



Department
for Transport

TAG UNIT A2.2

Appraisal of Induced Investment Impacts

September 2016

Department for Transport

Transport Analysis Guidance (TAG)

<https://www.gov.uk/transport-analysis-guidance-webtag>

This TAG Unit is guidance for the **APPRAISAL PRACTITIONER**

This TAG Unit is part of the family **A2 – ECONOMIC IMPACTS**

Technical queries and comments on this TAG Unit should be referred to:

Transport Appraisal and Strategic Modelling (TASM) Division
Department for Transport
Zone 2/25 Great Minster House
33 Horseferry Road
London
SW1P 4DR
tasm@dft.gsi.gov.uk

Contents

1	Overview	2
1.1	Introduction	2
2	Understanding Induced Investments	3
2.2	Transmission Mechanisms and Displacement	3
2.3	Measuring Induced Investments	4
2.4	Economic Narrative	6
2.5	Complementary Interventions	7
3	Quantifying and Valuing Dependent Development	9
3.1	Introduction	9
3.2	Quantifying Dependent Developments	10
3.3	Valuing the Welfare Effects of Dependent Developments	12
3.4	Checklist for Appraising Site-Specific Dependent Developments	16
4	Quantifying and Valuing Output Change in Imperfectly Competitive Markets	16
4.1	Introduction	16
4.2	Quantifying Output Change in Imperfectly Competitive Markets	17
4.3	Valuing Output Change in Imperfectly Competitive Markets	17
4.4	Checklist for Appraising Output Change in Imperfectly Competitive Markets	18
5	Reporting Induced Investment Impacts	18
5.1	Introduction	18
5.2	Economic Case	19
5.3	Strategic Case	19
5.4	Economic Impacts Report	20
6	References	22

1 Overview

1.1 Introduction

- 1.1.1 This unit provides guidance on how to quantify and value induced investments impacts – changes in the level or location of private sector investment as a result of a transport investment – and their inclusion within transport appraisal as part of the value for money assessment and also for use in other parts of the Transport Business Case in terms of number of jobs and GDP. The particular induced investments captured in this unit include dependent development and output change in imperfectly competitive markets.
- 1.1.2 Transport investments can have a broad spectrum of impacts and it is by no means certain that private sector investment will increase at either the local or national level; any induced investments will be context specific. For this reason prior to analysing induced investment impacts, scheme promoters should develop an Economic Narrative, which articulates and justifies the scope of the analysis; this will inform the Appraisal Specific Report (ASR). The Economic Narrative should contain information on the following: (1) a summary of the expected induced investment impacts and justification for their occurrence on the basis of economic theory and context specific evidence; (2) the associated welfare change (including the identification of any relevant market failures); and (3) the methods to quantify and value the impacts.
- 1.1.3 In line with the principles of HMT Green Book guidance, the Department’s appraisal process uses welfare analysis to determine value for money. Under a well-defined set of circumstances user benefits will capture the entire welfare effects of a transport investment, including investment impacts. However, if there are (a) significant feedback effects into the transport market as a result of land use change or (b) ‘distortions’ or market failures that mean the economy is not functioning efficiently, additional benefits (or disbenefits) will arise as the impact of transport investment is transmitted into the wider economy.
- 1.1.4 The value for money assessment is based on national welfare impacts. Key to any assessment of induced investment is **displacement** – the extent to which induced investment impacts at the local level represent a relocation of investment from other locations. Changes in investment at a local level may not represent benefits at a national level.
- 1.1.5 In specific circumstances induced investment impacts may also be valued in terms of changes in Gross Domestic Product (GDP). However, only welfare measures of induced investment impacts, which account for all associated impacts, can be reported in the Economic Case: GDP measures can be reported in the Strategic Case, if they help inform the extent to which a transport scheme will achieve an economic objective, such as to rebalance the economy or regeneration a specific area.
- 1.1.6 The analysis which informs the GDP estimates in the Strategic Case should be presented in an Economic Impacts Report alongside the welfare analysis, to ensure the analysis can be objectively scrutinised.
- 1.1.7 This unit is structured as follows:
- Section 2 “Understanding Induced Investments” explains the mechanisms by which transport schemes can impact on private sector investments and the circumstances in which these impacts may increase welfare over and above user benefits;
 - Section 3: “Quantifying and Valuing Dependent Developments” provides guidance to value the welfare and GDP effects associated with dependent developments;
 - Section 4: “Quantifying and Valuing Output Change in Imperfectly Competitive Markets” provides guidance to value the welfare and GDP effects associated with imperfect competition; and
 - Section 5 “Reporting Induced Investments” provides guidance for reporting the welfare and GDP effects associated with induced investments in the Strategic and Economic Cases, as well as the information to be included in the Economic Impacts Report.

2 Understanding Induced Investments

2.1.1 Induced investments refer to changes in investment as a direct response to a transport investment. Changes in investment will affect the level and location of economic activity, and as a result output, employment and productivity. This section outlines the transmission mechanisms through which transport investment can affect investment and how the impacts can be included in a Transport Business Case.

2.1.2 The section is structured as follows:

- Section 2.2 explains the transmission mechanisms through which transport investments can induce investment and the concept of displacement;
- Section 2.3 provides guidance for measuring the impact of induced investments in the Transport Business Case;
- Section 2.4 provides guidance on producing an Economic Narrative; and
- Section 2.5 discusses how private-sector investments should be appraised where they are dependent on a number of complementary interventions (not just local transport improvements).

2.2 Transmission Mechanisms and Displacement

2.2.1 Through improving accessibility, as measured by reductions in generalised travel costs, transport investment may induce behavioural changes in terms of firms' investment decisions. As mentioned in A2.1 - Wider Impacts Overview, accessibility improvements are equivalent to productivity increases as output can be produced with reduced resources (time and financial). Productivity increases can also be considered as increases in the effective returns to capital and labour: employees can allocate less time to work purposes due to reductions in commuting travel time, which means the opportunity cost of working is reduced (a similar argument holds for businesses).

2.2.2 Increases in the effective returns to labour and capital, the corollary of GTC reductions, will be transmitted to secondary markets, as households and businesses change their behaviour in response to the new opportunities. With respect to increases in the effective returns to capital, businesses may change their decisions about the desirable level or location of investment and hence economic activity and as a result output, employment and productivity.

2.2.3 Induced investments are associated with land use change (changes in the purpose or intensity of usage). For example, if a transport investment were to induce a housing developer to replace terraced housing with an apartment block (induced investment), this would be equivalent to an increase in the intensity of usage. Similarly, if a manufacturing business were to relocate from an urban to a rural area, it may involve a change in the purpose of land use in the latter from agricultural to manufacturing.

2.2.4 The impacts of induced investments will be context specific; the type and magnitude of economic impacts which occur will depend on the scheme type and more importantly the local attributes, such as workforce skills and developable plots. Given the importance of local attributes, complementary interventions, such as investment in skills and land zoning, may be required for the full potential of the transport investment to be realised.

2.2.5 Understanding these impacts is important – not least – because any changes in the level and location of economic activity will change the demand for travel. These feedback effects have the potential to change accessibility, as measured by generalised travel costs, and lead to further changes in behaviour and economic activity. An important role of the Economic Narrative is to understand the potential significance of these feedback effects and to consider how these can be represented in the modelling approach – see A2.1 - Wider Impacts Overview for more details.

Displacement effects

- 2.2.6 Key to any assessment of the impact of induced investment in secondary markets is additionality. In accordance with HMT Green Book guidance only government expenditure which affects the supply-side of the economy is considered additional.
- 2.2.7 Whilst transport investment may increase investment at the local level, only changes at the national level are considered additional. The extent to which an induced investment is additional will be dependent on the level of deadweight and displacement.
- Deadweight – the level of investment which would have occurred in the absence of the transport investment (non-dependent development); and
 - Displacement – the extent to which investment is relocated from one industry or location to another.
- 2.2.8 Displacement can occur in many markets, for example:
- Capital market – the decision to undertake a given investment may be at the expense of other potential investments. For example, a transport scheme may affect where a developer decides to build new offices rather than affecting the total number offices built or the type of investment (e.g. retail or residential development).
 - Product market – increased production by one business may lower the demand for goods of their competitors. For example, a new supermarket may draw customers away from existing retailers.
 - Labour market – an investment may draw inputs such as labour away from alternative uses. As a consequence, transport schemes may influence the location (but not necessarily the level) of total employment.
- 2.2.9 If induced investment leads to displacement of economic activity, the areas or industries losing economic activity will experience a loss of investment. For example, if households were to move to a new residential development and abandon existing houses, the net national impact would equal the value of the new houses less the value of abandoned properties. Likewise, if consumers were to shop at a new retail development and abandon an existing shopping area, the net national impact would equal the value of the new retail development less the value of the abandoned retail units.
- 2.2.10 There is a lack of evidence on the extent to which displacement occurs. Therefore, the default position of all transport appraisals is 100% displacement unless context specific evidence can be provided, which demonstrates that increases in investment will lead to increase in economic activity at the national level. In the case of housing, evidence should be presented that residential investment is responding to demand pressures.

2.3 Measuring Induced Investments

- 2.3.1 The Department's appraisal process is based on the principles of the HMT Green Book guidance, which advocates the use of cost-benefit (welfare) analysis to determine the value for money of investment spend. Welfare analysis captures a broad range of impacts, such as economic, environmental and social. The results of welfare analysis are reported in the Economic Case and inform the value for money assessment.
- 2.3.2 GDP analysis may be used to inform the strategic case. The results of GDP analysis should not be used in the economic case and value for money assessment, A2.1 - Wider Impacts Overview for information on the links between GDP and Welfare analysis.

Welfare Analysis

- 2.3.3 Within Welfare analysis economic impacts are primarily captured by the estimation of user benefits – see User and Provider Impacts (A1.3). Under a well-defined set of circumstances user benefits will capture the entire welfare impact of a transport investment. These conditions are that the feedback effects into travel demand, as a result of land use change, are insignificant and that the rest of the economy is operating perfectly efficiently. Whilst improvements in transport may be transmitted into the wider economy (e.g. increased productivity being passed through as reduced demand for labour) under these assumptions such changes are simply transfers and net out in aggregate and can be ignored.¹
- 2.3.4 These conditions fail if there are (a) significant feedback effects into the transport market as a result of land use change or (b) ‘distortions’ or market failures that mean the economy is not functioning efficiently. In these situations additional benefits (or disbenefits) may arise when the impact of transport improvements is transmitted into the wider economy.
- 2.3.5 Table 1 defines and describes market failures and distortions associated with induced investments. This unit provides guidance to appraise induced investment impacts associated two particular types of market distortions: dependent developments which are associated with land rationing and investments to expand output in imperfectly competitive markets. Sections 3 and 4 provide guidance as to how these wider economic impacts can be quantified and valued.

Table 1 - Market failures and distortions associated with induced investments		
Market failures and distortions	Explanation	Potential context-specific evidence to identify market failures and distortions
Product markets		
Imperfect competition	Where markets are dominated by a small number of businesses, there is a risk that supply is restricted in order to raise prices above marginal production costs. This may result in an inefficiently low levels of production and investment in this sector.	<ul style="list-style-type: none"> • Small number of businesses in a given sector. • Evidence for ‘barriers to entry’ of a given market. • Evidence that businesses in this sector have ‘market power’ (i.e. can set prices above marginal production costs).
Tax distortions	Firms make investment decisions on the basis of private costs and benefits. Nevertheless, the requirement to pay tax on profits may distort businesses incentives, potentially resulting in an inefficiently low levels of production and investment.	<ul style="list-style-type: none"> • Evidence that tax distortions are influencing businesses’ investment decisions.
Positive externalities from product variety	There may be positive externalities to consumers and businesses as a result of an increase in the variety of goods and services available.	<ul style="list-style-type: none"> • Evidence that proposed investments will significantly increase the variety of goods and services available
Land markets		
Imperfect competition	If land is owned by a small number of individuals or institutions there is a risk that supply is restricted in order to raise the value of developed land. This may result in an inefficiently low level of investment in new developments.	<ul style="list-style-type: none"> • Land held by a small number of land-owners. • Large areas of under-utilised land in city centres (e.g. warehouses, poor quality developments etc).
Co-ordination failure	Developers may under-invest in local transport improvements due to co-ordination failure, resulting in an	<ul style="list-style-type: none"> • Evidence that there are a number of developers who might benefit from local transport improvements.

¹ See TIEP (2014).

	inefficiently low level of investment in new developments.	
Land rationing	Planning policies may be inefficiently restrictive, resulting in an inefficiently low level of investment in new developments.	<ul style="list-style-type: none"> • Significant differential between the price of developed and un-developed land in the local area.
Externalities from dynamic clustering	New developments (both residential and non-residential) may raise productivity due to dynamic clustering (i.e. productivity benefits from increased clustering of households and businesses). This may result in productivity losses elsewhere (due to dis-agglomeration effects)	<ul style="list-style-type: none"> • Large-scale developments to be located within a city's Functional Urban Areas (defined in TAG Unit A2.4 – Productivity Impacts). • Large-scale housing developments to be built within a city's travel-to-work area.

2.3.6 In addition there are a number of further ways in which private-sector investments may result in wider economic impacts. For example:

- **Dynamic clustering**– Increases in economic activity near existing economic clusters may result productivity benefits due to 'dynamic clustering' – see TAG Unit A2.4.
- **Employment impacts** - New non-residential developments may be associated with a move to more/less productive jobs – see TAG Unit A2.3.
- **'Attractiveness' benefits** – new commercial, industrial or retail developments may benefit existing businesses and consumers by increasing the variety of goods and services available. These benefits are only likely to be significant for large-scale developments such as station-area regeneration schemes. Currently WebTAG does not include methods for estimating these impacts; however, Venables (2015) includes a discussion how these impacts may be quantified.

2.3.7 There are a number of other potential market failures and distortions, which may occur in specific local contexts. If other types of market failures are considered relevant to a particular scheme, these should be justified in the Economic Narrative. See M5.3 – Supplementary Economy Models for guidance on the analytical principles for assessing market failures.

Gross Domestic Product

2.3.8 In certain circumstances GDP analysis may be used to supplement the cost benefit analysis, such as scheme prioritisation or understanding market failures not captured in the wider economic impacts guidance. For full details on assessing the costs and benefits of economic impacts and the circumstances in which GDP analysis may be warranted see TAG Unit A2.1.

2.3.9 Gross Domestic Product measures the value of marketable output produced by the factors of production and not the change in welfare. For this reason it should **not** be reported in the Economic Case. GDP estimates should be reported in the Strategic Case, if they inform specific economic objectives, such as to rebalance the economy or regenerate a local area.

2.3.10 In many instances the economic objectives of the Strategic Case will be locally focussed, such as to increase investment and GDP in a regeneration area. In such circumstances displacement may not be a primary concern of the scheme objectives. However, the national GDP impact should also be presented. This ensures that there is a direct read across from the national welfare measure in the Economic Case to the GDP measure reported in the Strategic Case.

2.4 Economic Narrative

2.4.1 Any analysis of induced investment impacts should be justified in an Economic Narrative, as set out in A2.1 - Wider Impacts Overview. Within the Economic Narrative, the scheme promoter should describe what, if any, induced investment impacts are expected to occur and justify these. In

addition, the scheme promoter should identify the welfare impacts associated with any investment impacts, whether these impacts are captured fully by user benefits or whether there are market failures, which provide additional sources of benefits and disbenefits. Finally, the Economic Narrative should outline the methodologies which will be utilised to quantify and value the induced investment impacts. Box 1 provides a checklist of the types of information, which should be provided in the Economic Narrative, when assessing induced investment impacts.

- 2.4.2 The next sections of this unit provides guidance to estimate two potential induced investment impacts: dependent developments – new residential or non-residential developments which require a complementary transport investment to receive planning approval; and the output change in imperfectly competitive markets – an increase in the production of goods or services where businesses benefiting from the transport improvement compete in imperfectly competitive markets.
- 2.4.3 If alternative transmission mechanisms or market failures have been identified, or it is decided to utilise more context specific parameters in the analysis than those presented in this unit, the employment impacts can be assessed – see M5.3 for guidance on the use of Supplementary Economic Modelling (SEM). Note the results of SEM can only be reported as sensitivity tests to the WebTAG methodologies – see TAG Unit A2.1 for more information.

2.5 Complementary Interventions

- 2.5.1 The outcome of a transport scheme may depend on a range of complementary public- and private-sector interventions. For example, proposed new developments may be 'dependent' on a number of other public-sector or private interventions in order to proceed, such as the provision of utilities or policies to develop the skills of the local workforce.
- 2.5.2 All relevant complementary interventions should be identified and justified in the Economic Narrative. In addition, the assumptions about the likelihood they will proceed and how they will be represented in the analysis should be explained.
- 2.5.3 The core scenario from transport appraisals should include only those complementary interventions which are near certain or more than likely to occur. Alternative scenarios should also be presented alongside under a range of plausible assumptions for these complementary interventions (e.g. alternative assumptions for developable land). For further information on scenario testing see TAG Unit M4 - Forecasting and Uncertainty.

Box 1: Example Information required in Economic Narrative for Induced Investment Impacts and Output Change in Imperfectly Competitive Markets

Below is a checklist of the types of information that should be presented in the Economic Narrative, if induced investment impacts are to be analysed. **This list is not exhaustive** and additional information may be required to set the context of the transport investment, justify the impacts and explain the appraisal approach.

1. Expected induced investment effects

- Is the transport investment expected to have induced investment impacts?
- If so, what effects are expected to occur?
 - Are these expected to be additional at the national level?
- Are the impacts dependent on any non-transport complementary interventions?
- If so, what complementary interventions are required and what is their relative importance in the realisation of the expected impact? Are the impacts expected to be additional at the national level?

2. Justify expected induced investment impacts

- What is the transmission mechanism through which transport investment is expected to have induced investment effects?
 - What evidence is there that transport acts as a barrier to investment?
- What evidence is there that firms will make additional investment as a result of the transport investment?

3. Dependent developments

- Has context-specific evidence been presented that the private-sector investment decision is 'dependent' on the transport improvement (i.e. will not occur without the scheme)?
 - If the private-sector investment will proceed even without the scheme then associated welfare impacts cannot be attributed to the scheme.
- Will the new development only be granted planning permission if there are local improvements to the transport network?
- Is the transport improvement expected to 'unlock' land for development which couldn't previously be accessed?
- Have all complementary interventions together with their relative importance in the realisation of the development been identified?
- Have all alternative development sites been identified?
 - To what extent will the development displace economic activity?

3. Output change in imperfectly competitive markets

- Do businesses benefiting from the transport improvement compete in imperfectly competitive markets?
- Is the expansion of production of goods and services 'dependent' on the transport improvement?

4. Quantifying and valuing induced investment impacts

- How are the induced investment effects to be quantified and valued?

3 Quantifying and Valuing Dependent Development

3.1 Introduction

- 3.1.1 A dependent development is a specific type of induced investment. As outlined in A2.1 - Wider Impacts Overview, transport investments can induce land use change. However, this need not necessarily be the purpose of the transport investment; land use change may be an unintended consequence of a scheme which targets a problem on the transport network. In the case of dependent development, the transport investment is targeted at changing the land use of a specific, identifiable plot.
- 3.1.2 The National Trip End Model (NTEM) contains forecasts of population, households and employment and allocates this across Great Britain. The accommodation of these households and employees will necessitate new residential and non-residential developments. However, these developments may be dependent upon complementary investments, such as transport investment, utility connections or the provision of school places – dependent development is the name given to those residential and non-residential developments which require a complementary transport investment.
- 3.1.3 Dependent development refers to a specific plot of land, which requires a complementary transport investment in order for a residential or non-residential development to proceed; in the absence of a transport scheme, the transport network would not provide a 'reasonable level' of service to new and/or existing users.
- 3.1.4 There is no precise definition of reasonable level of service, such that decisions about dependency are judgement based. However, if additional traffic can be accommodated by the network without significant increases in the costs of travel for existing users, then the network can be assumed to provide a reasonable level of service.
- 3.1.5 For example, if traffic flows on a road network remain within the 'flat' part of the speed/flow curve, the network should be assumed to provide a reasonable level of service. Similarly, if there is no crowding on a public transport network, it should be assumed to be providing a reasonable level of service.
- 3.1.6 This approach is consistent with the proposition that what is of concern to the transport authority is the transport external costs resulting from the new development. "Transport external cost attributable to the new development" refers to the change in costs (including time, vehicle operating costs and charges) caused to all other transport users on the network by the traffic generated by the new development. Transport external costs are discussed in more depth in Appendix B. In addition, the dependent development may be associated with environmental and social impacts, such as local air quality and noise – see section 3.3.
- 3.1.7 As outlined in TAG Unit A2.1, the methodology to estimate user benefits is less accurate under land use change and this could potentially have significant implications for Transport Business Cases predicated on land use change. In the case of dependent developments, the user benefits, estimated under the fixed land use assumption, can be supplemented with an estimate of the change in land value; the land value uplift approach may only be adopted in cases of dependent development due to methodological short-comings – see section 3.4 for details on estimating land value uplift. Changes in land value associated with dependent development can potentially include the welfare associated with wider economic impacts arising at that site. Therefore, they should be presented as a sensitivity test and the risk of double counting considered in the Economic Narrative and presentation of results.
- 3.1.8 The quantification and valuation of dependent developments is associated with distortions and market failures in the land market. Land rationing, where the regulation of land for housing and other activities leads to planning restraints on residential and commercial uses can restrict supply. Estimation of dependent development impacts values the welfare benefits resulting from a transport investment's impact on land rationing; easing the constraints on the use and development of land.

3.1.9 Prior to analysing dependent developments an Economic Narrative should be produced. It should include information on the following:

- a. identification of a development and any other complementary interventions
- b. justification of development's dependence on a transport investment and any identified complementary interventions;
- c. identification of the associated welfare effect, including any distortions in the land market; and
- d. outline how the dependent development guidance will be applied.

3.1.10 See section 2 above for example information for inclusion in the Economic Narrative. For further guidance for producing an Economic Narrative see A2.1 - Wider Impacts Overview.

3.1.11 This section provides guidance for quantifying and valuing the welfare, jobs and GDP impacts associated with dependent developments.

- Section 3.2 provides guidance to quantify potential site-specific dependent developments;
- Section 3.3 provides guidance to value dependent developments; and
- Section 3.4 provides a checklist for valuing the welfare, jobs and GDP impacts of site-specific dependent developments.

3.2 Quantifying Dependent Developments

3.2.1 The quantification of dependent developments requires several transport model scenarios, summarised in Table 1. These are required to estimate the following:

- Dependency test
- Identification of Appropriate Scheme
- User benefits under fixed land use
- Transport external costs under variable land use (see section 3.3)

Table 1 – Combinations of Scenarios – with/without dependent development and the transport scheme

	Without Dependent Development	With Dependent Development
Without transport scheme	P	Q
With transport scheme	S	R

* This table appears similar to Table 2 in TAG Unit A2.1, however, there are subtle differences. Scenario A in TAG Unit A2.1 is a baseline scenario i.e. without transport scheme and without land use change. In contrast to this scenario P is a hypothetical scenario, which includes those parts of residential and commercial developments which can be accommodated without imposing excessive costs on existing transport users. In reality a developer may choose not to construct the non-dependent residential or commercial development in the absence of the transport scheme. The hypothetical scenario is required in order to identify an appropriate transport scheme and the associated costs and benefits.

Dependency Test

3.2.2 The dependency test demonstrates the extent to which a development is dependent upon a complementary transport investment. A dependency is likely to occur where a development will breach 'a reasonable level of service' on the transport network. The following should be noted with respect to the dependency test:

- There is no precise definition of 'reasonable level of service', such that decisions regarding dependency are ultimately judgment based;

- If a development is not dependent on a transport scheme, then the need for a transport scheme should be considered solely on transport grounds.

3.2.3 Appendix A sets out in detail how these tests can be undertaken. The underlying principle is to compare the transport flows and costs on the existing transport network, with and without the proposed development. With additional development, traffic flows will usually increase. To demonstrate dependency, this increase must be exceptional to show that the network has reached a critical point.

3.2.4 These tests should consider the extent to which some, but not all, of the potential developments could be accommodated in the existing transport network. It may be the case that only a fraction of the development is dependent on a transport investment. In such instances the non-dependent traffic should be assumed to occur in both the with- and without-transport scenarios.

Identification of an Appropriate Transport Scheme

3.2.5 The selection of an appropriate scheme should take account of the need to resolve the dependency as well as the wider aims for the transport scheme.

3.2.6 A key element of the assessment should be to explore whether each transport scheme considered resolves the dependency issue under consideration. To carry out this assessment, a third scenario must be considered for each potential transport scheme: Scenario C - with the new development and with the transport scheme

3.2.7 This scenario should be subject to the same tests and analyses as were used in the dependency testing (Appendix A). Attention should focus on those parts of the network where the new development is expected to have greatest impact.

3.2.8 For some transport schemes, this analysis may suggest that dependency has not been fully resolved. There may be good reasons for retaining a scheme that does not fully resolve dependency. For example, if a transport scheme is being developed to address transport related goals, it may not be sufficient to address the needs of a new development as well. In these circumstances, further analysis should be carried out to determine the extent to which the transport scheme does 'unlock' the development. Only that part of the development which would be unlocked by the transport scheme should be used in the assessment of the benefits of the dependent development.

3.2.9 If a low cost transport scheme can be shown to resolve the dependency, any more costly transport schemes should be tested as increments to the low cost transport scheme. The incremental analysis should assume the low cost transport scheme and the development are part of the 'without scheme' transport scenario. A conventional transport appraisal should be used to assess the incremental transport benefits of the more costly transport scheme.

Other Non-Transport Complementary Interventions

3.2.10 A development may be also dependent on other non-transport complementary interventions, such as the provision of school places or utilities. These other non-transport complementary interventions should be identified, such as through discussions with developers and local authorities, and appropriately represented in the appraisal.

3.2.11 Currently, there is no guidance for the inclusion of non-transport complementary interventions in appraisal or attribution of impacts. However, if these are near certain or highly likely to be relevant for a scheme appraisal, the following steps should be followed:

1. The non-transport complementary interventions should be identified in the Economic Narrative (see sub-section 2.3 for advice on developing an Economic Narrative);

2. Report assumptions and forecasts regarding the extent to which complementary interventions, such as utility upgrades, are expected to occur;
3. Model and report scenario analysis to demonstrate the core scenario results are significant given uncertainty surrounding complementary interventions; and
4. The associated costs, if known, should be accounted for in the value for money assessment as disbenefits – see section 3.3 for more details.

3.2.12 Alternative scenarios should be presented alongside assumptions that complementary investment will go ahead. For further information on scenario testing see Forecasting and Uncertainty M4.

3.3 Valuing the Welfare Effects of Dependent Developments

3.3.1 This section sets out methods to estimate the incremental impact on scheme benefits arising from a transport scheme unlocking a development which would not have been possible in the absence of that investment. In estimating the incremental impact of dependent development on the benefits and costs of a scheme four elements need to be considered:

- Transport External Costs
- Environmental and Social Impacts
- Land Amenity Value
- Land Value Uplift adjusted for Displacement

3.3.2 If the development is also dependent on other non-transport complementary interventions (NTCI), such as the provision of local schools or utilities, and the costs are known, these should also be included in the valuation of the dependent development - NTCI. Note: if the developer has contributed to the cost of any complementary interventions, these may be accounted in the estimate of land value uplift – this will depend on the valuation methodology. In cases where the land value uplift has been estimated using the residual land valuation methodology (Appendix D), developer contributions will already be included within the estimation of land value uplift, such that NTCI should only include those costs borne by third parties.

3.3.3 These elements are combined to establish the incremental impact on scheme benefits. As discussed in unit A2.1 these should be added to estimates of other benefits as a sensitivity test as part of a Level 3 appraisal. Given the potential for land-values to double count impacts from elsewhere in the appraisal and/or rely on further complementary investment not considered in schemes costs, the onus is on the analyst to demonstrate in the Economic Narrative the extent to which the increase in land value is additional and to describe the full range of interventions required to deliver that site. The evidence presented in the Economic Narrative will then inform the weight placed on this sensitivity test.

Table 2: Benefits arising from Dependent Development

<i>Total Benefits = -TEC_v + Other_v + LVU_D - LAV - NTCI</i>	
<i>TEC</i>	Transport External Costs
<i>Other</i>	This includes Environmental Impacts, and Social and Distributional Impacts – TAG units A3 and A4 respectively
<i>LVU_D</i>	Land Value Uplift adjusted for displacement

<i>LAV</i>	Land Amenity Value
<i>NTCI</i>	This refers to the costs associated with Non-Transport Complementary Interventions – the benefits are assumed to be captured by the land value uplift.
<i>v</i>	Variable land use – land use differs between the ‘do minimum’ and ‘do something’ scenarios, scenarios A and C respectively.

3.3.4 This is a rapidly developing area and the method detailed above deals with one form of dependent development. Therefore, it is critical that the Economic Narrative sets out the basis on which dependent developments may occur in response to investment in transport. In more complex cases it is advisable to contact the Department at an early stage to discuss potential approaches. This is particularly recommended (though not limited to) situations where:

- a significant number of dependent trips are made on public transport;
- it is considered that the scheme will unlock development across a wide area rather than at a specific site; and
- the dependent development is considered likely to generate significant dynamic agglomeration impacts.

Transport External Costs

3.3.5 Transport external costs refer to the costs imposed by dependent transport users on all other users, such as increased levels of congestion or over-crowding. These costs arise as a result of those trips which are dependent on the transport scheme. Where a transport model is available and it is proportionate to do so transport external costs should be estimated using the approach in Appendix B. If a transport model is not available, an alternative approach is to estimate this impact using the Marginal External Cost guidance in TAG Unit A5.4.

3.3.6 The assessment of transport external costs of the dependent development requires two transport model runs:

- Scenario S - without the new housing but with the transport scheme; and
- Scenario R - with the new housing and with the transport scheme

3.3.7 Both runs should employ the same transport network, which should include the transport scheme. Both of these model runs should be straightforward to carry out, since both scenarios would result in realistic forecasts of level of service.

3.3.8 An important point to note is that the transport scheme should reduce the transport external costs, compared to the without-scheme scenario, and the transport external costs estimated at this stage in the baseline scenario).

Environmental and Social Impacts

3.3.9 The transport scheme may be associated with environmental and social impacts, such as local air pollution and road safety impacts. These impacts will arise as a result of dependent users and any changes to the travel behaviour of other users. Environmental and social impacts should be estimated using the approaches described in TAG Units A3 and A4. The assessment of environmental and social impacts requires two transport model runs:

- Scenario P - without the new housing and without the transport scheme; and
- Scenario R - with the new housing and with the transport scheme

Land Amenity Value

- 3.3.10 The 'amenity value' of a plot of land refers to the level of pleasantness of the area. For example, where new developments are built on greenfield land there may be a loss in the land amenity value if the area becomes less desirable for recreational activity.
- 3.3.11 Default assumptions for the amenity value of different types of land can be found in the WebTAG data book 'Valuing Housing impacts Workbook', based on estimates obtained by Department of Communities and Local Government (2001). The welfare impact from the change in land amenity value can be estimated as the difference between the present value benefits for different land types: it is assumed that developed land has no amenity value, such that land use change is associated with a loss of amenity value.

$$LAV = \text{Amenity Value}_{\text{Developed Land}} - \text{Amenity Value}_{\text{Existing Land Use}}$$

$$LAV = - \text{Amenity Value}_{\text{Existing Land Use}}$$

- 3.3.12 Where a scheme is expected to have major landscape impacts it may be desirable to undertake context-specific analysis for the change in land amenity value.

Land Value Uplift and Displacement

- 3.3.13 Land value uplift measures the difference between the price of land in its new and former uses and represents the private gain to land owners. It is used as a proxy to value the welfare effects associated with the dependent development.
- 3.3.14 Land value uplift will capture any impacts which are capitalised into land values. It could potentially capture any of the following impacts: user benefits, land market distortions and other wider economic impacts, such as agglomeration economies.
- 3.3.15 In the case of the dependent development the associated land value uplift will capture user benefits to new residents, which are missing from user benefits estimated under fixed land use; these can be considered additional to the fixed land use user benefits estimated via the rule of a half methodology. Note land value uplift should only be estimated for those parts of the development which are dependent on the transport investment. Nevertheless, there are significant drawbacks with the use of land value uplift in transport appraisal:
1. Theory suggests the relationship between land rents and GTCs is ambiguous; land rents need not necessarily increase in response to GTC reductions, the response will depend upon the elasticity of substitution between land and other consumption goods;²
 2. Land value uplift will capture any impacts capitalised into land, such that causal factors are ambiguous: it could potentially include the welfare associated with wider economic impacts and complementary interventions, which could potentially lead to double-counting or the false attribution of benefits respectively. For this reason the default position is that other wider economic impacts should not be added to estimates of land value uplift;
 3. Land value uplift is a local site specific measure, as such it will not account for the loss of land value on other sites, which will occur if there is a relocation of economic activity. In other words it fails to account for displacement. Furthermore, there is a lack of robust evidence on displacement factors – the extent to which land value uplift at one specific plot is at the expense of another area – which could lead to inaccurate estimates of the net land value change.
- 3.3.16 For these reasons, the scheme promoter should attempt to identify the causal factors driving the land value uplift, such as user benefit capitalisation, land market distortions or other wider economic impacts. In addition, the robustness of land value uplift as a measure of welfare is

² Arnott, R. J. & Stiglitz, J. E. (1981), "Aggregate Land Rents and Aggregate Transport Costs," Economic Journal, Royal Economic Society, vo. 91 (362), pages 331-347, June

considered low and only included as sensitivity analysis within the value for money assessment – see section 6 for details on reporting the land value uplift associated with dependent developments.

- 3.3.17 The preferred method to estimate land value uplift is the residual valuation methodology – see Appendix A. The application of this methodology will require a valuation surveyor. Where this is not possible, land prices can be estimated by comparison to similar developments or using benchmark estimates from land value surveys. Potential sources of benchmark land price data include the following:
- DCLG (2015) provides estimates for the average prices of residential, greenfield and brownfield land in England (with residential land split by Local Authority).
 - VOA (2011) provides estimates for average land prices for greenfield land, residential developments, retail developers, offices and industrial developments split by region.
 - DCLG’s appraisal guidance includes data for average land-value uplifts for new business parks and city centre developments on brownfield and greenfield land split by region.
- 3.3.18 Note benchmark results will not be context specific and could provide estimates significantly different from the outturn.
- 3.3.19 All land prices should be converted to the same base year as the rest of the transport appraisal and reported in market prices (i.e. including indirect tax).
- 3.3.20 As mentioned in above, land value uplift is a local site specific measure and does not account for the relocation (displacement) of economic activity or households from other locations. As a result land value uplift is likely to over-estimate the national welfare effect of a dependent development. For example, new offices or houses in one location may reduce the level of economic activity or number of households elsewhere, if businesses or households were to relocate. Thus land value uplift should be adjusted to account for displacement.
- 3.3.21 As mentioned above, one element of dependent developments is the accommodation of NTEM household and employment growth forecasts. In this context displacement is demonstrated by the extent to which the dependent development could take place on an alternative site with either no transport investment or a reduced requirement. This can be done as follows:
1. Estimate the number of houses or employment space required to accommodate the NTEM forecasts: the required number of houses should be assumed equal to the forecast increase in household, while employment space should be assumed equal to the average floor space per employee. Note deviations from these simplifying assumptions should be explained.
 2. Estimate the extent to which all other developable sites, for which no or a less significant complementary transport investment is required, can accommodate the NTEM consistent housing and employment forecasts.
- 3.3.22 If the other developable sites can accommodate the NTEM consistent housing and employment forecasts, the dependent development is **not** additional: the land value uplift would be of zero value at the national level.
- 3.3.23 Nevertheless even in cases where the land value uplift is 100% displaced there could be other market failures present, such as agglomeration impacts, which make the identified site more attractive than the alternatives. If such a case were made, the market failures and an appropriate valuation methodology would need to be identified and justified in the Economic Narrative. Note if the market failure cannot be valued, the impact should be reported as a non-monetised impact in the value for money assessment.

Other Non-Transport Complementary Interventions

- 3.3.24 Development may be also dependent on non-transport complementary interventions, such as the provision of local schools or utilities. For this reason the land value uplift associated with a scheme may not be entirely attributable to the transport investment. If the costs are known, these should be included in the valuation of the dependent development as disbenefits to ensure the analysis reflects all known and quantifiable costs and benefits.
- 3.3.25 Note it may be the case that the costs of non-transport complementary interventions are unknown. In such instances, non-transport complementary interventions should be reported in the Economic Case together with an explicit acknowledgement that it has not been possible to cost these and care should be taken when interpreting the benefits of the transport scheme.

Estimating Jobs and GDP Impacts

- 3.3.26 The local or national jobs and GDP impacts associated with a dependent development cannot be inferred from the land value uplift approach. If an estimate of jobs and GDP is considered relevant to the Transport Business Case, such as to inform an economic objective in the Strategic Case, these may be estimated by way of ‘additionality modelling’ – see M5.3 – Supplementary Economy Modelling.
- 3.3.27 Note estimates of jobs and GDP should **not** be reported in the Economic Case, as these are non-welfare measures. Land value uplift is the appropriate measure of welfare associated with a dependent development, as it values distortions in the land market.

3.4 Checklist for Appraising Site-Specific Dependent Developments

- 3.4.1 Table 3 provides a checklist of the key evidence requirements when quantifying and valuing site-specific dependent developments.

Table 3 - Site-Specific Dependent Development Checklist	
Issues	Check
Identify and quantify potential site-specific developments;	
Demonstrate that these developments are ‘dependent’ on the transport improvement	
Identify market or government failures associated with these developments	
Demonstrate that welfare gains from site-specific dependent developments are ‘additional’ at the national level (i.e. increase the productive capacity of the country)	
Identify and value other public-sector costs associated with enabling dependent developments	
Estimate the welfare impacts associated with these site-specific dependent developments	
(If required) estimate the jobs and GDP impacts associated with site-specific dependent developments	
Undertake uncertainty and scenario testing	

4 Quantifying and Valuing Output Change in Imperfectly Competitive Markets

4.1 Introduction

- 4.1.1 Output change in imperfectly competitive markets refers to changes in the level of economic activity as a result of a transport investment. Changes in the level of output as a result of a transport investment are not unique to imperfectly competitive markets. However, the presence of a market

failure – the market structure affecting the level of competition – means that there are additional sources of welfare which should be captured.

- 4.1.2 In a perfectly competitive market the value of the output is equal to the cost of production. A reduction in generalised travel costs lowers the costs of production, which as noted in section 2 acts to raise the effective return to capital and induce investment. The value of the resulting increased output will equal the magnitude of the change in generalised travel costs. Therefore the welfare effects, associated with increased output, resulting from a transport investment will be fully captured by business user benefits.
- 4.1.3 In the case of imperfectly competitive markets the value of the output is greater than the costs of production. As in the case of perfect competition, a reduction in generalised travel cost will induce investment and hence output. However, the value of the resulting increased output will not be fully captured by the magnitude of the change in generalised travel costs. Business user benefits will therefore fail to capture the total value of the output change. The methodology described below estimates the additional welfare effects, associated with increased output in imperfectly competitive markets, resulting from a transport investment.
- 4.1.4 Prior to analysing output changes in imperfectly competitive markets an Economic Narrative should be produced. It should include information on the following: (1) identify potential changes in output as a result of a transport investment and justify these; (2) identify the sources of welfare, including any market failures and distortions; and (3) outline how the output change will be quantified and valued. See A2.1 - Wider Impacts Overview for guidance on producing an Economic Narrative.
- This section provides guidance for quantifying and valuing the benefits associated with output change in imperfectly competitive markets. The methodology contained within the section implicitly assumes induced investment and land use but these are not quantified. The structure of this section is as follows:
 - Section 4.2 provides guidance to quantify output change in imperfectly competitive markets;
 - Section 4.3 provides guidance to value dependent developments; and
 - Section 4.4 provides a checklist for valuing the welfare, jobs and GDP impacts of site-specific dependent developments.

4.2 Quantifying Output Change in Imperfectly Competitive Markets

- 4.2.1 The methodology to estimate output change in imperfectly competitive markets does not seek to explicitly quantify the change to net investment or the associated land use. Instead the methodology uses the conventional transport user benefits and applies an uplift factor.
- 4.2.2 The estimation of convention transport user-benefit assessment requires two transport scenarios, in which the only difference is the presence of the transport scheme in the do-something.
- 4.2.3 Note because of potential double-counting, output change in imperfectly competitive markets should **not** be estimated in cases of dependent development. If output change in imperfectly competitive markets are to be estimated with variable land use, scenarios A and C in Table 2 of TAG Unit A2.1 should be used. See A1.3 User and Provider Impacts for guidance on how to estimate user benefits.

4.3 Valuing Output Change in Imperfectly Competitive Markets

Welfare Effects

- 4.3.1 The welfare effects which arise due to the presence of imperfect competition (the market structure distorts the efficient operation of the market), is estimated by applying a 10% uplift factor to the business and freight user benefits – see DfT (2005) for an explanation of how this has been estimated.

- 4.3.2 The methodology outlined here is a simplified approach. Supplementary economy modelling may be used to ascertain more context specific estimates of the welfare effects arising from imperfect competition – see M5.3 Supplementary Economy Modelling. Note the results of supplementary economy modelling should be reported alongside those derived from the methodology in this section and will only be included as a sensitivity test in the value for money assessment.
- 4.3.3 Output change in imperfectly competitive markets does not need to be interpolated between modelled years or extrapolated after the final modelled year. This is because it is a proportion of business user benefits which should have already been interpolated and extrapolated – see TAG Unit A1.3.

Estimating Jobs and GDP Impacts

- 4.3.4 The increase in GDP associated with output change in imperfectly competitive markets is equal to the additional welfare, as estimated by the 10% uplift (described above). It is not possible to infer the change in jobs associated with increased output. As a consequence where there is a desire to estimate the change in employment associated with increased production this should be done following principles laid out in M5.3 – Supplementary Economy Modelling.

4.4 Checklist for Appraising Output Change in Imperfectly Competitive Markets

- 4.4.1 Table 4 provides a checklist of the key evidence requirements when quantifying and valuing wider economic impacts from output change in imperfectly competitive markets.

Table 4 - Output Change in Imperfectly Competitive Markets Checklist	
Issues	Check
Provide evidence that businesses will increase output in response to the transport improvement	
Valuing transport user benefits	
Value the wider economic impact from output change in imperfectly competitive markets	

5 Reporting Induced Investment Impacts

5.1 Introduction

- 5.1.1 This section provides guidance on how Induced Investments should be reported in both the Economic and Strategic Cases of the Transport Business Case.
- 5.1.2 The purpose of the Transport Business Case is to aid the decision making process by presenting the robust evidence of the potential impacts of a transport scheme. Thus where the expectation of induced investment impacts can be justified and credible analysis produced, these should be reported.
- 5.1.3 Where precisely the induced investment impacts are reported in the Transport Business Case depends on the measurement approach. Only welfare analysis can be reported in the Economic Case, whilst GDP can be reported in the Strategic Case.
- 5.1.4 Note: whilst GDP and welfare analysis are reported in different parts of the business case, they both measure a common economic impact. As such there should be a common forecast of national employment impacts underpinning the welfare and GDP analysis.

5.2 Economic Case

- 5.2.1 The Economic Case sets out evidence to inform whether a scheme offers value for money to the taxpayer. This includes setting out quantitative and qualitative evidence for a scheme's impact on social welfare (including impacts on the economy, environment and society) and the cost of the scheme to the broad transport budget. All the costs and benefits of a scheme should be assessed at the national level, which for DfT-funded investments means the United Kingdom.

Site-Specific Dependent Development

- 5.2.2 Benefits arising from dependent development should be included as a sensitivity test as part of a Level 3 appraisal (see unit A2.1). Given the potential for land-values to double count impacts from elsewhere in the appraisal and/or rely on further complementary investment not considered in schemes costs, the onus is on the analyst to demonstrate in the Economic Narrative the extent to which the increase in land value is additional and to describe the full range of interventions required to deliver that site. The evidence presented in the Economic Narrative will then inform the weight placed on this sensitivity test.

Output Change in Imperfectly Competitive Markets

- 5.2.3 The monetised welfare benefits associated with output change in imperfectly competitive markets be included in the scheme's adjusted benefit-cost ratio (BCR) but not in the initial BCR. This recognises that the methods and evidence used to estimate these impacts are less widely-accepted.

5.3 Strategic Case

- 5.3.1 The purpose of the Strategic Case is to determine whether a proposed transport scheme achieves Government objectives, such as to regenerate a local area or reduce noise pollution. It is here that non-welfare measures of economic impacts, such as GDP, can be reported, if they inform the extent to which the proposed transport scheme achieves the Government's objectives. In the case of output change in imperfectly competitive markets, the welfare estimate is equivalent to the GDP change and the latter may be reported here. If additionality modelling is used to estimate GDP and jobs associated with dependent developments, these may also be reported in the Strategic Case.
- 5.3.2 If reporting economic impacts in the Strategic Case, the following principles should be adopted:

1. **Use appropriate metric to inform Strategic Case. This may differ from Economic Case, which must be welfare based.**

Within the Economic Case welfare is the metric used to value economic impacts. This serves a specific purpose to inform the value for money assessment. In the Strategic Case, however, an economic objective may be better informed by other metrics, such as change in GDP. For example, an economic objective to boost economic activity in a regeneration area may be best informed by the change in GDP and growth of employment. Any reported GDP figure should be a net present value and in the same price base as the welfare estimate.

2. **Analysis should be consistent with that in the Economic Case.**

The Strategic Case scenarios should be the same as those in the Economic Case in terms of the magnitude, nature and location of economic impacts and the assumptions underpinning the analysis, such as population, employment and workforce skills.

3. **The core scenario of economic impacts should use the WebTAG methodologies.**

The core estimate of economic impacts in the Strategic and Economic Cases should use the WebTAG methodologies set out in User and Provider Benefits (A1.3) and Wider

Economic Impacts (A2). TAG Units A2.1 outlines how the GDP change can be derived from the welfare estimates.

4. Estimates of GDP impacts may only be reported in the Strategic Case, if the corresponding welfare estimate are reported in the Economic Case.

As mentioned in bullet 3 above, the core estimate of GDP impacts can be derived from the WebTAG methodologies. Sensitivity tests of the GDP impacts can be estimated and reported in the Strategic Case but only if the corresponding welfare effects are estimated and reported in the Economic Case.

5. Local economic impacts should only be reported alongside the corresponding national impact.

The economic objective may be locally focussed, such as the regeneration of a local area. In this instance, it would be appropriate to report local impacts. Nevertheless, the corresponding national impacts should be reported alongside to aid transparency: reporting the national and local economic impacts together clarifies the extent of the assumed relocation (displacement) of economic activity.

5.4 Economic Impacts Report

5.4.1 All of the analysis and evidence base underpinning the forecast of induced investment impacts and the estimation of GDP and welfare analysis should be reported in an Economic Impacts Report – see TAG Unit A2.1 for information on producing an Economic Impacts Report.

5.4.2 The Economic Impacts Report is designed to improve the transparency of analysis, in order that it can be objectively scrutinised. To this end, the analysis should be set out in a clear manner such that someone could replicate the results reported in the Strategic and Economic Cases. This includes setting out the evidence base, including any assumptions, together with the analytical approach.

5.4.3 It is recommended that results are reported in tables and differences should be explained:

(a) If local GDP has been estimated it should be reported alongside national GDP

(b) National GDP estimates should be reported alongside the corresponding WebTAG welfare estimates

(c) Where sensitivity tests have been conducted, welfare estimates should be reported alongside the welfare estimates in the core scenario welfare estimate.

(d) Where SEM models have been used, National GDP and corresponding Welfare estimates derived from the same model should be reported

5.4.4 In the case of the dependent development, full account should be given of the dependency test, the identification of an appropriate transport scheme and displacement. If the methodology for output change in imperfectly competitive markets in this unit has been followed, the information requirement will be light touch.

5.4.5 Any departures from the methodologies in this unit, such as the use of alternative assumptions or analytical approaches, will be more information intensive and require a full account and justification – see TAG Unit M5.3 for guidance on the information to be reported.

6 References

Arnott, R. J., Stiglitz, J. E., (1981). "Aggregate Land Rents and Aggregate Transport Costs", *The Economic Journal* Vol 91, page 331-347

Bates, J., (2006). "Economic evaluation and transport modelling: theory and practice". In: Axhausen, K. (Ed.), *Moving Through Nets: The Physical and Social Dimensions of Travel*. Pergamon, Oxford

Department for Business Innovation and Skills (2009). "Research to improve the assessment of additionality"

Department of Communities and Local Government (2001). "Valuing the External Benefits of Undeveloped Land: A Review of Economic Literature"

Department for Transport (2005), "Transport, Wider Economic Benefits, and Impacts on GDP"

DfT (2013). "Value for money assessment: advice note for local transport decision makers"

Geurs, K., Zondag, B., de Jong, G., de Bok, M., (2010). "Accessibility appraisal of land-use/transport policy strategies: More than just adding up travel-time savings", *Transportation Research Part D* 15 (2010) 382–393

Martínez, F.J., Araya, C., (2000). "A note on trip benefits in spatial interaction models". *Journal of Regional Science* 40, 789–796.

Simmonds, D. C., and Bates, J. (2001) "Appraisal in land-use/transport interaction: design". Report to Government Office for the North-West.

Simmonds, D.C. (2012). "Advancing appraisal: from transport economic efficiency to land use transport economic efficiency". European Transport Conference, Glasgow, 2012

Venables, A. J. (2015). "Incorporating wider economic impacts within cost-benefit appraisal" Discussion paper for International Transport Forum

Appendix A Use of transport models to test and account for dependent development

A.1 Introduction

- A.1.1 Section 3 outlines the purpose of testing for dependency of a transport scheme that unlocks land use development. This appendix discusses how the analyst should go about this using modelling tools to determine the dependency of identified site-specific developments on transport investment. For larger-scale, non-specific developments derived from land use or economic models, the analyst should refer to TAG Unit M5.3 – Supplementary Economic Modelling.
- A.1.2 This annex describes two important processes:
- Calculating the volume of dependent developments that cannot be accommodated without transport intervention (“dependency testing”);
 - Creation of a new baseline scenario that accommodates non-dependent development to allow for calculation of the benefits and externalities arising from the volume of development identified that is dependent.
- A.1.3 To facilitate understanding, the reader may wish to assume the case that one large development site has been identified that is more than likely to reduce the surrounding transport network to an insufficient level of service. In reality there may be a number of different sites contributing to this outcome, which may require more care and judgment from the analyst in assessing dependency. This is explained later.

A.2 Testing for dependency

- A.2.1 The purpose of dependency testing is to determine at what point proposed site-specific developments will breach a ‘reasonable level of service’ on the transport network. In practice, transport networks often operate beyond the limits of a ‘reasonable level of service’, so it is not practical to define specific thresholds for a dependency test. However, it should be possible to form an opinion of whether or not a “reasonable level” is being met, based on readily available network characteristics. Therefore, this guidance is not prescriptive, but relies on the application of judgement supported by evidence.
- A.2.2 This is a key step in the process. If development is not dependent on a transport scheme, then the need for a transport scheme should be considered solely on transport grounds, as one would for a standard appraisal. In order to accept evidence of dependent development impacts, DfT would require the methodology set out in this Unit to be followed.
- A.2.3 The definition of dependency focuses on the impact of land use development on the existing transport network. Land use development may be dependent on a wide variety of other factors, but for a transport authority the key issue in determining whether a transport scheme is required is the impact of new development on the current transport network.
- A.2.4 This step in the process must achieve two objectives. First, it must determine whether new development is dependent on the provision of some form of publically funded transport scheme. Then, if dependency exists, the analyst must estimate how many planned new developments are dependent.
- A.2.5 To test for dependency, two initial scenarios are required:
- Baseline Scenario** - without the development and without any form of transport scheme;
- Scenario Q** - with the whole development but without any form of transport scheme.

- A.2.6 Scenario Q will be controlled to total trip end growth from the NTEM data set across the study area. The baseline scenario will not include the trips ends associated with the development that are being tested for dependency. For clarity:

Total trips in baseline scenario = Total Trips in Scenario Q (controlled to NTEM) – Development trips.

- A.2.7 The analyst needs to control the total trip ends in the matrix of Scenario Q to NTEM growth between the base year and forecast year. For the baseline scenario the productions and attractions associated with the development will need to be removed; this includes the productions and attractions associated within the zones that host the specific development site, but also the associated trip ends from elsewhere in the matrix. A simple approach may be to factor the trip ends across zones in the study area downwards to reflect this decrease. It should be recognised that 'study area' in this context is more likely to concern trips in the locale of the development, and will have a lower influence on more distant zones in the model in question, and this should be reflected in the matrix adjustment. TAG Unit M4 – Forecasting and Uncertainty gives details in matrix adjustment taking into account different patterns of development in forecast matrices.
- A.2.8 The analyst needs to judge, for the zones that host the development site(s), the appropriate level of growth between the base and forecast years and the associated trips where the development is included for Scenario Q. The simplest approach will be to add to the core NTEM growth in these zones and remove trips from other zones in the matrix to compensate. However, the analyst should take care not to overstate the amount of possible development in individual zones as this could affect the fidelity of the dependency test.
- A.2.9 For the baseline scenario this could result in growth in these zones being higher or lower than the growth from NTEM for these zones. The rationale is that presumably in many cases part of the NTEM growth is likely to be associated with the dependent development being examined. If that is the case, and trips in these zones are subtracted from the growth provided by NTEM for the baseline scenario, the level of development (and hence trips in the matrix) should not be lower in the forecast matrix than the base year (i.e. lower than zero growth).
- A.2.10 In the following, it is assumed that in the baseline scenario the network provides a reasonable level of service. Clearly if that is not the case then the new development is likely to be wholly dependent on some form of transport scheme. However, it must be demonstrated that the baseline scenario does not provide a reasonable level of service before this conclusion can be reached.
- A.2.11 Attention should focus on those parts of the network where the new development is expected to have greatest impact. If, in Scenario Q, the network no longer provides a reasonable level of service in those locations, then at least some of the new development can be assumed to be dependent on some form of transport scheme.
- A.2.12 The simplest approach to determining whether the network provides a reasonable level of service is to compare forecast transport demand at key locations with available capacity. This approach is likely to be appropriate where new development is restricted to a single site. It may be possible to adopt this approach without using a transport model.
- A.2.13 However, where new development is large, and/or new development is located in a number of different places, and/or the impact on the transport network is complex, this approach may be difficult to apply and interpret. In these circumstances, a transport model and a more detailed assessment of the impact of the development on the network will be needed.
- A.2.14 Model runs for the baseline scenario and scenario Q will usually be required. In some cases, it may be impossible to carry out the model run for Scenario Q - the model may not converge, for example. Provided the model is properly specified, this may be taken as evidence that the new housing is at least partially dependent on a transport scheme.

- A.2.15 Comparison of the model outputs for the baseline scenario and scenario Q will reveal where the new development has had the greatest impact on the level of service on the network. Dependency testing should focus on those key locations where there are significant increases in traffic flows or passenger loadings.
- A.2.16 Increases in traffic flows on highway networks will usually result in increased travel costs. To demonstrate dependency, increased travel costs in key locations affected by new development must be exceptional, demonstrating that the network has reached a critical point. The analysis should examine link transit times and junction delays in those key locations. If link transit times have increased sharply, or if significant junction delays have emerged, this may be taken as evidence of dependency.
- A.2.17 It may be helpful to calculate the transport external costs for links at key locations in the network – for details of how to do this, see Appendix B. Transport external costs (or transport external costs per existing transport user) will reflect the size of the development and its impact on existing users.
- A.2.18 Essentially, the volume versus the capacity of links and junctions will have a fundamental influence on transport external costs (i.e. transit times and congestion), and the local network needs to be examined to identify instances where flows become unacceptably large.
- A.2.19 Where development is expected in a number of locations, it cannot be assumed that all of the new development is dependent. Further analysis is required to determine which developments are dependent and which are not. Developments that contribute only a small number of trips to the flows at key locations may be assumed to be not dependent on a transport scheme. To understand why this is so, consider the impact of a development in isolation, rather than as part of a package of developments. If its impact at the key location is small, it should be assumed that it is not dependent on a transport scheme at that location.

Creating a do minimum scenario – Scenario P

- A.2.20 After dependency has been tested and the scope of how new developments create unacceptable externalities on the transport network has been understood, the next step is to explore whether a reduced level of new development could be accommodated on the network without some kind of transport scheme. This will allow for an estimate to be made of the volume of new development that may be assumed to be dependent on some form of transport scheme.
- A.2.21 This analysis may be carried out using a trial and error process, reducing the number of dwellings or employment floorspace from Scenario Q (and hence the number of trips generated) and repeating the dependency analysis discussed above until a level of new development is found that does not lead to an unacceptable level of service on the transport network. Where new developments are expected in a number of locations, those developments that have been demonstrated to be not dependent on a transport scheme should not be included in this analysis. It should, however, be included in the background pattern of housing development (i.e. assumed to be present in both scenarios).
- A.2.22 This analysis should have resulted in an estimate of the number (and, where multiple development locations are being considered, the location) of new homes or amount of new employment floorspace in the development site(s) that are dependent on the provision of a transport scheme.
- A.2.23 This process produces a new do minimum scenario (Scenario P) that includes all development that is judged to be 'non-dependent', Scenario P, to the point at which the transport network can accommodate them without exceeding an acceptable level of service. This scenario will then be used in the subsequent steps in the process to identify the welfare impacts of the volume of new development that is judged to be dependent on transport intervention.

A.3 Modelling Considerations

- A.3.1 The Department recommends that all scenarios be modelled using standard modelling methods. This will be an appropriately calibrated assignment model with sufficient detail in the area of interest (see TAG Unit M3.1 – Highway Assignment Modelling and where public transport is a particular consideration TAG Unit M3.2 – Public Transport Assignment Modelling). If in scope of the transport problem, a variable demand model should also be used in principle (see TAG Unit M2 – Variable Demand Modelling for the prerequisites). Where non-standard approaches are proposed, analysts should discuss this with the Department.

Modelling the Four Scenarios

- A.3.2 **Baseline Scenario** requires selected developments to be omitted. This involves identifying the number of dwellings/ amount of employment floorspace comprising a potentially dependent development and removing the associated number of trip ends from those zones in the trip matrix (or, indeed, not including the growth in trip ends that would occur should these developments go ahead). The TEMPRO software may be used for this purpose³.
- A.3.3 For **Scenario Q**, the first step is to explicitly model each development that is expected to have a significant impact on level of service on the transport network and thus is likely to be dependent on a transport scheme. This essentially involves including all of the development trips at each identified site that is potentially dependent. The total trip end growth in this scenario should be controlled to NTEM growth.
- A.3.4 **Scenario P** is constructed via the process described in the previous Section – it is characterised by a matrix of trips that include all trips at the identified development sites that may be accommodated before breaching an acceptable level of service on the transport network. At this stage, the dependency testing analysis has been completed, and the baseline scenario is no longer used.

Modelling for **Scenarios R** and **S** should follow standard modelling procedures. In each case, the analysis must add a transport scheme to the appropriate 'without scheme' network. Scenario R should build upon scenario Q, with scenario S building on scenario P.

Use of Variable Demand Modelling

- A.3.5 A key issue to consider when modelling scenario Q is whether variable demand modelling is needed. The Department recommends that the usual standards should be applied: if a fixed matrix analysis suggests that the housing development significantly increases network congestion, variable demand modelling of some sort should be applied. The application of variable demand modelling may suggest that the trips generated by the development can be accommodated on the network (for example, bus services may accommodate much of the travel demand related to the site so traffic congestion may remain acceptable). In that case, the housing development is not dependent and the appraisal of any transport scheme may follow standard guidelines, taking scenario Q as the 'without scheme' scenario.
- A.3.6 It may be argued that the application of variable demand modelling means that dependent trips from the development are imposing costs on all other trips. This may be true, but is irrelevant. Growth in the number of developments over time and their impact on user costs in the 'without scheme' scenario is an integral part of forecasting for standard scheme appraisal. Provided the overall level of service remains satisfactory, some increase in costs to existing users is acceptable. This guidance is intended to address circumstances, where specific, localised developments result in an unacceptable – and therefore unrealistic – level of service on the network.

³ See guidance at <https://www.gov.uk/government/collections/tempro> and also TAG Unit M4 – Forecasting and Uncertainty.

Appendix B Transport External Costs Arising as a Result of Land Use Development: Technical Theory and Detail

B.1 Principles

- B.1.1 Most land use developments give rise to trips on transport networks. These trips are usually regarded as 'new' trips (though, in reality many will have been diverted from other locations). These trips take place on transport networks already being used by other, 'existing' users. Thus they exacerbate current congestion, crowding and so on, leading to increases in costs (including journey times, the money costs of journeys, unreliability, crowding and so on) for existing users not associated with dependent developments. These increases in costs are termed the transport external costs of land use development. Transport external costs are an important consideration in the analysis of land use developments that are dependent on (i.e. cannot proceed without) transport schemes, particularly since in most circumstances they concentrate trip generations at particular points on the network.
- B.1.2 These costs can be estimated using the principles of marginal external costs. In that context, marginal external congestion cost is the change in costs (including time, vehicle operating costs and charges) to users of a given link in the transport network as a result of one additional - or 'marginal' - vehicle on the link.
- B.1.3 In the context of land use development, we can consider the marginal change in costs imposed on existing users of the transport network as a result of one additional trip generated by the development.

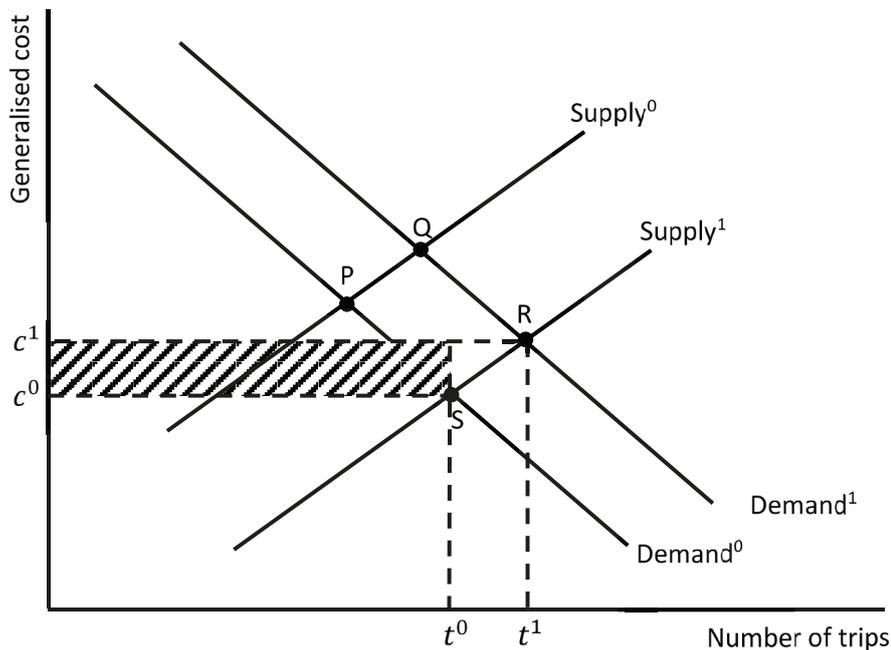


Figure B.1: The calculation of Transport External Costs

- B.1.4 Figure B.1 depicts the supply and demand curves for a given O-D pair ij . The points P-S have been labelled consistently with the naming of the four scenarios in Appendix A. The shaded area indicates the transport external costs of the dependent development on the base traffic.

Demand⁰ represents the trip matrix with no dependent trips;

Demand¹ represents the trip matrix with all trips, including dependent ones;

Supply⁰ represents the without-scheme scenario;

Supply¹ represents the with-scheme case (i.e. the transport scheme is present).

- B.1.5 The transport external costs of a land use development can be estimated using the following equation:

$$TEC = \sum_{ij} (c_{ij}^1 t_{ij}^1 - c_{ij}^0 t_{ij}^0) - \sum_{ij} c_{ij}^1 t_{ij}^D = \sum_{ij} (c_{ij}^1 t_{ij}^1 - c_{ij}^0 t_{ij}^0) - \sum_{ij} c_{ij}^1 (t_{ij}^1 - t_{ij}^0) = \sum_{ij} t_{ij}^0 (c_{ij}^1 - c_{ij}^0)$$

where c_{ij} and t_{ij} are, respectively, the cost per trip and the numbers of trips between zones i and j . The superscripts 1 and 0 denote the with and without land use development scenarios and the superscript D denote the matrix of trips generated by the development (i.e. $t_{ij}^1 - t_{ij}^0$).

- B.1.6 In basic terms, this is calculating the difference in costs between the matrix without the dependent trips included compared with the matrix with the dependent trips included. Then, this is multiplied by the total trips in the matrix without the dependent trips in order to determine the impact on those non-dependent users (i.e. their “external costs”).

- B.1.7 The transport external costs of a land use development can also be estimated on a link basis. This formulation may be useful in establishing dependency. The following equation should be used:

$$TEC_L = c_L^1 (f_L^1 - f_L^D) - c_L^0 f_L^0$$

where TEC_L , c_L and f_L are, respectively, the transport external costs, the link transit costs and the link flow for link L . Of course, $f_L^D = f_L^1 - f_L^0$, so this simplifies to $TEC_L = f_L^0 (c_L^1 - c_L^0)$, put simply the change in costs to the existing trips where development trips are also present.

TEC_L may be summed over all links in the network to give:

$$TEC = \sum_L TEC_L$$

B.2 Theoretical considerations

- B.2.1 The transport external costs of a development can readily be calculated using results from a conventional transport model. Model runs for two scenarios are required: Scenarios R and S from Appendix A, which are:

Scenario S: the scenario without the dependent development/trips, providing the matrices c_{ij}^0 and t_{ij}^0 ; and

Scenario R: the scenario including the trips generated by the land use development, providing the matrices c_{ij}^1 and t_{ij}^1 .

- B.2.2 The costs c_{ij}^0 and c_{ij}^1 for each scenario should be based on the same values of time, vehicle operating cost models and so on as are used in the application of any associated transport appraisal.
- B.2.3 It is important to note that TEC may be positive (implying that the land use development imposes costs on existing users) or negative. Negative values may arise where routing throughout the network occurs in less congested areas. This may particularly be the case where the dependent development is attracting more trips to a less congested route (since the scheme proposal may be ameliorating congestion significantly), through the trip distribution mechanism in the variable demand model.

Appendix C Principles Underlying Appraisal of Combined Land Use and Transport

C.1 Appraisal of combined land use and transport

- C.1.1 This section provides an explanation of the principle of breaking down benefits into transport benefits (given an assumed land use) plus additional land use / development related benefits.
- C.1.2 The objective is to estimate the combined benefits⁴ $S[T\&L]$ of a transport scheme, T, and a land use development, L, where the land use development cannot proceed without the transport scheme.
- C.1.3 In principle, the combined benefits would be estimated by comparing a scenario that includes both land use development and transport scheme with an alternative that includes neither. However, we do not have the tools to allow us to make that comparison. In particular, we know that conventional transport appraisal methods *cannot* be used if land use differs between with and without transport scheme scenarios.
- C.1.4 An alternative approach would be to assess the benefits of the two components separately, then combine them. But we cannot simply assess the benefits of the two components in isolation, then add them:

$$S[T\&L] \text{ is not equal to } S[T] + S[L]$$

where $S[T]$ is the benefit of the transport scheme **without the land use development**, and $S[L]$ is the benefit of the land use development **without the transport scheme**.

- C.1.5 Because the land use development is dependent on the transport scheme, the land use development cannot proceed in isolation and hence $S[L]$ does not reflect the true benefits of the development.
- C.1.6 However, we can assess the benefits of the transport scheme in isolation, then assess the benefits of the land use development incrementally, adding the two to give:

$$S[T\&L] = S[T] + S[L/T]$$

where $S[L/T]$ is the benefit of the land use development, assuming that the transport scheme already exists.

- C.1.7 $S[T]$ can always be estimated, though the result may suggest that the transport scheme **in isolation** is not good value for money. There is no change in land use between the without- and with-scheme scenarios, so conventional transport appraisal techniques may be applied. In both scenarios the only determinants of demand will be growth and the limitations of the transport network, so there should be no extraordinary inconsistency between network capacity and demand.
- C.1.8 $S[L/T]$ - the incremental benefits of the land use development, assuming the transport scheme is already present - can also be estimated satisfactorily. Because the transport scheme is assumed to be present, the problem reduces to that of estimating the benefits of the land use development alone.
- C.1.9 Note that the alternative form - $S[T\&L] = S[L] + S[T/L]$ - is not acceptable. As discussed above, the land use development cannot be built without the transport scheme, so the benefits of the land use development in isolation are not relevant.

⁴ We use the term 'benefits' here to refer to the net present value (NPV) of benefits less costs.

C.2 Benefits of land use development

C.2.1 DCLG have developed a methodology for estimating the benefits of land use development based on 'land value uplift' arising from the development, LVU, less transport and other externalities, TE and OE:

$$S[L/T] = LVU - TE - OE$$

C.2.2 The land value uplift - LVU - arising from the land use development may be estimated by subtracting the value of the land in its 'without development' use from its value in new (residential/non-residential) use. Note that, because the transport scheme is assumed to have been implemented, the value of the land in its new use will reflect the improved accessibility provided by the transport scheme. However, the benefits $S[T]$ of the transport scheme will not have captured these benefits because it is based on a land use scenario that excludes the land use development L. Thus, there is no double counting across $S[T]$ and $S[L/T]$.

C.2.3 For information on the methodology to estimate land value uplift see Appendix D.

C.2.4 The transport externality, TEC, is the additional cost imposed on users of the transport system as a result of the construction of the land use development. The cost can be estimated using a transport model.

Appendix D Derivation of Land Value Uplift

D.1 Origin of Land Value Uplift

- D.1.1 Land value uplift refers to the change in land prices as a result of land use change. Households' and businesses' willingness to pay for land depends on the purpose and intensity with which they will use it. Thus, if either of these change (land use change), so too will households' and businesses' willingness to pay and hence the land value.

D.2 Residual Land Valuation Methodology

- D.2.1 One commonly used method to determine the maximum value households and business will place on land is the residual methodology. This method involves estimating the final value of the development (Gross Development Value) and subtracting from this an estimate of the development costs. Note developers will have their individual views on both the Gross Development value and development costs, and hence the maximum value they are willing to pay for the land. The residual method is equal to:

$$\text{Maximum Land Value} = \text{Gross Development Value} - \text{Development Costs}$$

- D.2.2 The Gross Development Value is equal to the expected total revenue which the developer will receive from the sale of the completed development. For example, in the case of a housing development the GDV would equal the expected price per house multiplied by the number of houses. Similarly for non-residential developments the GDV would equal the expected price per square foot multiplied by the total floor space.
- D.2.3 The Development Costs include the costs of construction, fees charged for professional services and Government, and profit – but not cost of land before development. If a developer makes contributions to a non-transport complementary intervention, such as utility connections or the provision of a school, these will be included in the development costs.
- D.2.4 To determine the land value uplift, the price of the land in its existing state must be subtracted from the expected value of the land after development has taken place.

$$\text{Land Value Uplift} = \text{Land Value after Development} - \text{Land Value before Development}$$

- D.2.5 In the case of a redevelopment, in which there is an existing development on the plot, it is unlikely the land price can be directly observed. However, this can be estimated using the residual land valuation methodology. This would involve subtracting an estimate of the costs to build the existing development from the current value of the property.