (work package 6). Figure 1.1 shows a schematic of this.

Figure 1.1 – Relationship between work packages of NeTIRail-INFRA



Within Work Package 1 there are six tasks – see Figure 1.2. Task 1.4 (wider economic effects) provides the 'tools' that will calculate the wider economic benefits estimated in Task 1.3.1 (benefit valuation) and appearing in the synthesised business case (Task 1.6).

Figure 1.2 – Relationship of Task 1.4 to other tasks within WP1



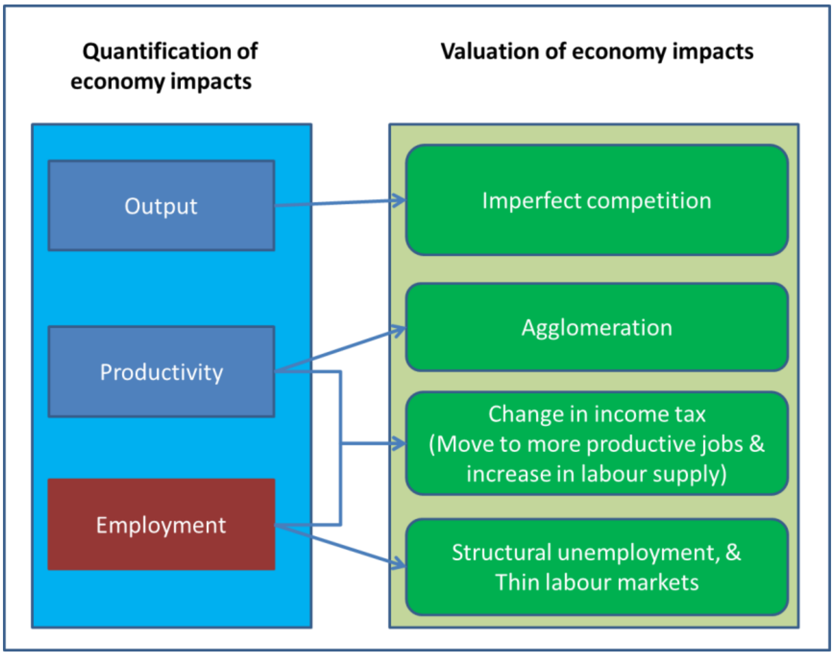
1.2.2 Report Objectives

Within Task 1.4 (wider economic effects) there are two distinct elements: quantification and valuation (see Figure 1.3). Before the wider economic impacts can be valued in a cost benefit analysis it is necessary to predict the scale of the impacts on the economy – e.g. in terms of productivity, employment and output. This is the quantification stage and is represented by the left hand column in Figure 1.3. The literature is quite developed in the context of changes in productivity and its relationship with economic mass and there is also a large literature on the relationship between transport infrastructure and output in the aggregate. However, the literature remains fairly embryonic in terms of estimating employment impacts from changes in transport quality.

The second stage is concerned with the valuation of changes in the wider economy within the cost benefit analysis. Here the literature is also well developed – with regard to how to value productivity due to agglomeration, labour supply impacts and impacts on unemployment. This is represented by the right hand column in Figure 1.3.

The principle evidence gap this task addresses therefore is the development of a model regarding the relationship between rail infrastructure and employment (the red box highlighted in Figure 1.3) – focused around the NeTIRail-INFRA interests (busy commuter line, low trafficked line and freight line in the East European countries Slovenia, Romania and Turkey). This model will be developed by examining how employment has changed in response to historic rail investments. The purpose of this deliverable is to identify the evaluation studies and the econometric methods to be used in estimating the relationship between historic rail investment and changes in employment. The models for economic output, productivity and the valuation methods for all the economy impacts will be derived from a survey of the literature and will be described in the subsequent deliverable associated with this task.

Figure 1.3 – Scope of Task 1.4 wider economic effects



1.3 Report Structure

Following this introductory chapter, Chapter 2 presents a selective review of evidence on the impacts of transport infrastructure on the economy and employment in particular. Chapter 3 describes the method used to create a long list of potential rail investments that could be evaluated, and the method to reduce it down to a short list. The respective lists are also presented. Chapter 4 then reviews the econometric methods available for an evaluation study and outlines the statistical methods we would intend to employ on the evaluation studies. The final chapter, Chapter 5, brings the report to a conclusion and sets out the remaining steps in Task 1.4.

2. Transport and Employment Impacts - a review

2.1 Introduction

Transport influences the size of the economy through a number of mechanisms. Firstly, by reducing cost of business travel, workers become more productive, increasing output. Secondly lower transport costs reduce costs of delivery, reducing input and output prices, again prompting an increase in profits and/or an expansion in output. Reduced transport costs increase the proximity of firms and workers to one another, raising productivity further through economies of scale. Reductions in commuting costs will mean that more workers are willing to work at a given wage, increasing the labour supply and employment. Reductions in freight transportation costs will mean firms become more productive, in most circumstances expanding output and employing more workers. Businesses and workers will move to more productive locations, leading to a change in the composition of the economy and workforce.

Whilst there is an established literature on transport investment and economic impacts, the empirical evidence is largely focused at an aggregate level, i.e. how varying levels of infrastructure investment affect productivity and output. These relationships are captured through elasticities which measure the sensitivity of economic impacts to accessibility changes. More specifically, they measure the proportionate change in output or productivity for a proportionate change in investment or agglomeration respectively.

Recent work on the relationship between infrastructure and productivity focuses on the relationship between transport and economic performance through the link between increased agglomeration and productivity. Agglomeration economies are scale economies which arise from positive externalities stemming from increased concentration of economic activity. These economies raise labour productivity and in so doing increase multi-factor productivity. Transportation improvements support agglomeration economies by enhancing market access and connectivity between firms and their workers, their suppliers and their customers.

According to the UK's Eddington Report (2006), "the broad consensus is that a doubling of city size is associated with an increase in productivity of 3-8%." This implies an elasticity range of 0.04-0.11. Rosenthal and Strange (2003) find estimates typically lie between 0.03 and 0.08.

Early studies on infrastructure and output such as Aschauer (1989), and Munnel (1990)) typically were estimated using a Cobb-Douglas production function with macroeconomic time series data. These studies found very high rates of return for investment in public infrastructure but were criticised on a number of grounds. These included the logical argument that continued investments in US interstate highways could not yield the same returns as stemmed from the initial development of the network. There were econometric issues associated with a possible spurious linkage between increasing levels of inputs and outputs. The work was also criticised for other estimation issues such as the direction of causality (does reduced growth of output actually reduce demand for infrastructure?) and omitted variable bias (energy prices rose just as the stock of infrastructure capital and overall productivity stopped rising but were not controlled for in estimation). A second generation of studies starting with Holtz-Eakin (1994) (who used a panel approach of US state level investments) found much lower returns. A recent meta-analysis (Melo et al 2013) highlights the disparity in estimates employing different data sources and econometric approaches.

See Straub (2011) and Mackie et al (2011) for a more detailed overview of these respective linkages.

The literature on employment impacts is far less developed. Employment impacts can be identified in various ways. One approach, covered in Section 2.2 below is to estimate aggregate local level employment/employment rates as a function of local labour market characteristics and measures of human capital, with variation driven by changes in these variables across time or spatial differences across areas, or through panel data which combines both sources of variation. Within these models, employment can be based on data from employers or households. Firm level data is potentially more informative as it helps to understand whether employment arises from new firms entering an area or from increased employment from existing firms. Another approach is to model individual labour market outcomes (i.e. whether an individual is employed or not) based on a combination of localised factors and personal characteristics, as discussed in section 2.3.

2.2 Transport and Local Labour Market Outcomes

Sanchez (1998) uses a cross section of block[1] group census data and GIS to analyse the location and employment characteristics of workers with varying levels of accessibility to transit. Accessibility is measured by straight line distances to nearest bus and rail stops/stations as well as frequency at nearest bus stop. A two-stage least squares regression is used to estimate the relationship of transit accessibility with labour participation levels for the cities of Portland Oregon and Atlanta Georgia. He finds that transit access, but not always frequency, is a significant factor in determining average rates of labour participation of areas within these two cities.

Ozbay et al (2006) look at the issue of accessibility measures using 18 county-level data from New York/New Jersey for the year 2000. Accessibility between each combination of residential and employment locations is estimated, as a function of modal travel times and socioeconomic and travel characteristics. They find accessibility (measured in units of weighted travel time) is positively affected by public transit and car travel times. Accessibility emerges as a significant determinant of employment for all job types. Specifically, they find the number of new employments induced by a 10% accessibility improvement to be 0.46%. They also examine the issue of causality by estimating accessibility as a function of employment, which suggests that employment growth does influence accessibility.

A similar earlier analysis by Berechman and Paaswell (2001) focuses on the impact of changes in accessibility on employment in specific job areas in the low income South Bronx area of New York. Accessibility between residential and employment locations is measured as a function of weighted modal times and costs, car ownership and household income. They use census block group data on 13 job types in 17 employment sectors, based on any locations where residents of the Bronx work. This work has similar findings to those of Ozbay et al. (2006), that a 10% improvement in accessibility improves employment by 0.44%.

[1] Blocks are statistical divisions of census tracts, generally defined to contain between 600 and 3,000 people

Work by Buchanan (GLA Economics 2009), forecasted the distribution of employment growth in Greater London for various future scenarios up to 2031, specifically focusing on the relationship between employment and public transport and highway accessibility. Accessibility indices were calculated using a gravity model applied to zonal population measures and zone-to-zone generalised time measures from the TfL's London Transportation Studies (LTS) model. Using the Public Transport (PT) based indices they found that accessibility explained around 85% of employment density and conclude that employment clustering in Central London is almost entirely dependent on public transport access. This is questionable on two counts. Firstly, it takes no account of the direction of causation in this relationship, i.e. is PT accessibility higher to serve the higher density areas, rather than driving density itself? Secondly, no other localised covariates were examined, implicitly assuming all other missing variables (e.g. population characteristics) are not correlated to the accessibility measures.

Focusing on road network accessibility, the work by Gibbons et al (2012) is a 'robust' econometric estimation of linkage between accessibility and employment. They construct a panel (1998-2007) database of employment at the ward level married to measures of road construction schemes. They deal with the issue of endogeneity by looking at the impact of these schemes in areas close to (10-30km), but not directly on top of these schemes, the implication being that these are true wider economic benefits that are incidental to the main target area of these schemes and can thus be considered as 'quasi random' in the selection of treatment areas. Their measure of accessibility is an index capturing the amount of employment reachable per unit of travel time along the major road network in a given location, based on ward to ward travel times. They use a 'fixed effects' approach to avoid any bias arising from the correlation of unobserved time invariant area level effects with accessibility. They find a 10% improvement in accessibility leads to around a 3% increase in the number of businesses and employment up to 30km from the site, although the estimates range between zero and 10% depending on sector and specification. Employment varies due to entry and exit of firms in an area, not due to a response from existing firms.

2.3 Public Transport and Individual Labour Market Outcomes

There is a considerable amount of literature on estimating the employment status for individuals (i.e. unemployed or not) as a function of personal and regional characteristics e.g. Gunderson (1980). Logit and probit models are standard tools in predicting probabilities of individuals' employment and labour force participation. Such models are analogous to regression models but estimate the probabilities of a discrete outcome (eg employment status) for an individual.

Rice (2001) analyses 62 US cities (and a larger but more aggregated set of data on 76 cities) and uses individual level probit analysis to examine the impact of public transit route density on individual's probability of employment whilst controlling for other city characteristics as well as individual characteristics. Rice finds density of public transit routes has a positive effect on the probability of employment for the low education population, which is significant at the 5% level. There was however no significant effect for the overall population. A 10% increase in public transport density is associated with an increase in 0.6% in the probability of employment – roughly half the size of effect of a comparable increase in car ownership. The results do not control for the endogeneity of car ownership, and she suggests this could be done following the same procedure as Raphael and Rice (1999) who instrumented for car ownership using state gasoline taxes and average insurance premiums.

2.4 Summary

The aggregate approaches covered in section 2.2 more readily lend themselves to the calculation of transport-employment wider economic impacts, as they facilitate the coverage of a wider spatial area in a cost-effective way and provide absolute numbers on employment changes. There are clearly issues with endogeneity which emerge from the non-random way in which transport projects are targeted at more productive areas and which require addressing in any robust analysis through choice of appropriate control and treatment areas. Consideration must also be given to possible biases arising due to car ownership rates and accessibility possibly being a function of employment itself.

There is clearly an evidence gap here which can partially be addressed through the ex-post case studies proposed in this report. Recent work undertaken by the What Works Centre for Economic Growth (2015) has highlighted the importance of establishing (and the current lack of) a credible evidence base on the linkage between transport and the economy. Of the six studies which passed its criteria of robustness for consideration looking at employment effects of road based projects, only two actually identified positive employment effects. They found no high quality evaluations on employment effects of rail infrastructure – only evidence of land value effects was found. The study found no high quality evaluations of evidence of the impacts of trams, buses and active modes on any economic outcomes.

3. Evaluation Study Selection

3.1 Evaluation study project long list

In order to consider possible projects, we have taken a number of approaches. We conducted desk research to identify some large scale investments using sources such as the European Investment Bank website and European TEN-T based reports. We have consulted project partners, particularly on the operational side, such as RCCF, SZ and INTADER. We have also held discussions internally with colleagues at ITS to discuss the suitability of potential UK evaluation studies in more detail, as well as contacting VTI who have knowledge of historic Swedish investments.

Table 3.1 – Evaluation Study Long List

Project	Line type	Investment type/ Description	Opening year	Investment cost	Other comments
Turkey					
Izmir Commuter Train	Busy commuter line	Re-construction and upgrade plus new stations Upgrading of 80 km section of suburban railway network to surface metro linking Izmir centre to Aliaga (north) and Cumoavasi (south)	2010	€150 million (EIB loan value)	Confounding with refugee crisis (Izmir is a point of departure to Greek Islands)
Istanbul-Ankara Railway	High speed rail line	New line	2010 (1st phase), 2015 (2nd phase)	€2,700 million	
Ankara and Konya railway	High speed rail line	New line	2011	€300 million	
Kütahya-Alayunt	Busy line with mixed traffic	10 Km second track was constructed next to existing track in order to reduce to travel time	2009	€4.3 million	
Tecer-Kangal	Busy line with mixed traffic	48 km New railway superstructure	2011	€20.7 million	
Tekirdağ-Muratli	Busy/freight dominated	31 km Second track superstructure in order to connect railway to Muratlı port	2013	€6.2 million	
Cumaovasi-Tepeköy	Very busy line with mixed traffic	30 km İzban metro track was extended to Tepeköy station	2013	€8.7 million	
Ankara-Sincan	Busy line – high speed rail line	28 km It is constructed to bring HST, which arrives to Sincan, to Ankara on a HST dedicated track - new track	2013	€17.4 million	
Arifiye-Pamukova	Very busy line with mixed traffic	2.track infrastructure and substructure	2014	€22.0 million	

Project	Line type	Investment type/ Description	Opening year	Investment cost	Other comments
Slovenia					
Divača–Koper	Freight line and commuter line	Enhancement of existing 48km line from port of Koper to main rail network at Divača. Modernization of signaling and safety devices and electronic devices to enable remote automatic traffic management, increasing throughput capacity of line. Reconstruction and upgrading of Koper, Hrpelje-Kozina and Divača stations.	ongoing	€130 million, half of which funded from Cohesion fund.	Divača-Koper railway section is a part of the trans-European transport network (TEN-T), and serves as an axis for lines from Lyon to Trieste, Ljubljana, Budapest and onto the Ukrainian border. Bottlenecks will not really be addressed until completion of a second line which commenced construction in 2016.
Murska Sobota – Hodos (Slovenian Hungarian Border)	International/local/passenger and freight	30km new line	2001	€97 million	Part of TEN-T corridor V Max speed 160km/h, electrified from 2016
Romania					
Bucharest Metro lines	Commuter lines	Construction of new lines on Metro system including line M3 – a 5 mile, 6 station section from Gara de Nord to Dristor and 2 miles of line M4 from Gara de Nord to 1 Mai	1989-2000	€100 million loan from EIB	Impact might be at too small spatial scale to be detected and conflated with other urban enhancements (e.g. roads).
Bucharest-Brasov	Intercity line	Modernisation of 170km of existing line including improvement of geometry, railway stations, electrificiation and safety enhancements allowing 160km/h for passenger trains and 120km/h for freight trains	2011		Electrification still on-going. Impact might not be large enough to be detected and may be too recent.
UK					
Stirling-Alloa-	Relatively lightly used local	Re-opening of 21km of line between	2008		This line re-establishes links to

Project	Line type	Investment type/ Description	Opening year	Investment cost	Other comments
Kinkcardine rail link	line offering hourly services. Also used for freight.	Stirling and Alloa to rail traffic. Provides passenger services from Alloa to Stirling and beyond and opportunities for Freight			isolated communities.
Mansfield to Nottingham (Robin Hood line)	Busy commuter line (half hourly services)	Re-opening of line closed in 1964 which left Mansfield the largest town in Britain without a station.	1995 with final extension to Worksop in 1998		Mansfield is a deprived area.
Larkhall-Milngavie	Local passenger line	Re-instatement of 4.7km of track and 2 stations and a 1.6 km extension with an additional station.	2005		Represents a short extension into the region bringing the link to an additional areas rather than regenerating a whole region
Manchester Metrolink, Phase 1 and 2	Commuter line	Replacement of heavy rail lines from Bury-Manchester Victoria and Altrincham to Piccadilly with light rail and linked through on-street running in city centre. Phase 2 is a new line linking Eccles and Media City	1992, 1999	£270m, £250m respectively (2016 prices)	Popular light rail service replacement providing through service. Previous evaluation work has identified control and treatment areas.
Edinburgh-Borders	Commuter line	Connects Edinburgh with Galashiels and Tweedbank following alignment of previously closed line.	2015		Probably too soon to identify economic effects
Sweden					
Svealandsbanan	Primarily passenger/busy commuter line	Upgrading of existing and construction of partially new tracks	1997	€331 million	
Blekinge Kustbana	Was a low traffic line/ commuter line	Upgrading of existing tracks and electrification	Mid-1990ties		
Haparandabanan	Primarily freight	Upgrading, including higher axle load and electrification plus partly new	Around 2010		

Project	Line type	Investment type/ Description	Opening year	Investment cost	Other comments
		tracks			
Hamnbanan i Göteborg	Freight	From one to two tracks on a short line taking cargo from port to marshalling yard	Recent		

3.2 Data availability

When considering our case studies we have to consider the following data requirements for our 'treatment' and 'control' areas:

- Appropriate/consistent levels of geography
- A measure of changes in accessibility
- A measure of economic impact, e.g. GVA
- Measures of other economic drivers
- Repeated measurement of same areas and variables over time

3.2.1 Turkey

The Turkish Statistical Institute (http://www.turkstat.gov.tr/Start.do) offers a portal for statistical data. A wide range of data is available, including labour force statistics, over multiple time periods. Unfortunately, these data are only available at an aggregate level: at the NUTS2 sub region level. There are26 NUTS2 sub regions in Turkey. Some of the projects in Table 3.1 are entirely contained within a single NUTS2 region – for example the Izmir suburban/metro line is wholly contained within the NUTS2 sub region Izmir, which has an urban population of 4 million (in 2013).

3.2.2 Slovenia

The Republic of Slovenia Statistical Office hosts detailed macroeconomic time series data. The SI-Stat Data Portal allows interrogation of statistics on demography, economy and environment by geographical area and year.

- Labour Market including employment and activity
- Demography
- Population
- Educational attainment
- Road vehicles
- Geography

These are available at the municipality and statistical region level

Geography

Slovenia is divided into 12 statistical regions (NUTS3) and 212 municipalities within these regions with consistent data series going back to at least year 2000.

3.2.3 Romania

The Romanian National Institute of Statistics (www.statistici.insse.ro) hosts detailed macroeconomic time series data. This requires registration for access with TEMPRO-Online (granted). Datasets include:

- Population and its demographic structure
- Measures of social deprivation

- Economic activity
- Income
- Educational attainment
- Demography
- Registrations of road vehicles
- Railway network length by network type
- Occupations and industrial composition

Geography

There are 8 development regions in Romania, these areas are subdivided into 41 counties (and the municipality of Bucharest) and represent the NUTS3 level. These counties have an average population of 445,000 with maximum of 772000 and minimum of 210,000.

These data are available at the development region and county level, in some cases back to year 1990, in most cases at least back to 2000.

3.2.4 UK

The Scottish and British Censuses offer data at very disaggregated levels down to areas of around 1,500 population. Census data is collected every 10 years, providing easily available and consistent datasets for 1991,2001 and 2011.

Data includes detailed information on

- Population and its demographic structure
- Measures of social deprivation
- Economic activity
- Income
- Educational attainment
- Demography
- Car ownership
- Occupations and industrial composition

The UK also offers the potential to examine micro datasets on firms. The Annual Business Survey (ABS), is the main structural business survey conducted by the Office for National Statistics. It surveys around 62000 firms and crosses most business sectors, collecting financial data from businesses' end year accounts, including turnover, wages and salaries, purchases of goods and services, stocks and capital expenditure. ABS is a key source of data used in the compilation of the Input-Output Annual Supply and Use tables for National Accounts. The data is available via the ONS Virtual Micro Data laboratory.

3.2.5 Sweden

Statistics Sweden may offer data on an individual level allowing for aggregation to arbitrary geographical areas. The smallest regularly produced area type is the so called SAMS-areas. These areas are in most cases much smaller than municipalities. These data are collected yearly by the tax authorities.

The individual data includes detailed information on

- Coordinates for place of residence and work place
- Income
- Educational attainment
- Employment status
- Car ownership

There is also aggregate data describing the population at aggregate levels like municipality on

- Demographic structure
- Income distribution
- Economic activity

Statistics Sweden also offers datasets on firms. Företagsdatabasen (an annual database on all workplaces including publicly owned) is the main base. In addition, Statistics Sweden supplies data aggregated to sectors of economic activity.

3.3 Evaluation study short list

Our short list selection criteria is based on identifying an historic rail investment that:

- Maps onto the case study line types: busy commuter line, low trafficked line and freight line;
- For which data that can support an evaluation exists;
- That has been open sufficiently long for employment impacts to be observed; and
- Is ideally situated in the case study countries (Slovenia, Romania and/or Turkey)

Our research indicates that whilst there has been at least one suitable rail investment in Turkey the data available would not support an evaluation of employment impacts. In Romania, whilst we have identified two potentially suitable investments a closer inspection indicates that the employment impacts are likely to be too small or diffuse to be able to identify in a suitable evaluation study. For Slovenia we identified two potential evaluation studies of which one is too recent and has ongoing construction work associated with a second line. Across our three countries of interest this only left the one potential evaluation study: Murska Sobota – Hodos (Slovenian Hungarian Border).

Given the limited number of potential evaluation studies we have broadened our long list to include potential investments from Sweden and the UK for which data suitable for an evaluation exists. For the UK five investments have been identified. On closer examination we have only retained three (Mansfield to Nottingham, Manchester metro and Stirling-Alloa investments) on the short list. The other investments are either too recent or the employment impacts are likely to be too small to identify. With respect to the Swedish historic investments we have only excluded “Hamnbanan i Göteborg” improvement as this represents an upgrade of a short section of track between a shunting yard and a port and will not be specifically associated with employment impacts in the vicinity of the project aside from in the rail and port sector.

This short listing procedure therefore gives rise to a short list of seven potential evaluation studies. In the next stage of the study this will be reduced to a maximum of four following a detailed consideration of the data available and the accessibility and economic changes observed.

Table 3.2 – Evaluation Study Short List

NeTIRail-INFRA Line Type	Rail investment project
Busy commuter line	Murska Sobota – Hodos (Slovenia) Mansfield to Nottingham (UK) Manchester metro (UK) Svealandsbanan (Sweden)
Low Trafficked line	Stirling- Alloa (UK) Blekinge kustbaba (Sweden)
Freight	Haparandabana (Sweden))

Note: The Murska Sobota – Hodos (Slovenia) line carries a mixture of local, international and freight services and is not neatly categorised into a single NeTIRail-INFRA line type.

4. Outline of proposed evaluation method

4.1 Evaluation methods

The classic 'gold standard' evaluation method is a randomised trial in which participants in a programme are randomly selected. This is has a Scientific Maryland Scale (SMS) Level 5 (see Table 4.1). Of these participants some are randomly chosen to be 'treated' and others act as a control group. Tavistock (2010) give an example of a walking and cycling to work initiative in which such an evaluation is conducted. See Box 1 below. Within this experimental design one would regress the outcome (e.g. increased employment) on the treatment (i.e. the change in accessibility) and other employment influencing factors.

Box 1: Randomised trial transport evaluation example

The 'Walk in to Work Out' evaluation aimed to test whether a 'self-help intervention' delivered to individuals via written materials could increase active commuting behaviour as there had been little prior investigation into ways in which active commuting could be encouraged (Mutrie et al., 2002). Study participants who had been identified as thinking about, or doing some irregular, walking or cycling to work were selected from three Glasgow workplaces which were in the same area of the city and served by a range of public transport links and marked cycle routes. Those volunteering to participate in the trial were randomly split into experimental and control groups. The experimental group received the 'Walk in to Work Out' pack immediately; whereas the control group was told the pack would be forwarded six months later (but did, in fact, not receive it within the lifetime of the study). Follow-up questionnaires used to measure outcomes were sent to both groups after six and twelve months to measure the effectiveness of the intervention. The experimental design offered statistical proof that those individuals who received the pack were twice as likely as those who had not to increase walking to work.

Source: Tavistock (2010, p53)

With transport infrastructure it is not possible to create a randomised trial as the infrastructure investment is not random. The counterfactual has to be identified using alternative methods. The identification of the counterfactual is important as the inter-relationship between transport planning and economic growth lead to ambiguous causal effects. That is transport improvements are often targeted towards areas of high congestion which typically have high levels of economic activity (growth in which may be an outcome of interest). This endogeneity has to be controlled for in the analysis – which a simple cross-sectional analysis cannot do (cross-sectional type analyses are given a Level 1 or 2 on the SMS scale in Table 4.1). A number of techniques have been utilised that are described below. Ideally the methods employed should also be able to distinguish between pure growth and displacement. This is necessary because changes in local outcomes may just be a result of displacement or sorting between different areas.

Table 4.1 – Scientific Maryland Scale

Robustness scores (based on adjusted Maryland Scientific Methods Scale)
Level 1: Either (a) a cross-sectional comparison of treated groups with untreated groups, or (b) a before-and-after comparison of treated group, without an untreated comparison group. No use of control variables in statistical analysis to adjust for differences between treated and untreated groups or periods.
Level 2: Use of adequate control variables and either (a) a cross-sectional comparison of treated groups with untreated groups, or (b) a before-and-after comparison of treated group, without an untreated comparison group. In (a), control variables or matching techniques used to account for cross-sectional differences between treated and control groups. In (b), control variables are used to account for before-and-after changes in macro level factors.
Level 3: Comparison of outcomes in treated group after an intervention, with outcomes in the treated group before the intervention, and a comparison group used to provide a counterfactual (e.g. difference in difference). Justification given to choice of comparator group that is argued to be similar to the treatment group. Evidence presented on comparability of treatment and control groups. Techniques such as regression and (propensity score) matching may be used to adjust for difference between treated and untreated groups, but there are likely to be important unobserved differences remaining.
Level 4: Quasi-randomness in treatment is exploited, so that it can be credibly held that treatment and control groups differ only in their exposure to the random allocation of treatment. This often entails the use of an instrument or discontinuity in treatment, the suitability of which should be adequately demonstrated and defended.
Level 5: Reserved for research designs that involve explicit randomisation into treatment and control groups, with Randomised Control Trials (RCTs) providing the definitive example. Extensive evidence provided on comparability of treatment and control groups, showing no significant differences in terms of levels or trends. Control variables may be used to adjust for treatment and control group differences, but this adjustment should not have a large impact on the main results. Attention paid to problems of selective attrition from randomly assigned groups, which is shown to be of negligible importance. There should be limited or, ideally, no occurrence of 'contamination' of the control group with the treatment.

Source: Madaleno & Weights[2] (2014, p4)

Note: These levels are based on but not identical to the original Maryland SMS. The levels here are generally a little stricter than the original scale to help to clearly separate levels 3, 4 and 5. Changes have been made by Madaleno & Weights.

4.1.1 Dose response methods

Graham *et al.* (2014) in a recent paper exploit dose response methods to control for the non-random manner in which transport investments may be assigned to particular localities. In these methods the non-random treatment is conditional on a number of location specific characteristics including traffic and congestion levels and economic performance. In contrast to the literature discussed below (which focuses on economic outcomes in the main) they also consider traffic outcomes as well as economic outcomes. They use US data from the construction of the interstate highway network and find that urban road network expansions have induced demand, but have not ameliorated congestion or raised productivity ('naïve' regressions would find a positive relationship between capacity growth and wages).

[2] http://whatworksgrowth.org/wp-content/uploads/2014/10/Scoring-Guide-final.pdf

The dose response approach requires that there are not unobserved differences between the locations that receive the infrastructure and those that do not. Difference-in-differences and instrumental variable approaches can be used in situations where this condition does not hold. Dose response methods would be given a Level 3 or 4 SMS evaluation score.

4.1.2 Differences–in–Differences

The differences- in-differences (DiD) method exploits the fact that different observations experience differing levels of treatment, with some observations experiencing no treatment. If all observations experience the same background changes then the impact of the treatment can be isolated statistically (without a counterfactual having to be formally defined). The use of longitudinal data also allows for the control of unobserved fixed effects. Difference in Differences would give a Level 3 or 4 on the SMS scale.

Box 2: Difference in difference transport evaluation examples

Gibbons and Machin (2003, 2005) analyse the impact of the Jubilee Line Extension and the extension of the Docklands Light Railway (DLR) on employment and residential house prices using differences-in-differences methods. For the house price study they used data on housing transactions from the Nationwide building society for 1997 to 2001 within 30km of Holborn and a second sample within 20km of Bromley. The areas overlap. Distances from houses to underground, Docklands Light Rail and national rail stations were measured using Euclidean distance. For the study on employment they derived employment data from the Office for National Statistics’ Annual Business Inquiry series at the Census ward level, for 1998 to 2001. This was undertaken for 781 London wards and 2019 wards in the South East for each year. Euclidean distance from the ward centroid to the nearest underground/DLR/national rail station was used as the accessibility variable. For the house price study they find that, for properties within 2km of a station, a 1km reduction in station distance causes about a 2% increase in prices. Usefully, they compare their differences-in-differences estimate with a more conventional cross-sectional estimate. They find that estimates based on cross-sectional variation alone are three times as large as differences-in- differences estimates. This suggests that train stations are not selected at random and more valuable land is more likely to receive a train service. This highlights the endogeneity problem identified earlier and the need to control for it in the study methodology. The study on employment found similar effects – though the impact of the accessibility change on employment was much less marked than it was on house prices.

Graham et al. (2013) use differences-in-differences at the level of Spanish regions to examine the impact of the new Madrid-Barcelona high speed rail line. They find no observable impacts on GVA per capita from the construction of the new high speed rail line.

4.1.3 Instrumental Variables

Instrumental variable (IV) estimation methods can also be used to control for the endogeneity in the location of transport schemes. That is transport infrastructure proposals are typically targeted towards the more productive locations. The challenge with IV estimations is the identification of an appropriate instrument. Redding and Turner (2014) in their survey of this literature identify two types of instrument – the planned route and historic route. Baum-Snow (2007) first used the planned route IV using 1947 plan for the US interstate highway network. Duranton and Turner (2012) develop the historical route IV approach using maps of major US explorations from 1535 to

1850 and a map of the US rail network in 1898. Instrumental variable evaluation methods would give a Level 3 or 4 evaluation on the SMS scale.

Box 3: Instrumental variable transport evaluation examples

In a UK context Gibbons et al. (2012) in their study of the impact of major new roads in the UK on firm level activity use a mixture of approaches. They employ differences-within-groups (rather pure differences-in-differences) to account for the lagged effect of changes in firm activity vis a vis new road infrastructure. They also instrument this differences-within-groups specification to account for transport investments being non-random. The instrument they use is ex post accessibility with fixed land uses. Partly for data reasons, but also to further control for endogeneity in the location of transport investments, they focus the discussion of their results on wards that are not immediately adjacent to the new roads. For the first set of models they estimate (employment at the firm level) the data they use is sourced from the Office for National Statistics (ONS) Business Structure Database (BSD), which they accessed through the UK's Secure Data Service (SDS). For the second set of models, the productivity regressions, they used the ONS Annual Respondents Database (ARD). The ARD holds responses to the Annual Business Inquiry (ABI) (now BRES) completed by a stratified random sample of units, extracted from the BSD. The ABI was a comprehensive business survey covering balance-sheet information including gross value added, wages, intermediate inputs, employment, industry, and investment. Gibbons et al. (2012) found that ward level employment and the number of firms were sensitive to new road infrastructure with the major road schemes analysed contributing an additional 3,600 jobs (Gibbons et al., 2012 p34). They were unable to say whether these jobs were displaced or 'new'. They also find some limited evidence on firm level increases in labour productivity, output and wages amongst existing firms – but it is the effect on the number of firms in a locality that is strongest.

4.1.4 Inconsequential Units Approach

This approach relies on an argument being constructed that a locality experiences new transport infrastructure 'by accident'. This is most pertinent to the context of the development of new inter-city transport networks which then 'accidentally' give small rural settlements part-way along the route a large change in accessibility. Examples include the construction of the inter-state highway network in the US (exploited by Chandra and Thompson (2000)) and new high speed rail lines in Germany (exploited by Ahlfeldt and Federsen, 2010). Chandra and Thompson (2000) also offer one of the few attempts at identifying displacement effects. They find that in a rural context almost all the local gains in economic activity have been displaced from regions that did not benefit from a direct connection to the interstate highway network.

4.2 Proposed method for NeTIRail-INFRA

The most robust level of evaluation as shown in Table 4.1 are random or quasi-random experiments. In transport, random trials are simply not observed in practice. Quasi-random experiments, the next level of robustness, require the identification of treatment areas which were not considered in the planning or decision making regarding the scheme. Evidence of such considerations and identification of such inconsequential units are generally difficult to find. The dose response approach requirement that there are not unobserved differences between the locations will be too much of a constraint in our case studies. Good instruments for IV approaches in non-experimental datasets are notoriously difficult to identify. This is due to the inter-relationship (endogeneity) between most observable socio-economic variables. It is impossible to prove instrument exogeneity – instead intuitive plausibility is relied on.

Level 3 approaches are generally more practical to apply, especially for our purposes where we are looking at applying a consistent approach across a number of case studies, but can still yield acceptably robust models.

Given the identified shortcomings or inherent difficulties with the approaches identified above, we propose to use the difference in differences (DiD) method. This is an established technique for establishing causal influences of interventions (i.e. rail service enhancements) on outcomes (e.g. employment). This approach uses panel analysis to examine how 'treatment' areas (exposed to the intervention) have performed over time relative to 'control' areas (outside the scope and thus unaffected by the intervention).

To implement such an approach we need matching data on the treatment and control groups. Matching data is required for 2 periods (time period 1 and 2), before and after the treatment.

The DiD estimator is derived by taking the difference in outcomes for the treated groups before and after the treatment and comparing with the difference in outcomes for the untreated groups. In this way the DiD estimator is purged of any existing difference between treatment groups and any general time period effects.

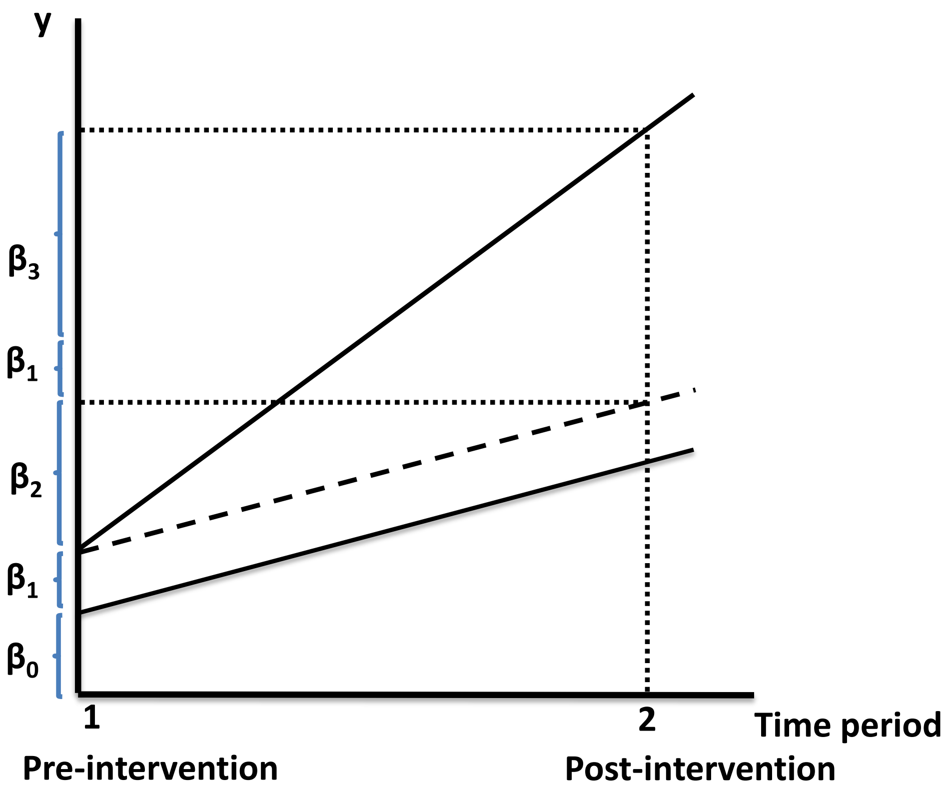
It can be expressed algebraically in the equation below and with reference to the accompanying Figure 4.1.

$$y = \beta_0 + \beta_1 T + \beta_2 S + \beta_3 (T \cdot S) + \varepsilon$$

Here *y* represents the outcome variable (e.g. employment), *T* is a dummy variable with a value 1 for the treatment group and 0 for the control, and *S* is the time period dummy which is 1 if time period is 2 (post-intervention). ε represents model error. *y* is expressed as a function of an underlying model constant, β_0, the pre-existing difference between the two groups, β_1, the time-related effect, β_2. The treatment effect β_3 is illustrated as the remaining difference after the removal of pre-existing differences and time effects.

Where possible, other observable characteristics of areas will be controlled for but the remaining difference in economic outcomes between 'treatment' and 'control' areas are considered to be attributable to the changes in rail provision.

Figure 4.1 – Graphical illustration of the difference in difference effect.



4.2.1 Data requirements of evaluation methods

Panel data regression based approaches require repeated observations over time over a number of cross sectional units to represent treatment and control areas. Hence our dataset will require, each for treatment and control areas, the following:

Appropriate/consistent levels of geography

Most European countries report annually (or even monthly) regional economic indicators suitable for our analysis such as demographic and socioeconomic data. However, much of this data, as collated in EUROSTAT publications is at the NUTS2 level of aggregation. These are usually states or regions within European countries and can number as few as 2 in the case of Eire. This is too aggregate for our purposes. The impacts of improvements to local rail lines will be undetectable and effectively washed away by other larger changes due to other interventions not controlled for. For this reason we require data at least at the NUTS3 level which provide much more spatial disaggregation, broken down to municipal regions or counties. These number 42 in Romania, 21 in Sweden and 93 in England for example. This is the level of data at which Graham et al (2012) for example used to examine impacts of high speed rail in Spain. In some cases we will require further disaggregation, for example In Slovenia there are only 12 NUTS3 regions.

A measure of accessibility

At the basic level, the availability or not of access to an improved rail line represents an improvement in accessibility. In case study areas where supporting data exists we will try to establish further detail on accessibility, such as distance, journey times or generalised costs of journeys from population centroids to rail stations.

A measure of economic impact, e.g. employment

We require measures of employment or employment rates as the dependent variable in our analysis. Where possible this may be broken down into sectoral measures, as in the Graham et al (2012) work.

Measures of other economic drivers

Additional control variables will be identified in the modelling to control for other changes in economic outcomes which have arisen from other sources, e.g. underlying macro-economic shocks, changes in socio-demographic, human capital or industrial structure. These can be captured through census type information on ethnicity, gender, industrial composition, population, population density, car ownership etc.

Repeated measurement of same areas and variables over time

Clearly consideration has to be given to temporal and spatial consistency and availability of the supporting data. Outcome and control variables need to be available for all areas and time periods and measured in a consistent way. Over time, geographical areas may be merged, further subdivided or re-classified. Sometimes this can be worked around through supplied conversion tables. Series can change the way variables are measured over time, such as employment. We will pay close attention to such potential complications from an early stage.

5. Summary and Next Steps

5.1 Summary

This intermediate report has presented the work undertaken to date as part of the Task 1.4 Wider economic effects. The objective of the task is to develop a toolkit by which the wider economic effects of the innovations in WPs 2, 3 and 4 can be estimated. Employment, agglomeration economies and increased output effects will be estimated as part of the toolkit.

To develop the toolkit the most substantive task is the estimation of a model that links changes in employment to investments in rail infrastructure. This will be based on observed employment impacts in the vicinity of historic rail investments. Having reviewed data availability and historic rail investments in the three case study countries (Slovenia, Romania and Turkey) we find there to be insufficient potential evaluation studies and have therefore widened the net of potential evaluation studies to include historic investments in Sweden and the UK. This has given a short list of seven evaluation studies covering the three NeTIRail-INFRA line types (busy commuter, low trafficked and freight). The effect of these investments on employment will be evaluated using a Differences in Differences evaluation method. This will give robust findings at around Level 3 on the Scientific Maryland Scale.

5.2 Next Steps

To develop the employment model it is now necessary to start examining the six short listed investments in detail and identify which should be taken forward for empirical study. As part of the empirical work there will be a need to compile the employment changes and the accessibility changes for each investment and estimate a relationship between employment and changes in accessibility. There will then be a task to synthesise the findings of the different empirical strands for use in Task 1.3.2 (benefit valuation).

In parallel to this work stream there will be another work stream reviewing the literature and researching local economic conditions with the aim of quantifying agglomeration and output effects and valuing these effects and the employment effects being estimated using the model being developed.

Figure 5.1 overleaf provides a more detailed work plan of the next steps in Task 1.4.

Figure 5.1 – Workplan for Task 1.4

				M15 Aug-16	M16 Sep-16	M17 Oct-16	M18 Nov-16	M19 Dec-16	M20 Jan-17	M21 Feb-17	M22 Mar-17	M23 Apr-17	M24 May-17
Employment model	Scope and method	Identify rail interventions for long list	Complete										
		Identify data availability	Complete										
		Short list of rail evaluations	Complete										
		Identify evaluation methodology	Complete										
		Draft and submit Intermediate Report (D1.5)	Complete										
	Model estimation	Collate data for evaluation study locations		■	■								
		Finalise evaluation studies (select from short list)		■									
		Create accessibility indices			■	■	■						
		Estimate models					■	■	■	■			
		Synthesise evaluation study findings									■		
Valuation of employment effects	Review marginal tax rates in case study locations					■	■						
	Review unemployment in case study locations					■	■						
	Calculate shadow price of labour where relevant					■	■						
Quantification and valuation of agglomeration impacts	Review of urbanisation elasticities						■	■					
	Collate wage rate and GDP data for case study locations						■	■					
Valuing increased economic output	Review evidence of price-marginal cost mark-ups in case study locations							■	■				
Wider economic effects toolkit	Beta test wider economic test tools on case study data									■	■		
Final deliverable	Draft											■	
	Deliverable review and revision												■
	Deliverable submission												■

6. References

Ahlfeldt, G.M. and Feddersen, A. (2010) From periphery to core: economic adjustments to high speed rail. Working paper. Report dated September 2010. Available at: http://eprints.lse.ac.uk/29430/

Aschauer, D.A. (1989) Is public expenditure productive? Journal of Monetary Economics, 23(2), pp. 177–200.

Baum-Snow, N. (2007). Did highways cause suburbanization? *Quarterly Journal of Economics* 122(2):775–805.

Berechman, J., and Paaswell, R. _2001_. “Accessibility improvements and local employment: An empirical analysis.” *J. Transp. Stat.*, 4_2/3_, 49–66.

Chandra, A. and E. Thompson (2000) Does public infrastructure affect economic activity? Evidence from the rural interstate highway system. *Regional Science and Urban Economics* 30(4):457–490.

Duranton, Gilles and Matthew A. Turner. 2012. Urban growth and transportation. *Review of Economic Studies* 79(4):1407–1440.

Gibbons, Stephen and Stephen Machin (2003) Employment and rail access: an evaluation of the wider benefits of transport improvements.

Gibbons, Stephen and Stephen Machin (2005) Valuing rail access using transport innovations. *Journal of Urban Economics* **57**(1):148–169

Gibbons, S. T. Lyytikäinen, H. Overman and R. Sanchis-Guarner (2012) *New Road Infrastructure: the Effects on Firms*. SERC discussion paper 117, September 2012.

GLA Economics (2009), Accessibility-based employment projections, Technical Paper 2, Greater London Authority, November 2009

Gunderson, Morley (1980), Probit and Logit Estimates of Labor Force Participation, Industrial Relations: A Journal of Economy and Society, Volume 19, Issue 2, pages 216–220, March 1980

Graham, D.J., R. Brage-Ardao and P.C. Melo (2013) Measuring the Impact of High-Speed Rail on Economic Performance: Evidence for the Madrid-Barcelona corridor. Paper presented at *European Transport Conference, Frankfurt, October 2013*. http://abstracts.aetransport.org/paper/index/id/136/confid/1

Graham, D.J., E.J. McCoy and D.A. Stephens (2014) Quantifying Causal Effects of Road Network Capacity Expansions on Traffic Volume and Density via a Mixed Model Propensity Score Estimator, *Journal of the American Statistical Association*, Volume 109, Issue 508, 1440-1449, DOI: 10.1080/01621459.2014.956871

Holtz-Eakin, D (1994), Public Sector capital and the productivity puzzle, Review of Economics and Statistics 76 (1):12-21

Johnson, D.H., Mackie, P., Ercolani, M., (2014), Buses and the Economy II: Task 3 Report: Econometric Analysis**,** *www.greenerjourneys.com/wp-content/uploads/2015/08/10.pdf*

Mackie, P.J., Graham, D.J., and Laird, J.J., (2011) The Direct and Wider Impacts of Transport Projects - a Review in R. Vickerman and E. Quinet Handbook on Transport Economics

Madaleno, M., and Waights, S., (2014), Guide to scoring methods using the Maryland Scientific Methods Scale, http://www.whatworksgrowth.org/public/files/Scoring-Guide.pdf

Melo, P.C., Graham D.J., and Brage-Ardao, R., (2013) The productivity of transport infrastructure investment: A meta-analysis of empirical evidence, Regional Science and Urban Economics 43 (2013) 695–706

Munnell, A.H. (1990) How does public infrastructure affect regional economic performance? New England Economic Review, September–October, pp. 2–22

Mutrie, N et al (2002) "'Walk in to Work Out': a randomised controlled trial of a self help intervention to promote active commuting" *Journal of Epidemiology and Community Health*, Vol 56, pp. 407-412

Ozbay, K., Ozmen, D., and Berechman, J. (2006). "Modeling and Analysis of the Link between Accessibility and Employment Growth." *J. Transp. Eng.*, 132(5), 385–393.

Raphael, S., and Rice, L., (1999). "Car Ownership, Employment, and Earnings," working paper.

Redding, S.J. and M.A. Turner (2014) *Transportation costs and the spatial organization of economic activity*. NBER Working Paper 20235. http://www.nber.org/papers/w20235

Rice, L., (2001), Public Transport and Employment Outcomes, Department of Economics Working Paper, University of California

Rosenthal, S. S. and W. C. Strange (2003), "Geography, Industrial Organization, and Agglomeration," *Review of Economics and Statistics*, 85 (2): 377-393.

Sanchez, T.W., (1998), The Connection Between Public Transit and Employment, Center for Urban Studies DP89-7, Portland State University.

Straub, S., (2011) Infrastructure and Development: A Critical Appraisal of the Macro-level Literature, The Journal of Development Studies, 47:5, 683-708

Tavistock (2010) *Guidance for transport impact evaluations. Choosing an evaluation approach to achieve better attribution*. Report to the Department for Transport. Report dated March 2010.

Venables, A.J., Laird, J.J., and Overman, H., (2014), Transport investment and economic performance: Implications for project appraisal, https://www.gov.uk/government/uploads/system/uploads/...data/.../TIEP_Report.pdf

What Works Centre for Local Economic Growth, Evidence Review 7: Transport, July 2015, whatworksgrowth.org