Impact assessment framework

A report for ECO

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Table of Contents

1 Introduction

The motivation for impact assessment is to improve decision making. Impact assessment covers a range of methodologies including multi-criteria analysis (comparing apples and oranges), cost-effectiveness analysis (comparing apples and money) and cost-benefit analysis (comparing apples with apples by representing impacts in money terms).

The aim is to build on and complement ECC report 125 which, amongst other things, lists the following steps for impact assessment:

i. Identification of the issue/problem(s)
ii. Describe the policy/measure and identify the objectives
iii. Identify and describe the regulatory options
iv. Determine the impacts on all stakeholders including relevant spectrum incumbents
v. Determine the impact on competition (if relevant)
vi. Assess the impacts and choose the best option
vii. Monitoring and evaluation

Investing effort in the first three steps can aid and simplify subsequent steps involving analysis and decision making, and may lead to a redefinition of the problem. Further, the initial steps involve taking a view about the preferred option before the analysis of impacts.

This is analogous to the formation of a hypothesis in science before it is tested, and is necessarily a "creative" step. In addition to forming a prior view of the first best option, the option to do nothing or wait should be considered.

We therefore focus first on the decision problem rather than going directly to impact assessment. In doing so we focus on a number of questions: what is the problem and what are the available options, are there other means of addressing the problem including other policy instruments, do market players have good information and incentives to make appropriate decisions without policy intervention, and is a decision required now or is it efficient to wait?

We then consider impact assessment, in particular what the relevant incremental impacts are and what should and should not be counted. Finally we introduce the economic concepts required in carrying out cost benefit analysis and illustrate both the overall decision methodology and the application of cost benefit analysis by considering two separate questions, namely whether a transmission to digital TV accompanied by analogue TV switch off is appropriate and whether the same transition is appropriate for radio.

Our report is structured as follows:

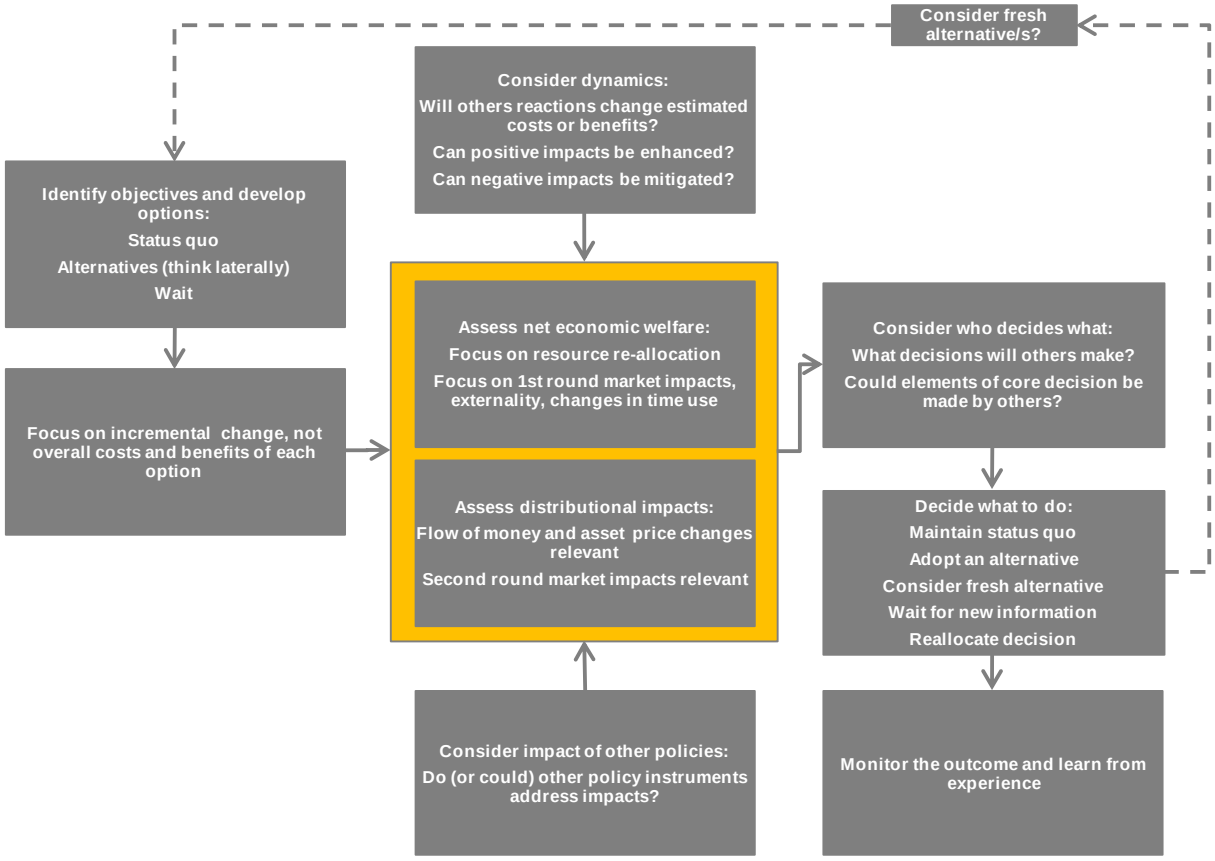
- Section 2 sets out the high level decision problem.
- Section 3 introduces key considerations in impact assessment including high level categories of impacts.
- Section 4 sets out e fundamentals of cost benefit analysis.
- Section 5 illustrates the overall methodology utilising the separate examples of TV and radio digital switchover.

2 High level decision framework

"Everything should be made as simple as possible, but not simpler." Albert Einstein

Figure 2-1 below sets an extended decision framework which includes dynamics in terms of the reaction of other stakeholders to alternative policies and market developments and the possibility that the process is iterative. The reason for introducing this general framework is that it is easy to lose sight of these dynamics once one embarks on a specific impact assessment.

Figure 2-1: Framework for analysis of impacts



The framework builds on the ECC report 125 on impact assessment in the following ways:

- It explicitly introduces the possibility that others stakeholders, in particular market players, consumers and other regulatory bodies, will make decisions that either impact on the balance of costs and benefits or may internalise the balance of costs and benefits – a policy of doing nothing or ensuring that private decisions take full account of costs and benefits may then be the best option.
- It divides impact assessment into two parts – evaluation of impacts which exposes distributional impacts and evaluation of net benefits which relies more on an economic framework to isolate the net impact and sidestep identification of each and every distributional impact. Depending on the problem one or the other or both approaches may be appropriate.

- It introduces the possibility that at the end of the analysis it becomes clear that a different alternative option/s in terms of policy should be considered.

The various boxes are described in more detail below. We also note that the direction of travel may not always be one way as the answer to the question someway along the decision process might lead one to reframe the set of options. This is not an uncommon outcome of impact assessment – rather than a precise answer to the initial question one is guided to a better question.

Considering the boxes Figure 2-1 in from left to right and top to bottom we have:

- **Identify objectives and develop options**
  - The objective may be the maximisation of overall social welfare (the default assumption in cost benefit analysis) or it may involve specific outcomes (in which case cost effectiveness analysis may be more appropriate).
  - Options include doing nothing, adopting some alternative/s and waiting (as waiting may reveal new information about the nature of the problem and/or the costs and benefits of alternatives). The option to wait is frequently exercised in private decisions.
- **Focus on incremental change versus a clear counterfactual – the outcome without policy change**. Focussing on incremental change versus a clear counterfactual is both conceptually the correct way to proceed, and should greatly simplify the analysis. It is not necessary to consider all the impacts of alternatives, rather one can focus on the difference in impact of alternatives.
- **Consider dynamics.** In particular will other stakeholders' reactions change relevant costs or benefits? If some private party, for example a manufacturer, will bear both the costs and benefits of adopting different technologies and associated standards is there a reason to over-ride their judgement? If a particular policy decision is taken how will others react and how will that change the overall balance of costs and benefits?
- **Consider impact of other policies.** Sometimes it happens that a different policy instrument from that being considered offers a more effective means of achieving a desired objective. For example, one might consider the distributional impacts of a specific policy option – the impact on different groups incomes and the creation and destruction of jobs across the economy – but lose sight of the fact that Governments intervene via taxes, income support and specific labour market interventions to achieve particular distributional outcomes.
- **Assess net economic welfare and distributional impacts.** The approaches taken to assessing impacts along the value chain and the approach taken to assessing net impacts differ. It can be much more efficient to go directly to a net impact assessment rather than attempt to add up all the impacts, for reasons we will set out later in Section 3.
- **Consider who decides what and decide what to do.** You may decide that it is best if the decision is left to or delegated to someone else. Sometimes this is the wisest course of action. In other instances it is appropriate for you to decide. Another possibility is that having completed the analysis of initial policy options it becomes clear that one should focus on a different policy question.
- **Monitor outcomes and learn**. It is important to avoid selection bias i.e. focussing on policies that produce good outcomes. It is also essential to isolate changes due to the policy change from other changes that may occur over time for other reasons. One approach is to specify measures of success, and their dependence on policy and other factors, in advance. Another approach

would be to benchmark outcomes against changes in other parts of the world where different policies were adopted or to carefully control for other factors via judgement or statistical techniques.

3 Key considerations in impact assessment

"The cost of a thing is the amount of what I will call life which is required to be exchanged for it, immediately or in the long run." Henry David Thoreau

The previous section set out broader considerations in relation to decision problems such as the question of who should decide. Here we focus on impact assessment (assuming we make the decision).

Impact assessment covers a range of methodologies including multi-criteria analysis (comparing apples and oranges), cost-effectiveness analysis (comparing apples and money and pairs and money) and cost-benefit analysis (comparing apples with apples by representing impacts in money terms).

Decisions involve weighing costs and benefits, whether we recognise this or not. The application of systematic methodology to assist in weighing costs and benefits is not new, as the following illustrates.

Letter from Benjamin Franklin to Joseph Priestley, 19 September 1772

In the Affair of so much Importance to you, wherein you ask my Advice, I cannot for want of sufficient Premises, advise you what to determine, but if you please I will tell you how. When these difficult Cases occur, they are difficult chiefly because while we have them under Consideration all the Reasons pro and con are not present to the Mind at the same time; but sometimes one Set present themselves, and at other times another, the first being out of Sight. Hence the various Purposes or Inclinations that alternately prevail, and the Uncertainty that perplexes us.

To get over this, my Way is, to divide half a Sheet of Paper by a Line into two Columns, writing over the one Pro, and over the other Con. Then during three or four Days Consideration I put down under the different Heads short Hints of the different Motives that at different Times occur to me for or against the Measure. When I have thus got them all together in one View, I endeavour to estimate their respective Weights; and where I find two, one on each side, that seem equal, I strike them both out: If I find a Reason pro equal to some two Reasons con, I strike out the three. If I judge some two Reasons con equal to some three Reasons pro, I strike out the five; and thus proceeding I find at length where the Ballance lies; and if after a Day or two of farther Consideration nothing new that is of Importance occurs on either side, I come to a Determination accordingly. And tho' the Weight of Reasons cannot be taken with the Precision of Algebraic Quantities, yet when each is thus considered separately and comparatively, and the whole lies before me, I think I can judge better, and am less likely to take a rash Step; and in fact I have found great Advantage from this kind of Equation, in what may be called *Moral or Prudential Algebra*.

Benjamin Franklin's moral or prudential algebra captures the spirit of impact assessment, namely the application of a systematic approach to aid decision making and the weighing of costs against benefits. Indeed, modern cost benefit analysis may allow a decision to be taken supported by the "Precision of Algebraic Quantities".

Before turning to some of the issues in relation to quantitative cost benefit analysis, it is helpful to consider broad categories of costs and benefit which help put structure on the problem.

3.1 Static versus dynamic impacts

Impact assessment is typically focussed on weighing up impacts in terms of the level of costs, incomes etc. However, we know that over time growth in productivity and growth in national income

have a large impact relative to one-off changes in levels.[1] It is worthwhile confronting this point early on.

It is difficult to attribute growth in real incomes to specific decisions. This is partly because economic growth is not well understood (we do know that sustained economic growth is a recent phenomenon and that it has been far from uniform across nations). It is also because any given decision typically has a small impact on output, and whilst this might be assessed the impact on growth is hard to infer or measure (An exception here is ICT generally where post 1995 there has been evidence of a significant contribution to aggregate growth in some countries). We may also think it reasonable that policies assessed in terms of static costs and benefits that are good are also likely to be good for growth.

A more pragmatic way of assessing dynamic impacts is to consider the impact on competition, on the basis that competition promotes innovation and growth. One can think of this as the conceptual basis for a specific focus on competition in ECC Report 125. In other words since competition is a proxy for dynamic impacts we should pay particular attention to any impact on competition, though recognise this may be hard to quantify.

3.2 Categories of impact

Table 3-1 sets out a framework for considering impacts in terms of a range of categories – private, wider economic, wider social and pseudo (things that should not be counted or should only be counted in specific circumstances).

Table 3-1: Overview of framework for considering impacts

Private	Wider economic	Wider social	Pseudo – not counted
Private costs are the resource costs valued in the market Private benefits might include: (i) Saving time or costs (ii) More of existing things (iii) New things	Non-appropriable private Externality Network effects Spill-over and virtual agglomeration Competition in sector and wider economy Resilience, adaptability and policy options Excess burden of taxation	Educated citizens Informed democracy and freedom of expression Cultural understanding Belonging to a community and inclusion Privacy Social capital, resilience and trust	Pseudo externalities Asset price changes (if already captured under private cost-benefit) Normal profits. Employment effects (other than impact on labour supply) "National competitiveness" (other than productivity impacts)

An explanation of the entries in the table is as follows:

Private impacts include the resource costs and benefits valued in the market (though not necessarily in money terms, for example, peoples time is valuable to them and service providers take account of this in considering how to make their services accessible and convenient).[2] If a decision mainly

[1] It is worth noting that the only sustainable source of growth in income per capita is labour productivity growth, since hours worked are necessarily limited for an individual.

[2] The value of peoples time is in general considered in the appraisal of transport projects, but much less widely in other impact assessments. Department for Transport. 2003. "Value of travel time savings in the UK: summary report." http://www.dft.gov.uk/pdf/pgr/economics/rdg/valueoftraveltimesavingsinth3130

involves impacts under this category, then the decision might reasonably be left to the parties involved. The categories under this heading are reasonably self explanatory.

Wider economic impacts that may not be fully valued or reflected in decisions in the market. An example would be greenhouse gas emissions which (in the absence of a market in pollution or abatement rights) involve global impacts via climate change which are not reflected via costs/benefits for individual emitters. Economists refer to the this general category as involving an "externality".

- Non-appropriable private refers to circumstances where potential private resource value cannot be captured by investors e.g. non-tradable radio spectrum.
- Externality refers to impacts such as environmental impacts which have costs (and may have benefits) which are not reflected in private decisions unless explicit "rights" such as carbon permits or pollution taxes are introduced.
- Network effects refer to the benefits arising from others using an application. Network effects arise when the value to each user of a network depends on the number of other users on the network. The value of one new user joining the network will then be greater than the value to that user, since all other users are better off as they now have the opportunity to communicate with the new user (the opposite happens with traffic congestion where each additional user imposes a cost on others). This additional benefit of each user joining the network is known as a network externality. One formulation of network effects is known as Metcalfe's Law which states that the value of a network grows as the square of the number of users.
- Spill-over and virtual agglomeration refers to the positive impact of agglomerations (i.e. cities) on productivity achieved without agglomeration. There is evidence of positive externalities in terms of productivity from agglomeration i.e. spatially concentrated economic activity, particularly in cities.[3]
- Competition in sector and wider economy. Policy may promote or discourage competition. For example, trade barriers discourage competition whilst policies which are technology neutral may promote competition in comparison with technology specific requirements.
- Resilience, adaptability and policy options refer to improved supply chain management, resilience to shocks and enhanced flexibility in terms of policy options. Fluctuations in output are driven by demand side shocks (e.g. consumer confidence) and supply side shocks (e.g. oil price shocks). The extent of ICT use and network connectivity in particular, are thought to have reduced volatility to demand side shocks by improving supply chain management and lowering inventories that amplify demand side fluctuations, and may also increase resilience to supply side shocks by offering substitution possibilities.[4]
- Excess burden of taxation refers to the economic costs (not the revenue itself) involved in raising public finance. The framework developed in the next section helps in understanding this distinction.

[3] Venables. 2004. "Evaluating urban transport improvements: cost-benefit analysis in the presence of agglomeration and income taxation." http://www.econ.ox.ac.uk/members/tony.venables/Xrail7.pdf

[4] Summers. 2005. "What caused the great moderation? – Some cross-country evidence." Federal Reserve Bank of Kansas City: Economic Review, Third Quarter. http://www.kansascityfed.org/Publicat/econrev/PDF/3q05summ.pdf

Wider social impacts includes impacts, positive or negative, that society values but which would not typically be expressed in money terms.[5] These categories are reasonably self explanatory and involve wider citizen costs and benefits not captured under the categories private and wider economic. In relation to this category Anderson and Stoneman (2007) noted that:[6]

"...impacts may be 'bad' (internet steals social time) or 'good' (email generates new social connections) and much time and energy has been wasted debating whether bad predominates over good, whether utopia predominates over dystopia. All of this misses the point... technology does not and has never had a simple linear predictable impact on society."

Pseudo impacts are considered as to clarity impacts that should generally not be assessed in a net impact assessment. However, the impact on particular groups or locations in relation to these considerations may be relevant to analysis of distributional impacts.

- Pseudo externalities that involve second round impacts mediated within markets that should not be counted (at least not double counted).
- Asset price changes that typically reflect flows of costs and benefits that should not be double counted. However, sometimes looking at asset price changes is a good way of estimating impacts, for example, say between broadband availability and house prices. [7]
- Profits. In competitive markets profits can be expected to represent "normal" returns on capital. In other words whilst they just cover the opportunity cost of capital.[8] Economists refer to this situation as one involving zero "economic profit" or zero "producer surplus". Unless profits are expected to exceed normal returns they should not be counted.
- Employment effects generally involve a reallocation of jobs with no net impact on employment – though one might expect the productivity of jobs created to exceed the productivity of jobs destroyed (assuming the change is worthwhile).[9] The two exceptions are changes in labour force participation which might come about if barriers to participation by specific groups were reduced, for example, the disabled; and changes in the efficiency of labour market matching which may change what economists refer to as "equilibrium unemployment".
- "National competitiveness" overlaps with productivity, which is reflected in private and wider economic benefits. Gains in productivity at the national level tend to be accompanied by offsetting shifts in the exchange rate. This means real incomes rise and national "competitiveness" does not. As economist Paul Krugman put it "*it is simply not the case that the world's leading nations*

[5] A useful source for evaluating the social value of policy is Melinda T. Tuan for the Bill & Melinda Gates Foundation. December 2008. "Measuring or valuing social value creation." http://www.gatesfoundation.org/learning/Pages/december-2008-measuring-estimating-social-value-creation-report-summary.aspx

[6] Anderson and Stoneman. 2007. "Predicting the socio-technical future (and other myths)." Chimera Working Paper Number 2007-10. http://www.essex.ac.uk/chimera/content/pubs/wps/CWP-2007-10-predicting-socio-tech.pdf

[7] Lehr, Osorio, Gillet and Sirbu. January 2006. "Measuring broadband's economic impact." http://cfp.mit.edu/groups/broadband/docs/2005/MeasuringBB_EconImpact.pdf

[8] This implies that the benefits of technological innovation can be expected to benefit consumers rather than producers, since productivity gains are competed away via lower prices and better service. There are exceptions to this general rule, but overall it is estimated that 90% of productivity gains in the US over the past century have gone to consumers rather than producers.

[9] If jobs are outsourced to other countries there may still be little if any net impact. One reason for this is that outsourcing is driven by a desire to raise productivity, and raising productivity raises incomes and demand in the domestic economy thereby leading to the creation of new jobs elsewhere (though this reallocation will have distributional impacts). Bhagwati, Panagariya and Srinivasan. 2004. The muddles over outsourcing. http://129.3.20.41/eps/it/papers/0408/0408004.pdf

are to any important degree in economic competition with each other."[10] Another way of thinking about this is that a change that improves the prospects for some activities improves a nation's comparative advantage in those activities and reduces the comparative advantage in all other activities.

The outcome of an application of the above methodology to estimating the incremental costs and benefits of next generation fixed broadband over current generation broadband is provided in Appendix B.[11] Both quantified and subjectively graded outcomes are shown for the above categories modified slightly to focus on next generation broadband (for example, the impact on piracy was considered).

There is a recurring theme in the above, namely that it is important to separate what should be counted in an assessment of net costs and benefits from what should not be counted to avoid errors of omission and inclusion. The following two sections expand on this point as it is one of the most common sources of error in impact assessment.

3.3 Impacts along value chain versus net impacts

A key step in the ECC 125 methodology is the determination of the "impacts on all stakeholders including relevant spectrum incumbents". This is a sensible step, but one which must be conducted with caution, particularly when it comes to an assessment of net impacts.

A distinction should be made between impacts and net impacts:

- Impacts could include impacts on various parties throughout the value chain and wider economy. These provide an indication of anticipated winners and losers.
- A net benefit estimate may, on conceptual grounds, leave aside impacts on parties which one would expect to be netted off by equal and opposite impacts on others.

A price decrease, for example, directly benefits consumers by an amount identical to the detrimental impact on producers. Whilst direct cost/revenue impacts are relevant in terms of impacts, they are irrelevant to net impacts. Likewise, a change in revenue received by government is not directly relevant to a net impact assessment.

What is relevant in terms of net impacts is changes in behaviour associated with price changes and their associated costs and benefits. For example, if the price of a service is increased consumers will consume less of it, thereby losing the benefit of foregone consumption. This is a real economic cost.

This implies that, whilst in terms of procedure it is natural to think of impact assessment first and net benefit estimation second, a net impact assessment is conceptually different and may be best thought of independently of an assessment of impacts. In particular, the boundary of analysis for net benefit estimation is tighter than for impact assessment.[12]

[10] Krugman. March/April 1994. "Competitiveness: a dangerous obsession." *Foreign Affairs*. http://www.pkarchive.org/global/pop.html

[11] Plum. June 2008. "A framework for evaluating the value of next generation broadband." A report for the Broadband Stakeholder Group. http://www.broadbanduk.org/component/option,com_docman/task,doc_view/gid,1009/Itemid,63/

[12] Boardman, Greenberg, Vining and Weimer. 2006. "Cost-benefit analysis – concepts and practice." Third Edition. Pearson Prentice Hall.

The environmental economics literature also points to the risk of counting so called pseudo externalities:[13]

> *"There is a category of pseudo-externalities, the pecuniary externalities, in which one individual's activity level affects the financial circumstances of another, but which need not produce a misallocation of resources in a world of pure competition…Pecuniary externalities result from a change in the prices of some inputs or outputs in the economy. An increase in the number of shoes demanded raises the price of leather and hence affects the welfare of the purchases of handbags. But unlike a true externality… it does not generate a shift in the handbag production function."*

By second round effects we mean impacts throughout the economy beyond the immediate impacts. In relation to private benefits, no account should in general be taken of second round effects. This conclusion reflects the fact that costs and benefits beyond immediate impacts represent a redistribution of primary costs and benefits rather than involving additional net impacts.

3.3.1 Wider impacts that should be considered in net benefits

There are a number of circumstances in which wider impacts should be considered. For example:

- Where a market is "missing" e.g. a complete market in greenhouse gas abatement.
- Where secondary markets are distorted e.g. by taxation.

Environmental externalities which are not internalised to the market via taxes, tradable permits or regulation involve costs which are not reflected in market prices and quantities. These costs should be considered in assessing net benefits. For some externalities, estimates of the costs have been made and can be readily applied, for example, for greenhouse gas emissions. However, where an externality is internalised via taxes or permits it should not be counted twice.

Another important missing market is the value of people's leisure and working time. If a policy change involves time costs or savings for people these should be valued. This approach is orthodox in transport infrastructure project appraisal where the main benefits of projects are often time savings.

Taxation involves net social costs since it distorts market decisions regarding investment, savings, consumption and labour supply. Additional government revenue may therefore involve a benefit in terms of reduced taxation. The additional source of government revenue may of course involve a cost itself. For example, if the source is general taxation, no account of revenue should be made in a cost benefit assessment. However, if the source is auction receipts for a scarce resource such as spectrum then the potential welfare gains from reduced taxation should be counted.

[13] Baumol and Oates. 1988. "The theory of environmental policy." Second edition. Cambridge.

4 Fundamentals of cost benefit analysis

"Sometimes the questions are complicated and the answers are simple." Dr Seuss

ECC Report 125 sets out an approach to impact assessment. In terms of methodology there is a spectrum between purely qualitative to quantitative, and hybrids in between (including what Benjamin Franklin referred to as *Moral or Prudential Algebra.* In this section we focus on quantification.

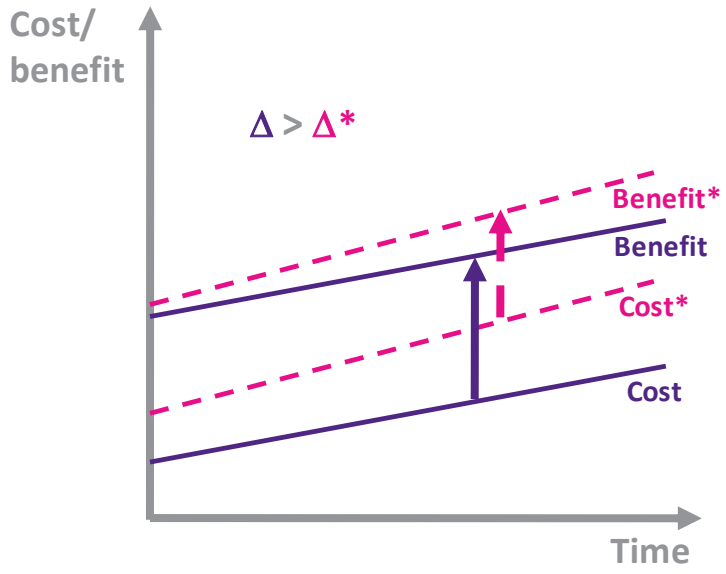
An important general point is that the default assumption in terms of objective for cost benefit analysis is that it is the maximisation of overall social welfare (a concept discussed below). If some other objective is considered then cost effectiveness analysis may be more appropriate. Cost effectiveness analysis may nevertheless draw on the concepts developed in this section.

4.1 Focussing on incremental change

It is important to consider the impact of policy options against a counterfactual where policy remains unchanged. This is both conceptually correct since we are interested in the impact of policy change, not the overall impact of a given policy. It is also likely to greatly simplify analysis since costs and benefits that remain unchanged between to alternative policies need not be evaluated.

Figure 4-1 illustrates the costs and benefits of two alternatives over time. A counterfactual or base case (purple solid lines) and an alternative (magenta dotted lines) are considered.

Figure 4-1: incremental costs and benefits of two alternatives



In the case illustrated the net benefits of the counterfactual are greater than the net benefits of the alternative (even though the benefits of the alternative are greater). Further, in order to estimate the incremental costs and benefits any elements of costs or benefits that are unchanged between the alternatives do not need to be considered.

4.2 Valuing costs and benefits

Costs and benefits should normally be based on market prices as they usually reflect the best alternative uses that the goods or services could be put to (the opportunity cost).

Costs should be expressed in terms of relevant opportunity costs. It is important to explore what opportunities may exist. An example of an opportunity is to use spectrum in a different, more valuable, way than in its current use.

Costs of goods and services that have already been incurred and are irrevocable should in general be ignored in an appraisal. They are 'sunk costs'. What matters are costs about which decisions can still be made. However, this includes the opportunity costs of continuing to tie up resources that have already been paid for.

Depreciation and capital charges should not be included in an appraisal of whether or not to purchase the asset that would give rise to them (although for resource budgeting purposes they may be important). Depreciation is an accounting device used to spread the expenditure on a capital asset over its lifetime. Capital charges reflect the opportunity cost of funds tied up in capital assets, once those assets have been purchased. They are used to help test the value for money of retaining an asset. They should not be included in the decision whether or not to purchase the asset in the first place.

Real or estimated market prices provide the first point of reference for the value of benefits. There are a few exceptions where valuing at market prices is not suitable. If the market is dominated by monopoly suppliers, or is significantly distorted by taxes or subsidies, prices will not reflect the opportunity costs and adjustments may be required.

The results of previous studies may sometimes be used to estimate the economic value of changes stemming from current policies. Some of the estimates set out in Appendix A exploit this technique (known as the 'benefit transfer' method). In the absence of an existing robust monetary valuation of an impact, a decision must be made whether to commission a study, and if so how much resource to devote to the exercise.

4.3 Valuing costs and benefits where there is no market value

Wider social and environmental costs and benefits for which there is no market price also need to be brought into any assessment. They will often be more difficult to assess but are often important and should not be ignored simply because they cannot easily be costed.

Most appraisals will identify some costs and benefits for which there is no readily available market data. In these cases, a range of techniques can be applied to elicit values, even though they may in some cases be subjective. There will be some impacts, such as environmental, social or health impacts, which have no market price, but are still important enough to value separately. Again, Appendix A identifies some of these. Revealed behaviour may allow estimation of values, for example, the relationship of house prices to environmental factors such as noise might allow the cost of noise to be valued. Alternatively willingness to pay can be estimated by asking people what they would be willing to pay for a particular benefit.

In considering non-market values it is important to include them, but it is also important to avoid double counting. For example, if energy production were already subject to a carbon tax and or emissions trading, then it would not be appropriate to include the environmental costs covered by such

mechanisms in addition to market prices for energy which already reflect existing interventions designed to “internalise” external impacts.

4.4 Net impact analysis

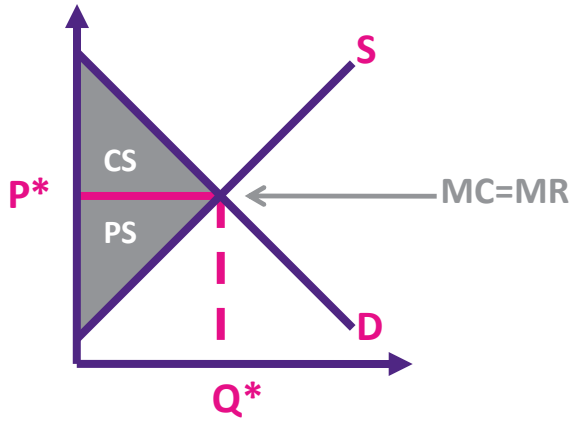
Economics tends to focus on net economic impacts – “economic welfare”. A key reason for this is that other more general policies are considered efficient means of pursuing distributional goals (such as taxes, welfare payments and public provision of specific services such as health and education). In this section we focus on net economic welfare.

A key consideration is that it is changes in behaviour – changes in demand and supply – that matter for cost benefit analysis, not the flow of money through the value chain. The following analysis is designed to illustrate what this means and how to estimate net impacts in practice.

The application of economics to impact assessment began with Jules Dupuit (an engineer) who developed the key concepts in 19th Century France. Dupuit defined "relative utility" as the area under the demand/marginal utility curve above the price and used it as a measure of the welfare effects of public works projects and pricing options. This concept was later referred to as Marshall's "consumer surplus".

Figure 4-2 shows supply and demand curves in a competitive market i.e. where firms are “price takers” and marginal cost (MC) equals price (P* is the competitive price) which equal marginal revenue (MR). Consumer surplus (CS) is the difference between what people are willing to pay and what they must pay for a service (and is therefore not directly observed). An analogous concept - producer surplus (PS) - is the difference between production costs (including a normal return on capital employed) and prices.[14]

Figure 4-2: Competitive market with efficient price level

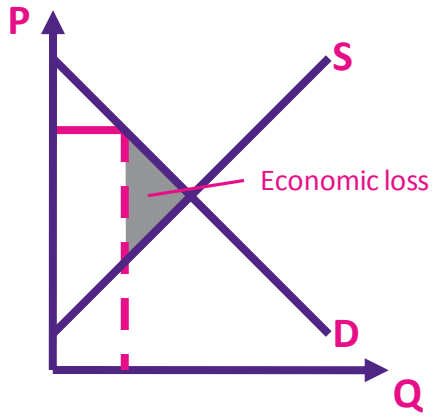


In the situation shown in Figure 4-2, where marginal cost and marginal revenue are equal and equal price, the sum of consumer and producer surplus (social welfare) is maximised. Any change in price above or below P* would result in loss of the sum of consumer and/or producer surplus, as illustrated

[14] Note that auction receipts will tend to reflect anticipated producer surplus – they do not reflect social surplus or consumer surplus.

in Figure 4-3 for a price increase above the competitive level. The loss of surplus is given by the shaded area.

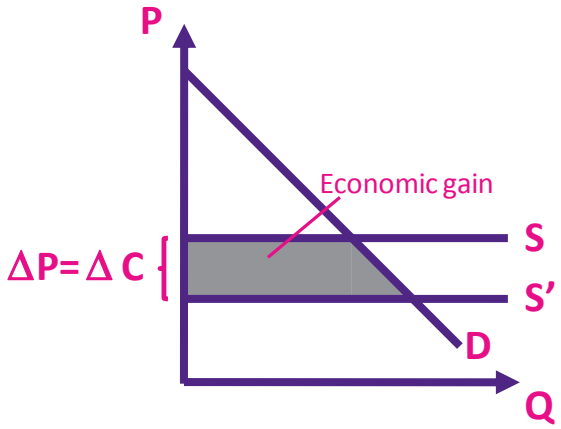
Figure 4-3: Loss of social surplus with price deviation from competitive levels



We now consider cases with a horizontal supply curve, as is often assumed in impact assessment. In this case producer surplus is zero with a competitive outcome. In other words firms earn what are termed normal returns.

In Figure 4-4 we introduce a productivity gain i.e. the marginal cost or supply curve is moved down. This results in a gain in consumer surplus equal to the area shown.

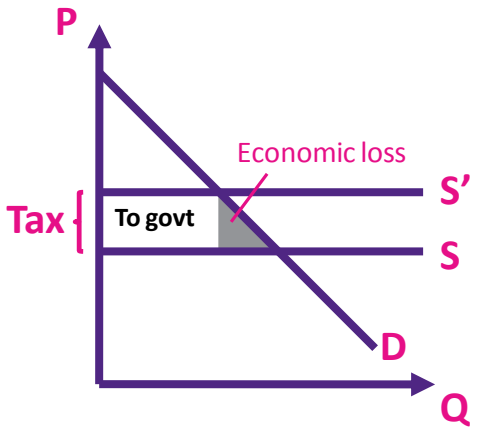
Figure 4-4: Gain in social surplus from a cost reduction



Note that the economic gain consists of two parts. First, a rectangle corresponding to the price reduction at the previous level of consumption. Second, a triangle representing the value of additional consumption stimulated by the lower price.

Figure 4-6 shows the impact of a price change driven by the introduction of a tax. The supply curve shifts up from S to S* and demand is reduced.

Figure 4-5: Impact of tax on social surplus

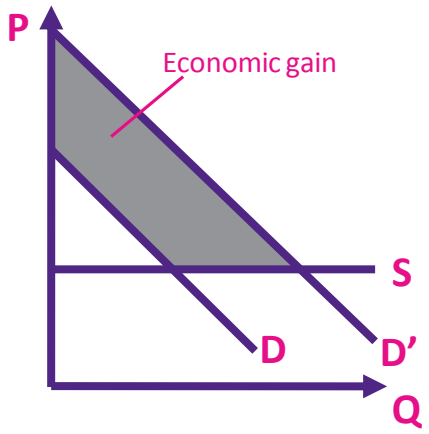


The government gains revenue amounting to the tax wedge times the level of consumption at the higher price (which will be redistributed in some way via lower taxes, lower debt or increased expenditure i.e. it will be transferred to someone else). Producers are no worse or better off (though in practice there may be some cost associated with adjusting to the lower level of demand).

However there is a loss to consumers which exceeds the amount of revenue raised by the government by an amount equal to the foregone consumption times its value – the triangular shaded area labelled economic loss. Raising tax revenue therefore involves an economic cost (rather than a gain) (estimates of the so called deadweight loss of taxation are provided in Appendix A).

Finally, we consider the possibility that demand grows resulting in an outward shift of the demand curve as illustrated in Figure 4-6.

Figure 4-6: Economic gain from an expansion in demand



It is apparent that an expansion in demand from D to D* can result in large economic gains (the gain in consumer surplus i.e. the difference between consumer willingness to pay and the price they pay). In the extreme one might consider the introduction of a new good or service where the gain is the entire area under the demand curve and above the supply curve. An example of this kind is fixed or mobile broadband.

In the above figures we see here a divergence between a common sense notion of impact (the total cost or benefit to a given party), and the concepts appropriate to the estimation of net economic benefit. This is typically given by the triangles rather than the rectangles in figures illustrating supply and demand. One implication is that the step between (iv) assessing impacts and (v) evaluation is not as simple as it might at first appear.

A key conclusion is that it is changes in behaviour – changes in demand and supply – that matter for cost benefit analysis, not the flow of money through the value chain. Monetary values do, however, allow valuation of changes in demand and supply. Other values, for non-market changes, must be estimated. A range of commonly used estimates are provided din Appendix A.

4.5 Competition

Step 5 of ECC 125 involves an assessment of the impact on competition (if relevant). In principle, the costs and benefits of any impact on competition would have been assessed under costs and benefits. However, as discussed in Section 3.1 competition has dynamic impacts on the rate of change of costs and benefits which may be hard to quantify. Therefore separate consideration of competition impacts is appropriate.

As an illustration, a change in competition might occur if new regulations were difficult for some manufacturers or service providers to comply with, for example, if they involved minimum costs of compliance which might prove prohibitive for smaller scale manufacturers or service providers. This might lead some to exit the market which could have two impacts:

- A reduction in the rate of productivity growth and rate of innovation, and a reduction in customer choice.
- If the reduction in the number of competitors were sufficient, higher price cost margins.

4.6 Methodology for adding things up over time

Costs and benefits almost always occur over time into the future and must be projected, expressed in consistent terms and summed.

4.6.1 Forecasts

It is important that anticipated inflation is treated consistently. The usual approach to impact assessment is to consider “real” costs and benefits before any allowance for inflation so that a unit of currency today is comparable with a unit of currency in the future.

Some costs and benefits can be expected to vary over time. In particular, capital expenditure costs may occur early whilst benefits may take time to build up. Further, some benefits or costs can reasonably be anticipated to fall or rise in real terms over time. A number of costs and benefits are related to anticipated real GDP growth per capita:

- Real wages will generally grow in line with real GDP growth per capita.

- The value of leisure time will grow approximately in line with real GDP per capita. One implication of this is that willingness to pay for services that allow time savings tends to increase relative to willingness to pay for time intensive services as income grows.

4.6.2 Discounting

Investors and consumers generally value benefits (and costs) more now than in the future. A method is therefore required for adding up costs and benefits over time to produce what is referred to as a net present value (NPV).

Costs and benefits will not all occur at the same point in time, and future costs and benefits are normally "discounted" at some rate to represent them in present value terms. The European Commission offer guidance on what discount rate to use and the recommended number is 4% real per annum (where real refers to after allowance for inflation). For example, a cost or benefit occurring in 10 years time would be reduced according to the discount rate compounded over ten years in order to convert the value into present value terms.

4.6.3 Uncertainty

Consideration of future costs and benefits necessarily introduces uncertainty. Uncertainty can be addressed via sensitivity analysis (testing the robustness of analysis to estimates of high or low values for costs and benefits). Alternatively distributions can be assigned to each variable and Monte Carlo analysis conducted to obtain a probability distribution for net benefits.

A decision might also be modified over time or pre-determined triggers included (for example sunset clauses) as a way of dealing with uncertainty. The combination of uncertainty and dynamic decision making introduces additional complexity which is considered below.

4.6.4 Asymmetry

In some cases a small change in policy in one direction might have a very different impact on costs and benefits to a change in the other direction. For example, if prices are reduced towards costs then net benefits steadily rise, however, as soon as prices are pushed below costs the supply of a good or service would cease (in practice the erosion of service might take time) – with large foregone benefits for consumers. In this situation, and where estimated values on which decisions are based are uncertain, it is efficient to "bias" policy away from the position that risks a high social cost outcome.

4.7 Taking account of the value of decision flexibility

An alternative to investing now is to wait – keeping open the option to invest or decide later. The option to invest in future (or never) is left open if investment or decision does not proceed immediately, whereas if investment or a decision does proceed it may be substantially irreversibly. Where the value of an option is expected to rise over time, or the return on the decision is uncertain, this asymmetry in terms of options can create a value to waiting.

In the two sub-sections below we give estimates of the impact of the value of waiting under conditions of certainty and uncertainty. These serve to demonstrate that the value of waiting can be large in some decision problems.

4.7.1 Certainty with growth

To give an indication of the magnitude of some of the above considerations, consider the case where there is no uncertainty but the value of a policy option is anticipated to grow at a rate of 2 per cent per annum – say in line with real income growth in the economy. For a 4 per cent discount rate this implies that the value of acting now must exceed the cost by 100 per cent before a decision to proceed now is worthwhile.[15] This means that if the value associated with the decision currently equals the cost it would be optimal to wait 15 years before proceeding.

4.7.2 Uncertainty and irreversibility

A hurdle rate is the required rate of return in a discounted cash flow analysis, above which an investment makes sense and below which it does not. The impact of uncertainty on investment hurdle rates with irreversibility and uncertainty is a multiple of the cost of capital and can be calculated under a set of simplifying assumptions (investment is one off and volatility follows a geometric random walk with variance σ^2).[16] In this case uncertainty remains constant over time (commodity prices more or less follow such a process). Figure 4-7 shows calculated hurdle rate multiples (on the vertical axis) as a function of the variance of expected returns for discount rate of 4 per cent and 10 per cent.

[15] The formula is V* = r/(r-g) I where r is the discount rate, g is the growth rate, V is value and I is the irreversible cost. From Dixit and Pindyck. 1994. "Investment under uncertainty." Page 138.

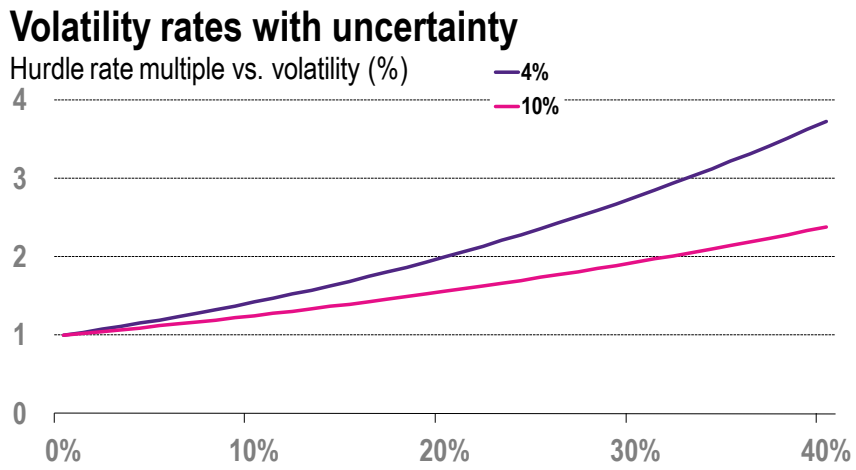
Invest/decide when value > $V^* = \frac{\rho}{\rho - a} I > I$ where ρ is the discount rate, a is the growth rate and I is investment.

The optimal time T* to wait before investing/deciding is $T^* = \max\left[\frac{1}{a}\log\left[\frac{pI}{(p-a)V}\right], 0\right]$

[16] Dixit. Winter 1992. "Investment and hysteresis." *Journal of Economic Perspectives*; Volume 6. The formula for the mark-up is:

$p^1 = \frac{\beta}{\beta - 1} p$ where $\beta = \frac{1}{2}\left[1 + \sqrt{1 + \frac{8\rho}{\sigma^2}}\right]$

Figure 4-7:



Source: Plum calculations based on real options formula

For a discount rate of 4 per cent and a variance of returns of 30 per cent the real options multiple is 2.76 i.e. the hurdle rate would be 11% instead of 4%. This gives an indication of the potential magnitude of impact on efficient decisions when real options are considered.

5 An illustration: TV and radio digital switchover

An illustrative example of the application of impact assessment is to consider two apparently similar questions, namely whether to migrate to digital TV broadcasting and whether to migrate to digital radio (DAB) and switch-off or greatly reduce the role of analogue broadcasting.

5.1 Digital TV and analogue switch-off

The transition to digital TV, now complete in some EU countries (see Table 5-1 below), [17] allows greater choice on the terrestrial broadcast platform and the potential to release UHF spectrum which can be utilised for mobile broadband, mobile TV and other applications.

Table 5-1: Timing of analogue TV switch-off

Time	Countries/regions
Complete	BE (Flanders), DE, FI, LU, NL, SE and major areas in AT
By end 2010	AT, DK, EE, ES, MT, SI
By end 2012	BE, BG, CY, CZ, EL, FR, HU, IT, LT, LV, PT, RO, SK, UK

The decision involves a public policy choice for two reasons:

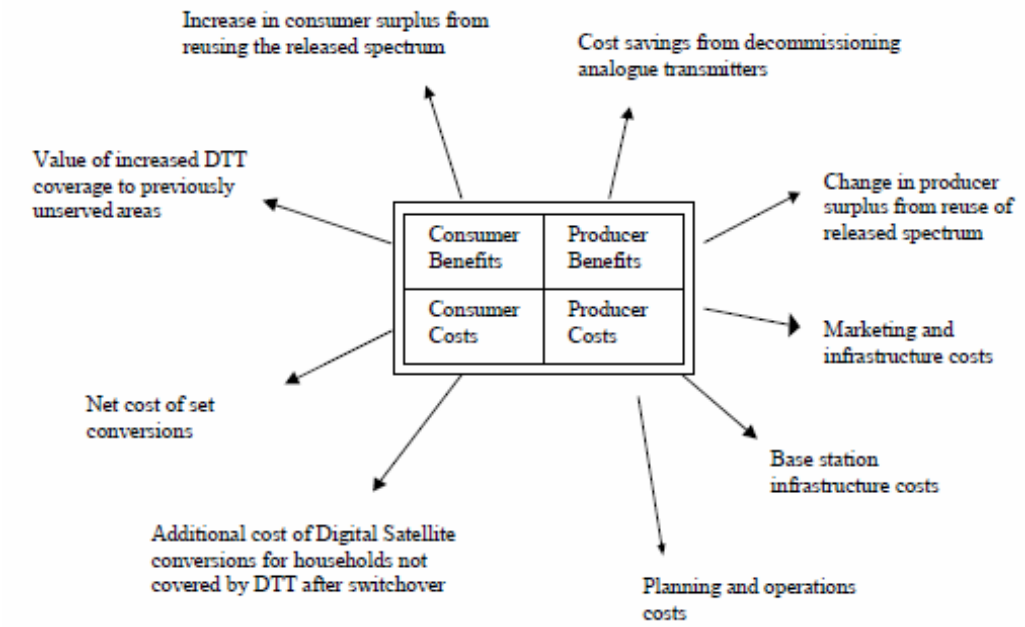
- First, the UHF spectrum utilised for broadcasting is both valuable for alternative use and generally is neither tradable nor priced so that a market mechanism to drive reallocation is absent.
- Second, governments have intervened historically in the TV market to promote universality, content quality and local content; and these interventions may be tied to technology specific means of delivery. In turn consumers have invested in reception equipment on an understanding that they are guaranteed access to public service content. Change therefore tends to involve political choices.

Detailed plans have been developed at the national level for "digital switchover", in the case of the UK involving a cost benefit analysis which weighed up the cost of achieving the transition including investment in new reception equipment (TV's or set top boxes and, for some, new aerials) against the benefits (the value of additional choice from an expansion of channels and the value of UHF spectrum released for other uses). A cost benefit analysis of digital switchover in the UK was published in February 2005. It considered a range of consumer and producer costs and benefits as illustrated in Figure 5-1. [18]

[17] European Commission. July and February 2009.
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1112&format=HTML&aged=0&language=EN&guiLanguage=en
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/266&format=HTML&aged=0&language=EN&guiLanguage=fr

[18] DCMS. February 2005. Cost benefit analysis of digital switchover.
http://www.digitaltelevision.gov.uk/pdf_documents/publications/CBA_Feb_2005.pdf

Figure 5-1: Impacts of TV digital switchover



In net present value terms (NPV) the cost benefit study identified the costs and benefits in Table 5-2.

Table 5-2: Cost benefit of TV digital switchover

Category	Net present value £ million in 2004
Benefits	
Consumer benefit in current non-DTT areas	3246
Consumer benefit from additional services in retailed spectrum	787
Consumer benefit from re-use of released spectrum	1181
Imputed consumer benefit of compulsory migration	689
Broadcaster benefits from savings on analogue transmission and energy cost	1377
Costs	
Non-voluntary consumer costs on reception equipment	2504
Additional consumer energy costs (incl. Social cost of carbon)	1651
Broadcaster investment in digital infrastructure	702
Marketing and practical support costs (excluding any targeted assistance)	174
Net benefit ((NPV)	**2249**

The analysis therefore supported digital switchover. A detailed technical plan was developed and agreed by government and industry with a phased regional transition to digital TV. Information was

provided to households to ensure they knew that analogue TV would be discontinued and what they needed to do to ensure continued reception. Further, targeted help was provided for groups such as the elderly to assist them with the transition.

One can contrast TV digital switchover with the move from analogue to digital cellular mobile communications. In general this transition was managed by the operators themselves who wanted to offer superior service to consumers, but also wanted to manage the transition in a way that did not harm their customers. Were UHF spectrum tradable and had the TV market been less subject to existing public policy intervention is conceivable that digital switchover would have been managed by the private sector.

If the above analysis were repeated today the estimated benefit of re-use of released spectrum for mobile broadband in particular might involve a larger value estimate based on more recent estimates[19] Further, today consideration might be given to a migration to satellite and broadband delivery of TV rather than digital terrestrial broadcasting given the development of HDTV and broadband since 2005.

5.2 Digital radio (DAB) and national FM switch-off

In the case of an assessment of moving to digital radio the circumstances are different for the following reasons:

- The relevant spectrum is unlikely to have much value in alternative uses (certainly not in relation to UHF spectrum).
- A move to digital radio is been contemplated after it has become clear that the internet and broadband provide an alternative delivery mechanism for radio (including on demand services such as Spotify – currently available in Sweden and the UK).
- FM radio is embedded in many more devices including car radios, alarm clocks and mobile phones. Replacing all of these devices with digital radio may be either impractical or expensive.

In 2009 the UK Government made a commitment in principle, conditional on50% take-up of digital radio by 2015 (any form of digital presumably including internet radio), to move to DAB only for national services. The decision was supported by a preliminary impact assessment (with further review and analysis anticipated, with the first review in Spring 2010, and a full cost benefit analysis before any Digital Radio Upgrade date is set).[20]

Table 5-3 summarises the findings of the preliminary impact assessment (note that these are annual costs and benefits rather than net present value estimates).

[19] See, for example, European Commission. 10 July 2009. Consultation document – transforming the digital dividend opportunity into social benefits and economic growth in Europe. http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/_document_storage/consultations/2009_digitaldividend/2009_0710_0904_digitaldividendconsultation.pdf

[20] Department for Culture, Media and Sport (DCMS). June 2009. Impact assessment of preparation for digital radio migration. In Digital Britain Report, page 109. http://www.culture.gov.uk/images/publications/digitalbritain_impactassessment.pdf

Table 5-3: Cost benefit of national radio switchover to DAB

Category	Annual value £ million
Benefits	
Cost saving to national broadcasters of licence extensions	10
Cost saving to national broadcasters of co-location and increased networking	23
Benefit after dual transmission on analogue and DAB ceases	38.9
Costs	
One-off cost to Government of not auctioning national analogue licences	10
Costs to multiplex operators and broadcasters of re-structuring multiplexes	Not quantified

A number of observations can be made regarding this preliminary analysis based on the framework developed in this report:

- The counterfactual is assumed to be analogue plus digital transmission, whereas an alternative might be analogue plus the internet delivery coupled with WiFi and mobile wireless.
- It is not obvious why the radio industry itself could not make a decision about whether or not to adopt digital radio given that the value of the spectrum to other users may be negligible.
- Estimated benefits appear to include the benefits of a separate and independent policy decision in relation to co-location of stations to reduce costs. [21] The costs and benefits if each independent decision should be considered and assessed separately.
- Government revenue foregone is counted as a cost to government and a benefit to the radio broadcasters, whereas the net impact of foregone revenue is the impact on the deadweight loss of taxation.
- The estimated benefit after dual transmission on analogue and DAB ceases may include fixed common costs such as site and mast costs which are a significant part of overall costs and would not be saved when dual transmission ends (assuming the sites themselves continue in operation).
- The costs of extending the digital radio transmission network to match existing coverage levels are not included, yet they are estimated to be substantial.[22]
- The costs to consumers of purchasing new radios for their homes and cars are not included.

[21] Collocation refers to the benefits of a separate policy decision – from the impact assessment: "One of the key principles which have underpinned the Government's policies for commercial radio since its introduction is that its content should be locally relevant and locally produced. Currently this is achieved by requiring stations to be located in the areas which they serve. The result of this is that radio companies are on the whole operated as a collection of small business with the main core business costs, such as staff and premises, being duplicated. The industry needs greater flexibility to realise economies of scale at a local level and reduce their overall fixed costs. For this reason we will relax the current rules and permit greater co-location of stations and in some cases more networking of programmes."

[22] The BBC Trust noted that they understand that the cost of extending DAB population coverage to 90% could cost £11 million per annum to increase the number of transmitters from the current 96 to 230 and that increasing coverage further to match FM radio may cost the BBC up t o£40 million per annum, as the number of transmitters would need to be increased to approximately 1000. Presumably there may be additional costs for commercial radio stations.

BBC Trust. December 2007. "The BBCs Efficient and Effective use of Spectrum". Page 40.
http://www.bbc.co.uk/bbctrust/assets/files/pdf/review_report_research/vfm/dt_spectrum.pdf

- The costs in terms of possible loss of coverage to those currently receiving analogue coverage in remote areas is not included.

5.3 Conclusion

The above two examples illustrate how apparently similar problems may differ. They also illustrate good practice and specific problems in relation to the analysis of digital radio in terms of problem definition, the question of who needs to decide what, the need to separate different policy questions when estimating costs and benefits and risks in terms of errors of omission and inclusion of costs and benefits.

Appendix A: Commonly used parameters

A number of parameters appear across a range of impact assessments and are common in nature i.e. they have the same value in different applications. These numbers may appear in guidance, particularly in relation to transport appraisal (which has a long history of the application of quantitative cost-benefit analysis).[23]

In Table A-1 we report estimates for the UK to indicate the areas where national estimates in other countries might be obtained. We also report European estimates where possible provides a list of commonly used parameters and sources.

Table A-1: Commonly used parameters in cost benefit analysis

	UK estimate	European estimate
GDP per capita	€29,700[24]	EU27: €25,100[25] Low EU27: €4,500 High EU27: €75,100 EU15: €29,200 Low EU15: €12,000 High EU15: €75,100
Inter-temporal discount rate	3.5%[26]	Financial: 4.76% Social: 5.5% SDR for the Cohesion countries and 3.5% for the others [27]
Value of leisure time (per hour per person)	Commuting: £5.04 Other: £4.46[28]	€4[29]
Value of working time (per hour per person)	£10.61[30] or £26.73[31]	€21[32]
"Value of life" (per casualty)	£1,428,180[33]	€1,018,200[34] (between €200,000 and €1,650,000 per EU country)

[23] For example, see the UK Department for Transport guidance: http://www.dft.gov.uk/webtag/

[24] 2008 forecast. Eurostat. http://nui.epp.eurostat.ec.europa.eu/nui/show.do?dataset=nama_aux_gph&lang=en

[25] 2008. Eurostat. http://nui.epp.eurostat.ec.europa.eu/nui/show.do?dataset=nama_aux_gph&lang=en

[26] HM Treasury Green Book. Annex 6. http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

[27] Guide to Cost-Benefit Analysis of investment projects. EC DG Regio. Annex B. http://www.eufunds.bg/docs/CBA_guide2008_en.pdf

[28] "Market price value of non-working time per person". Transport Analysis Guidance: Values of Time and Operating Costs. 2002. http://www.dft.gov.uk/webtag/webdocuments/3_Expert/5_Economy_Objective/3.5.6.htm#012

[29] UNITE study values (1998). Handbook on estimation of external costs in the transport sector. 2008. P28. http://ec.europa.eu/transport/sustainable/doc/2008_costs_handbook.pdf

[30] Value to employee - "Median gross hourly pay for all employee jobs". 2008. ONS. http://www.statistics.gov.uk/downloads/theme_labour/ASHE_2008/2008_all_employees.pdf

[31] Value to employer – "Market price value of working time per person". Transport Analysis Guidance. 2002. http://www.dft.gov.uk/webtag/webdocuments/3_Expert/5_Economy_Objective/3.5.6.htm#012

[32] UNITE study values (1998). Handbook on estimation of external costs in the transport sector. 2008. P28. http://ec.europa.eu/transport/sustainable/doc/2008_costs_handbook.pdf

[33] "Average value of prevention per casualty". 2005 Valuation of the Benefits of Prevention of Road Accidents and Casualties. Department for Transport. 2007. P10. http://www.dft.gov.uk/pgr/roadsafety/ea/pdfeconnote105.pdf

Quality adjusted life year	£20-30,000[35]	In the process of being researched. Currently same as UK.[36]
Value of greenhouse gas abatement (per tCO2)	2007: £25.5[37] 2008: £26[38] 2009: £26.5 2010: £27 2020: £32.9 2030: £40.1 2040: £48.9 2050: £59.6[39]	2010: €25[40] 2020€40 2030:€55[41] 2040: €70 2050: €85[42]
Deadweight loss or excess burden from taxation	25%-50% of revenue. [43] [44]	
Value of spectrum	Various specific estimates available from auctions etc. For discussion of difficulties of utilising generic estimates see Aegis and Plum (2009).[45]	

[34] 2002 "unit costs per fatality". Cost-benefit assessment and prioritisation of vehicle safety technologies. EC – DG TREN. 2006. P44-47. http://ec.europa.eu/transport/roadsafety_library/publications/vehicle_safety_technologies_final_report.pdf

[35]Measuring effectiveness and cost effectiveness: the QALY. NICE. Nov 2008. http://www.nice.org.uk/newsroom/features/measuringeffectivenessandcosteffectivenesstheqaly.jsp

[36] EuroVaQ. http://research.ncl.ac.uk/eurovaq/more/overview.html

[37] The 2007 value is based on the social cost of carbon consistent with the damage experienced under an emissions scenario which leads to stabilisation at 550ppm CO2. The equilibrium is informed by the social cost of carbon (based on damage costs) and the marginal abatement cost. http://www.defra.gov.uk/environment/climatechange/research/carboncost/pdf/background.pdf

[38] All other values are based on the 2007 value, but updated based on 1) the Stern Review's assessment of the rising incremental damage of each unit of carbon as temperatures rise and 2) the GDP deflator.

[39] "Shadow price per tonne of carbon released in 2007 prices". How to use the shadow price of carbon in policy appraisal. Defra. P3. http://www.defra.gov.uk/environment/climatechange/research/carboncost/pdf/HowtouseSPC.pdf

[40] 2010-2020 values are based on avoidance costs.

[41] 2030-2050 values are based on damage costs.

[42] "Recommended values for the external costs of climate change". Handbook on estimation of external costs in the transport sector. 2008. P264. http://www.europadecentraal.nl/documents/dossiers/Transport/2008_01_15_handbook_external_cost_en.pdf

[43] Edgar. March 1997. "On the marginal welfare cost of taxation." *American Economic Review*. Volume 77. Issue 1.

[44] Boardman, Greenberg, Vining and Weimer. 2006. "Cost-benefit analysis – concepts and practice." Third Edition. Pearson Prentice Hall. Page 428-429.

[45] Aegis and Plum. July 2009. "Estimating the commercial trading value of spectrum." http://www.ofcom.org.uk/research/technology/research/spec_future/specestimate/specestimate.pdf

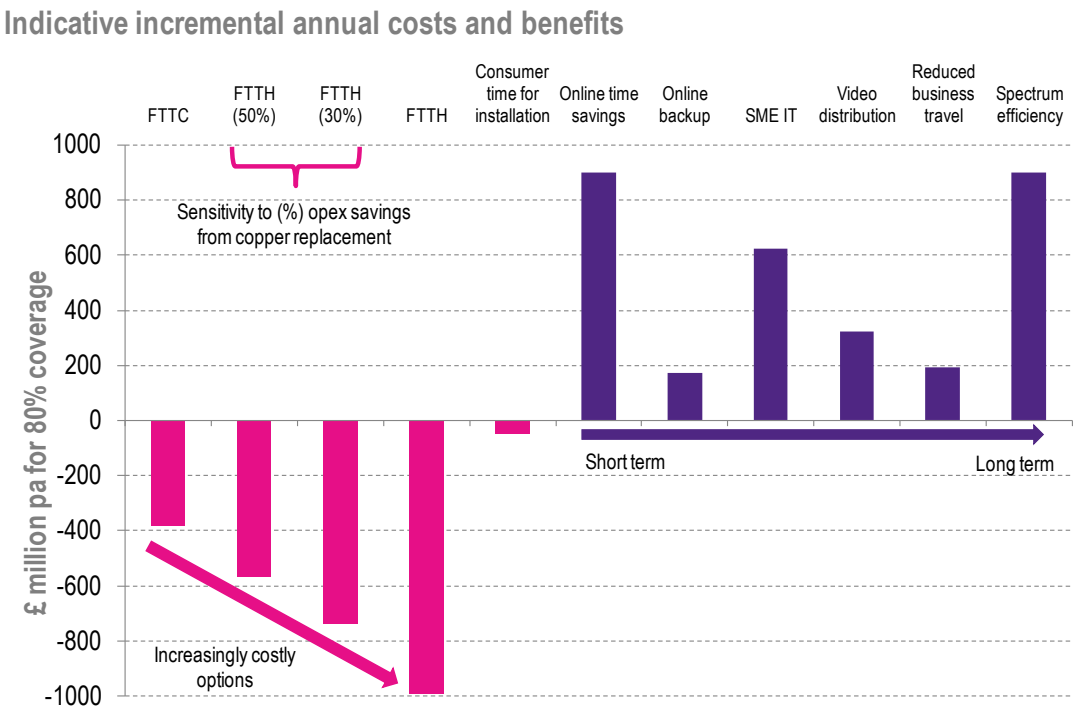
Appendix B: Fixed next generation broadband

A framework was developed for considering the economic and social costs and benefits of next generation broadband in a study for the UK Broadband Stakeholder Group.[46]

Key considerations including valuing next generation (fixed) broadband relative to a counterfactual of current broadband evolution (to ADSL2+) and more advanced wireless services. Both fibre to the cabinet (FTTC) and fibre to the home (FTTH) were considered.

To illustrate the methodology some elements of costs and benefits were quantified whilst others were assessed qualitatively. The results are shown in Figure B-1 and Table B-1.

Figure B-1:



[46] Plum. June 2008. A framework for evaluating the value of next generation broadband. http://www.broadbanduk.org/component/option,com_docman/task,doc_view/gid,1009/Itemid,63/

Table B-1: Qualitative assessment of other incremental benefits (+) and costs (-)

Scale	Private	Wider economic	Wider social
(+++)	Un-quantified increase in existing activity Un-quantified new things	Resilience, adaptability and policy options Spill-over and virtual agglomeration benefits	Social capital, resilience and trust
(++)		Competition in wider economy	Educated citizens Belonging to a community
(+)		Value of leased exchange land and buildings Reduced traffic congestion Network effects	Informed democracy
Neutral-unclear		Piracy Competition in telecoms Greenhouse gas emissions	Cultural understanding Privacy
(-)	Core network enhancement Costs of transition from copper to fibre with replacement Any change in operating costs associated with FTTC or FTTH	Traffic congestion and other disamenity during fibre build Excess burden of taxation for public funding	