Ex post evaluation of cohesion policy programmes 2000-2006

Work Package 10:
"Efficiency: Unit costs of major projects"

First Interim Report

Task 1: Review of Existing Literature and Evaluations

Draft version 2.1

TABLE OF CONTENTS

1. Introduction

1.1. Purpose of this report

1.1.1. This is the First Interim Report on Work Package 10 of the European Commission, Directorate-General for Regional Policy's ex post evaluation of cohesion policy programmes 2000-2006 financed by the European Regional Development Fund in Objective 1 and 2 regions. The title of Work Package 10 (WP10) is "Efficiency – Unit costs of major projects".

1.1.2. The notion of efficiency under WP10 refers to the achievement of the desired or projected benefits at a reasonable cost. The concern is with "major projects", which includes large infrastructure and productive (or business support) investments.[1] The Commission distinguishes between two aspects of evaluating efficiency: (i) output efficiency: unit costs and completion times of major infrastructure projects, including an analysis of cost and time overruns; and (ii) result efficiency: the cost per job created by productive investments.[2] These efficiency evaluations are required to cover a sample of 115 infrastructure projects and 40 productive investments. This sample of 155 is, in turn, derived from a population of 271 projects from 11 Member States.[3]

1.1.3. Sections 2, 3 and 4 of this Report are concerned with the first aspect of evaluating efficiency, that is, the output efficiency of major infrastructure projects. According to the specifications for the project, this report should cover Task 1, namely the review of existing literature and evaluations. In undertaking this review of existing literature and evaluations, the project team was required to:

- take stock of definitions, calculation methodologies and benchmark values for unit costs of infrastructure projects and cost per job created by "productive investments";[4]
- highlight the most appropriate definitions and calculation methods with a view to defining the methodological framework to be employed in this and future evaluations;
- review existing unit cost benchmarking methodologies and existing tools, and the various public and commercial databases in the various Member States concerned;
- comment on what data are meaningfully comparable for each sector and what other factors will drive differences in unit costs.

[1] In order for projects to be considered 'major', they must "comprise an economically indivisible series of works fulfilling a precise technical function and which have clearly identified aims". They must also be projects "whose total cost taken into account in determining the contribution of the Funds exceeds EUR 50 million." See Article 25 of Council Regulation 1260/1999 of 21 June 1999 laying down general provisions on the Structural Funds.

[2] However, as well as evaluating the efficiency of major projects undertaken in the 2000-2006 period, it is the Commission's intention that WP10 will also develop and test a methodology for investigating unit costs which can later be applied in future evaluations, such as the planned ex post evaluations of Cohesion Fund and ISPA projects.

[3] The total eligible expenditure involved in these projects amounts to €33 billion, of which approximately €15 billion is the ERDF contribution.

[4] When reporting cost benchmarks, currencies and price levels are to be made explicit, with all benchmarks normalised to EUR constant prices.

1.1.4. The report is required to present definitions, calculation methods and available benchmarks for:

- unit costs of infrastructure projects and components in the fields of road, rail, urban transport (metro, tramways/light rail), water supply, waste-water treatment for different standards, waste management and energy[5]; and
- costs per job created in projects involving direct support to enterprises (i.e., "productive investment").

1.2. Our approach to reviewing the literature

Infrastructure

1.2.1. In surveying the existing literature, we focused on assessments of the efficiency of infrastructure project delivery, as indicated by unit investment costs, completion times, cost overruns and time delays. We have endeavoured to summarise the main findings and provide appropriate recommendations, with a view to defining a methodology for this and future evaluations.

1.2.2. In respect of unit investment costs, we focused on the following three areas: (i) the cost definitions used and why (both for projects in the aggregate and (where possible and relevant) for the specific components of the infrastructure project; (ii) how unit costs are and/or should be developed and calculated; and (iii) the availability of unit cost benchmarks and the extent to which they can be utilised in Work Package 10.

1.2.3. We have also sought to reveal the most important explanatory factors identified in the literature for: (i) variations in unit costs across different projects; (ii) variations between outturn and estimated unit costs (i.e., cost overruns); and (iii) variations between the actual and estimated timing of projects.

1.2.4. Public documents and data from a wide range of sources have been considered, including academic research, private consultancy reports, reports by multilateral development organizations and financial institutions (such as the European Commission, European Investment Bank, the World Bank and OECD), government departments (such as HM Treasury, various departments of transport and the UK National Audit Office), professional institutions, and industry organizations (such as the UIC).

1.2.5. The types of studies covered were of a similarly wide variety, and included previous programme or project evaluation studies, broad statistical studies of project performance (costs, overruns and delays), in-depth analyses of a single or a small sample of project case studies, previous cost benchmarking efforts and databases, descriptive-theoretical papers and guidelines explicating the nature and causal relationships between the various determinants of project performance.

[5] The evaluation will focus mainly on transport projects. However, the Commission noted that it is important that the other fields are appropriately covered under Task 1 because the analysis performed will serve as a basis for future Cohesion Fund and ISPA evaluations.

Productive investments

1.2.6. For productive investments, we focused on measurements of the efficiency result of these types of investments, typically done by examining costs per job created by these investments. As in the infrastructure case, we have endeavoured to summarise the main findings and provide appropriate recommendations, with a view to defining a methodology for this and future evaluations.

1.2.7. Measuring true net employment effects is a complicated business. We have focused on the following three areas: (i) employment effects and job definitions; (ii) methodology for estimating and measuring the number of jobs created (and to a lesser extent, the costs of productive investments); and (iii) any existing and available benchmark costs per job created in previous research or programmes, and to what extent these can be meaningfully compared.

1.2.8. There are a number of studies and reports that address the issue of measuring employment effects. The principle work in this area, we believe, is the EC document "Measuring Structural Fund Employment Effects", which is based on the CSES "Study on measuring employment effects". Other studies contain some useful insights on definitions and methods.

1.3. Our approach to the benchmarking exercise

1.3.1. As set out in our project proposal and Inception Report, we have sought to identify and gather data from relevant cost benchmark databases. We have investigated a wide range of potential sources of databases including government ministries, industry/market organisations and multi-lateral agencies.

1.3.2. With one or two exceptions, we have not been able to identify any suitable databases. In some cases, where cost databases are maintained, they are for disaggregated input costs, such as concrete, steel or labour rates. These databases are used to prepare bottom-up cost estimates but do not provide any total or component project costs suitable for benchmarking in the context of this Study.

1.3.3. In a few countries, government ministries may maintain confidential databases of costs, but we have not been able to obtain further details or even the underlying information.

1.3.4. As a result of this absence of suitable benchmark databases, we have instead compiled a survey of individual project costs from a range of sources. This exercise, whilst limited, has, for some cost categories, yielded useful 'indicative benchmark ranges' against which costs of the sample projects can (as the Study progresses) usefully be compared.

1.3.5. Diagrammatic results of our benchmarking exercise are shown in Section 6.

1.4. Other issues covered in this report

1.4.1. This report also sets out a progress report on the data gathering exercise for the sample of major infrastructure projects and productive investments that are to be the subject of this Study.

1.4.2. The data gathering strategy was outlined in Section 3.3 of our Inception Report. Section 6 of this Report provides a comprehensive review of our progress in implementing that strategy.

1.4.3. At the seventh meeting of the Steering Group for Objective 1 and 2 programmes, we undertook to carry out some pilot testing of the information received utilising the initial data returns.

1.4.4. Once the data was in a comparable format, we hoped to compare the actual unit costs and completion times to the benchmarks identified in our review of the literature, previous studies and databases in Task 1. This would allow us check whether the unit costs provided appear plausible and whether it would be necessary to further interrogate the data through further contact with the provider.

1.4.5. This has, however, not been possible because the contact details were, in almost all instances incorrect or no longer valid and, therefore, establishing contact with someone prepared to assist was problematic. In some of the cases where information has been received, it is of insufficient quality to facilitate a meaningful analysis.

1.5. Structure of this Report

1.5.1. Sections 2, 3 and 4 examine, based on our review of the literature, the issues that arise in measuring the output efficiency of major infrastructure projects and the implications for WP10. More specifically

- Section 2 deals with the process of formulating robust and comparable unit cost definitions and measures;
- Section 3 deals with the determinants of costs and the implications for the analysis of differences between projects within sectors, both within and between countries;
- Section 4 examines the identification and measurement of project delays and cost overruns and analyses the reasons for these phenomena.

1.5.2. Section 5 provides a review of the (relatively sparse) literature on the measurement of employment effects and how this relates to the analysis of the result efficiency of productive investments.

1.5.3. Section 6 provides the results of our benchmarking exercise.

1.5.4. Section 7 provides a progress report on the data gathering exercise for Work Package 10.

2. Unit cost definitions and measurement for infrastructure projects

2.1. Introduction

2.1.1. The evaluation of output efficiency of major infrastructure projects involves, in the current context, making comparisons between the costs of those projects, i.e., cost benchmarking. However, because no two projects can be expected to be of equal size or specification, it would be meaningless to compare the total costs of projects. Costs for each project must, rather, be expressed on a common 'per unit' basis. For example, it is meaningless to compare the total cost of a 20km road project with the total cost of a 15km road project. Rather, it is necessary to compare the projects on a total cost per km basis.

2.1.2. For that reason, we are concerned with the concept of a 'unit cost definition', such as, for example, the 'total cost per km of road' introduced in the previous paragraph. The robustness of the results will depend on the consistent application of the unit cost definitions that are adopted as the basis for comparison. They must, therefore, be widely applicable and must facilitate comparability.

2.1.3. The choice of unit cost definitions gives meaning to the benchmark produced. The unit cost definition determines the comparability of the result (the benchmark) with other benchmarks, as well as its relevance in forecasting the cost of future projects. It is necessarily a technical issue, informed by the realities of the procurement and construction processes of infrastructure projects.

2.1.4. There are a number of important dimensions to the formulation of useable unit cost definitions. These are addressed in the following Sections of this part of the Report, as follows:

- Section 2.2 examines the types of costs to be included in the numerator of the unit cost definition[6];
- Section 2.3 examines the elements of projects for which to include those costs;
- Section 2.4 the methodologies required to normalise unit costs to take account of things like different time periods or different country-specific circumstances.

2.1.5. The remainder of this part of the Report includes Section 2.5, which analyses the implications for WP10 of the issues covered in the earlier Sections, and Section 2.6 which concludes.

[6] Note that the denominator of a unit cost measure is relatively straightforward matter. For example, it will consist of the number of kilometres of road or of rail or urban transport track or the population served by a water project. In general, however, the relevant metric will depend on the specific circumstances and purpose of the project.

2.2. The types of costs to be included

2.2.1. The main issue concerns which project costs should be included in the numerator of the unit cost measure. The unit of output to be used in the denominator of the unit cost measure is usually a relatively straightforward matter. For example, the World Bank's ROCKS framework for road projects suggests the use of road length (giving a cost per kilometre) or road surface area (giving a cost per square metre).[7]

2.2.2. The literature suggests that similar projects can use very different unit cost definitions. A couple of examples are illustrated as follows.

- Blanc-Brude et al. (2006) use project costs that incorporate design, engineering, construction and supervision, but that excludes land purchases, technical and price contingencies, taxes, start-up costs and fees, and the interest payments during the construction phase. The project cost, so defined, is divided by the length of the road that was constructed measured in km.
- The World Bank ROCKS framework uses 'civil work' costs, which incorporate items such as mobilisation (pavement-drainage), major structures (including line markings), contingencies and taxes, but excludes other agency costs such as design, land acquisition, resettlement and supervision.

2.2.3. The 1998 European Commission DGXVI (now DG REGIO) guidance on the cost-determining factors of infrastructure development was designed to provide desk officers with a basic understanding of the process by which project cost estimates are made so that they would be better able to review, with the project sponsors, the reasons for actual or anticipated cost and time overruns.

2.2.4. The study provided indicative shares of 5 cost categories for seven types of infrastructure project. The results are shown in Figure 1 below, which presents Table 1 from the Report.

Figure 1: Indicative shares of 5 cost categories for infrastructure types

Table 1

Major Cost Elements and Indicative Share of Total Cost for Seven Infrastructure Types

	Motorway Dual (1 km) Rural Area	Motorway Dual (1 km) Urban Area	Sewage Treatment Plant 50,000 people	Water Supply Network (1) 50,000 people	Public Building (2) 15,000 m^2	Energy 1 (3) CCGT Power Station	Energy 2 (4) City Gas Distribution Network
Planning/Design Fees	3-5%	3-4%	3-5%	5-7.5%	10-15%	5-10%	5-10%
Land Purchase	3-5%	20-30%	0-1%	1-2%	5-15%	0-10%	0-10%
Building & Construction	75-80%	60-65%	40-41%	75-80%	25-38%	15-30%	20-35%
Plant & Machinery	na	na	40-41%	na	10-18%	50-60%	40-50%
Contingencies	10%	10%	10%	10%	10-15%	10-20%	10-20%

Notes: Because a percentage range is given for each cost element, columns do not sum to 100%

1. *10 km pipeline from existing reservoir with new treatment plant and new mains network*
2. *Eight storey building in urban area with offices and function rooms*
3. *60 MW station with 20 km of transmission lines feeding into main grid, sufficient for a settlement of 50,000*
4. *LPG storage plant with 500 km pipeline network (15% primary distribution, 85% secondary distribution), 250,000 population*

Source: European Commission DG XVI (1998), "Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects", A User's Guide, Brussels.

[7] ROCKS stands for Road Costs Knowledge System.

2.2.5. While this is useful in providing an indication of the relative significance of different elements of cost, one must remember that diversities in the conditions under which projects are implemented must be borne in mind when using it as part of an evaluation framework.

2.2.6. While all approaches reviewed include construction, they are at odds over whether items like contingencies and taxes should be included. Similar considerations for other project sectors abound. For example, for rail projects, whether unit cost calculations for rail projects should include the cost of stations and rolling stock is a common theme.

2.2.7. Flexibility in the choice of unit cost definition will, of course, often be constrained by the availability of data. A common difficulty is the absence of cost breakdowns that would facilitate the disaggregation of costs required to develop comparable unit cost measures. Moreover, it is often unclear which items have been included in an aggregate measure.[8]

2.2.8. Unit cost benchmarks are most useful when they accurately reflect the average cost of sufficiently disaggregated components of an infrastructure project. For instance, large sections of tunnel or bridge on road or rail projects would usually be expected to substantially increase the costs of the project. Comparing the total cost of such projects with analogous projects that do not involve these fixed links would be meaningless.

2.2.9. NAO (2007) reported that, since 2003, all estimates submitted by the Department for Transport follow the Treasury guidance notes laid out in The Green Book. This means the following factors must be included in cost estimate calculations:

- Non-recoverable value added tax. This applies for work costs only; other key elements of scheme costs such as preparation, supervision and land are expected to be VAT recoverable. The method is expanded further below:
  - o The NAO approximated how much of the expected works costs on programme entry was susceptible to non-recoverable VAT and the expected non-recoverable VAT charge. Dividing non-recoverable VAT by the works cost gives a percentage which can be applied to the initial works estimate to give an approximation of the expected non-recoverable VAT charge upon programme entry. This approach assumes that the scope of the project has not changed significantly.
  - o For some schemes the elementary breakdown was not available. In these cases the Agency applied the calculated non-recoverable VAT percentage to the total works cost (including preparation and supervision, and land). This will have had the effect of overstating the initial cost estimate, and therefore understating the extent of cost increases.
- Inflation at 2.5 per cent to reflect the general price level; raised to 2.7 per cent in 2007-08. It is, however, widely agreed that this estimate remains insufficient due to the much higher level of construction cost inflation.
- A variable percentage increase to compensate for the tendency for project appraisers to be overly optimistic and to under-estimate costs (optimism bias). Depending on the quality of the risk assessment and the entry stage and complexity of the project this contingency allowance is set at between 3 and 45 per cent.

[8] Flyvbjerg, Bent, Mette Skamris Holm and Soren Buhl (2003), "How common and how large are cost overruns in transport infrastructure projects?" *Transport Reviews*, Vol. 23 No. 1.

2.2.10. The Highways Agency has adopted these factors into current estimates for UK national road projects. Similarly, Local Transport Plan estimates now have to include a contingency for cost under-estimation.

2.3. Elements of projects to include in cost definitions

2.3.1. As noted by the European Commission itself and in the literature, no two infrastructure projects will cost the same no matter how similar they are. For that reason, unit cost benchmarks will only be useful when they accurately reflect the average cost of sufficiently disaggregated components of projects.[9] For example, large sections of tunnel or bridge on a road or rail project would be expected to increase the total cost of the project and, therefore, comparing such projects with analogous projects that do not involve these elements would be meaningless.

2.3.2. The World Bank Road Costs Knowledge System (ROCKS) database is probably the most comprehensive and detailed available for any type of transport infrastructure. The main objective of the ROCKS system is to develop an international knowledge system on road work costs to establish an institutional memory, and obtain average and range unit costs based on historical data that could ultimately improve the reliability of new cost estimates and reduce the risks of cost overruns.

2.3.3. The database was created with data collected primarily from World Bank financed projects and has 2,043 records. The earliest record dates back to September 1984, and the most recent record is from June 2007. Sources of information include World Bank Implementation Completion Reports, project appraisal documents, civil works contracts, as well as from project supervision reports, pavement management information systems and procurement and disbursements reports. There are 837 records representing average costs for maintenance, rehabilitation, or improvement programs and 1,206 records for cost of works on individual sections, with a good distribution between the numbers of cost benchmarks derived from each of estimates (884), contracts (635) and actuals (524).

2.3.4. The existing database has data from 89 developing countries. For the majority of countries only a few lines of data are available, while for others such as Brazil, Chile, Russia, Poland, Ghana, Uganda, India, Thailand, Philippines and Bangladesh, there is a large set of data. Costs are classified by a cost date to capture the representative date of the expenditures.

2.3.5. The ROCKS framework separates road projects into two main categories, namely preservation and development, and further classifies these categories by type of road work and by predominant work activities. The classifications for preservation are presented in Figure 2 below.

[9] Flyvbjerg et al (2003) noted that acquiring disaggregated data to a level sufficient to facilitate meaningful comparisons is essential, but can be time-consuming (and, therefore, expensive) or even impossible.

Predominant Work Activity for Preservation Works

Work Category	Work Class	Work Type	Predominant Work Activity	Recommended Unit Cost	Alternative Unit Cost
Preservation	Routine	Routine Maintenance	Routine Maintenance 1L Road Routine Maintenance Unsealed 2L Highway Routine Maintenance Block 2L Highway Routine Maintenance Bituminous 2L Highway Routine Maintenance Concrete 2L Highway Routine Maintenance Bituminous > 2L Highway Routine Maintenance Concrete > 2L Highway Routine Maintenance Bituminous Expressway Routine Maintenance Concrete Expressway	$/km-year	
	Periodic	Grading	Light Grading Heavy Grading	$/km	
		Gravel Resurfacing	Regravelling	$/m2	$/km
		Concrete Pavement Preventive Treatment	Concrete Pavement Preventive Treatment	$/m2	$/km
		Bituminous Pavement Preventive Treatment	Fog Seal Rejuvenation	$/m2	$/km
		Surface Treatment Resurfacing	Slurry Seal or Cape Seal Single Surface Treatment Double Surface Treatment Triple Surface Treatment	$/m2	$/km
		Asphalt Mix Resurfacing	Asphalt Overlay < 40 mm Asphalt Overlay 40 to 59 mm	$/m2	$/km
	Rehabilitation	Strengthening	Asphalt Overlay 60 to 79 mm Asphalt Overlay 80 to 99 mm Asphalt Overlay > 99 mm Mill and Replace Bonded Concrete Overlay Unbonded Concrete Overlay	$/m2	$/km
		Concrete Pavement Restoration	Concrete Slab Replacement Concrete Slab Repair Concrete Diamond Grinding	$/m2	$/km
		Reconstruction	Reconstruction Unsealed Reconstruction Block Reconstruction Bituminous Reconstruction Concrete	$/m2	$/km

Number of Lanes: 1L - One Lane; 2L - Two Lane; 4L - Four Lane; 6L - Six Lane

Figure 2: Road preservation cost classifications under the ROCKS framework

2.3.7. The ROCKS classifications for new build projects are shown in Figure 3 below.

Predominant Work Activity for Development Works

Work Category	Work Class	Work Type	Predominant Work Activity	Recommended Unit Cost
Development	Improvement	Partial Widening	Partial Widening to Unsealed 2L Partial Widening to Block 2L Partial Widening to Bituminous 2L Partial Widening to Concrete 2L	$/km
		Partial Widening and Reconstruction	Partial Widening to Unsealed 2L and Reconstruction Partial Widening to Block 2L and Reconstruction Partial Widening to Bituminous 2L and Reconstruction Partial Widening to Concrete 2L and Reconstruction	$/km
		Widening	Widening Adding Bituminous 1L Widening Adding Bituminous 2L Widening Adding Bituminous 4L Widening Adding Concrete 1L Widening Adding Concrete 2L Widening Adding Concrete 4L	$/km
		Widening and Reconstruction	Widening Adding Bituminous 1L and Reconstruction Widening Adding Bituminous 2L and Reconstruction Widening Adding Bituminous 4L and Reconstruction Widening Adding Concrete 1L and Reconstruction Widening Adding Concrete 2L and Reconstruction Widening Adding Concrete 4L and Reconstruction	$/km
		Upgrading	Upgrading Unsealed to Unsealed 2L Highway Upgrading Unsealed to Block 2L Highway Upgrading Unsealed to Bituminous 2L Highway Upgrading Unsealed to Concrete 2L Highway Upgrading Block to Bituminous 2L Highway Upgrading Block to Concrete 2L Highway	$/km
	New Construction	New 1L Road	New Unsealed 1L Road New Block 1L Road New Bituminous 1L Road New Concrete 1L Road	$/km
		New 2L Highway	New Unsealed 2L Highway New Block 2L Highway New Bituminous 2L Highway New Concrete 2L Highway	$/km
		New 4L Highway	New Bituminous 4L Highway New Concrete 4L Highway	$/km
		New 6L Highway	New Bituminous 6L Highway New Concrete 6L Highway	$/km
		New 4L Expressway	New Bituminous 4L Expressway New Concrete 4L Expressway	$/km
		New 6L Expressway	New Bituminous 6L Expressway New Concrete 6L Expressway	$/km

Number of Lanes
1L - One Lane
2L - Two Lane
4L - Four Lane
6L - Six Lane

Figure 3: New road development cost classifications under the ROCKS framework

2.3.8. The Nichols Report (2007) asserts that, at a minimum, cost breakdowns for significant fixed link components (bridges and tunnels) are required. Flyvbjerg and COWI (2004) find that fixed link components are statistically distinct from 'normal' road components, both in terms of their unit cost and the risk of cost overruns. This provides a strong argument for treating fixed-link components as a separate category of project.

2.3.9. Stalder (2000) produced a study that was part of a wider project conducted by UIC for benchmarking the cost of railway infrastructure. The main objectives were: (i) to make the data comparable in the best way via harmonisation models; (ii) to compare the cost of investment and maintenance; (iii) to identify and analyse individual cost drivers; (iv) to derive cost reduction strategies.

2.3.10. In the process, Stalder adhered to the principles of (i) never comparing projects with each other but with benchmarks that adjust for the specific complexities and aspects of the environment; (ii) taking into account all infrastructure elements except stations (buildings and platforms); (iii) the application of precise, consistent definitions for each infrastructure element and its cost; and (iv) using cost per metre of track as the basis for comparison across project dimensions.

2.3.11. Figure 4 represents Table 2.5-1 of Stalder's report and shows a "simplified overview" of unit cost definitions and benchmarks for railway projects. Figure 4 shows track superstructure claiming 10 to 25 per cent of rail project costs.

Figure 4: Cost benchmarks for rail infrastructure project elements

Table 2.5-1 Cost benchmarks for project elements

project element	definition	cost benchmarks (simplified overview)		typical share of project cost
super- structure (N=141)	rails, sleepers, fastenings, switches, ballast or slab-track; without road-bed below ballast or slab	track without switches premium for 1 switch / tr-km premium f. traffic interference high-speed track slab-track	350 €/m of track 70 €/m of track 120 €/m of track 500 €/m of track 1'700 €/m of track	10–25 %

Source: Stalder, Oscar (2000), "International Benchmarking of Track Cost", part of a benchmarking programme by the International Union of Railways (UIC), Germany.

2.3.12. For urban transport projects:

- Pickrell (1985) distinguished stations as they represent a significant component of urban rail projects. The author also found that tunnelling and the elevation of stations were significant drivers of cost.
- Flyvbjerg et al (2008)[10] were able to establish the proportions of different elements of cost involved in urban transport projects. These breakdowns are equally relevant to the issue of establishing appropriate unit cost definitions and are shown in Figure 5 below. They produced a similar table for Latin American urban transport projects studied in BB&J Consult (2000). These breakdowns are equally relevant to the issue of establishing appropriate unit cost definitions.

Figure 5: Elements of cost observed in US urban transport projects

Table 7. Breakdown of metro capital costs by subsystem for five US metros.

Subsystem	San Francisco BART (%)	Atlanta MARTA Phase A (%)	Baltimore MTA Phase I (%)	Chicago CTA O'Hare (%)	Boston MBTA Red Line South (%)
Land	7	9	2	0	11
Guideway	37	33	25	20	15
Stations	19	20	30	28	33
Trackwork	3	2	2	7	7
Power	2	1	2	5	6
Control	4	2	4	8	7
Facilities	2	3	2	4	0
Eng./Mgt./Test	14	23	24	8	6
Vehicles	12	7	9	20	15
Total	100	100	100	100	100

Source: Federal Transit Authority 1992.

Source: Flyvbjerg et al (2008)

[10] Flyvbjerg et al. (2008) studied cost per kilometre variations across urban rail projects with a sample that included 17 European projects, 6 projects from the US, 6 from non-US/Europe and 4 from UITP (Athens, Cairo, Frankfurt and Lisbon). The latter were later rejected by the authors.

Figure 6: Elements of cost observed in Latin American urban transport projects

Table 8. Breakdown of metro capital costs by item for five metro extensions in Madrid, Caracas, Mexico City and Santiago.

Item	Mexico City Line B (%)	Caracas Line 3 (%)	Santiago Line 5 (%)	Santiago Line 5 extension (%)	Madrid extension excl. Arganda (%)
Civil works for tunnels only	24.5	32.8	36.4	40.5	54.6
Equipment	18.0	24.2	16.6	13.9	14.2
Rolling stock	36.2	15.7	24.8	21.4	15.4
Design and supervision	3.4	3.6	5.5	10.3	1.9
Track	5.3	2.8	6.3	4.3	3.5
Power	5.2	8.9	4.4	2.8	2.4
Signalling and communications	4.1	6.8	4.3	5.2	2.7
Station equipment	0.2	2.3	0.7	0.4	1.7
Escalators and lifts	0.3	2.1	0.2	0.9	2.7
Passenger toll equipment	0.5	0.7	0.5	0.2	0.3
Workshop equipment	2.3	-	0.3	-	0.6
Total	100	100	100	100	100

Source: BB&J Consult (2000)

Source: Flyvbjerg et al (2008)

2.3.13. BB&J Consult (2000) disaggregated total rail project costs into infrastructure (including service deviations and expropriations), equipment (line and station), rolling stock and other costs such as design, technical assistance, inspection, supervision.[11] The cost definitions and unit cost benchmark levels are shown in Table 1 below.

[11] BB&J Consult (2000) compared Madrid's metro extension experience with other Latin American cities in order to determine whether and how the experience could be applied elsewhere. A field survey and site visits were conducted for the metro systems of Mexico City, Caracas and Santiago de Chile.

Table 1: Cost definitions and benchmark unit costs for urban transport projects

Metro System	Cost Component	Unit Cost (in million US$ per line km)	Proportion of total cost
Mexico City	Total line	40.92	100.00%
	Infrastructure	13.37	32.67%
	Equipment (line and station)	8.58	20.97%
	Rolling stock	17.3	42.28%
	Technical assistance	1.62	3.96%
Caracas	Total line	57.98	100.00%
	Infrastructure (inc. services deviation and expropriations)	25.66	44.26%
	Equipment (line and station)	18.05	31.13%
	Rolling stock	11.69	20.16%
	Design, technical assistance, inspection, supervision	3.75	6.47%
Caracas Line 4 estimations	Total line	93.57	100.00%
	Infrastructure (inc. services deviation and expropriations)	40.68	43.50%
	Equipment	22.48	24.00%
	Rolling stock	25.77	27.50%
	Design, supervision, technical assistance	4.64	5.00%
Santiago Line 5	Total line	40.91	100.00%
Santiago Line 5 extension	Total line	70.11	100.00%
Madrid extention	Average implementation costs	22.79	100.00%
	Infrastructure (inc. services deviation and expropriations)	14.15	62.09%
	Equipment	4.13	18.12%
	Rolling stock	4.03	17.68%
	Design, technical assistance, inspection, supervision	0.48	2.11%
Madrid extention (only underground sections)	Average implementation costs	31.19	100.00%
	Infrastructure (inc. services deviation and expropriations)	19.83	63.58%
	Equipment	5.13	16.45%
	Rolling stock	5.54	17.76%
	Design, technical assistance, inspection, supervision	0.69	2.21%

Source: BB&J Consult (2000)

2.3.14. Literature on the relevant aspects of environmental infrastructure projects is much sparser. However, in the same way that 'normal' stretches of road should be distinguished from fixed-link components and railways stations from track, it seems logical to distinguish between plants/installations and pipeline (that makes up the water/sewerage network). In the 2005 ex post evaluation of a sample of projects co-financed by the Cohesion Fund in the period 1993-2000, ECORYS Transport examined water supply in terms of the cost per inhabitant and water networks in terms of cost per metre.[12] Similarly, wastewater treatment was measured in terms of cost per cubic metre or cost per inhabitant and in terms of cost per metre for networks. Solid waste management was measured in terms of cost per cubic metre or cost per tonne.

[12] A similar study to the one that is the subject of this Report was led by ECORYS on behalf of the Commission in 2005. The Study for DG REGIO employed a sample of 200 projects that were co-financed by the Cohesion Fund in the period 1993-2002, of which 60 transport and environmental projects from CF4 (Greece, Ireland, Portugal and Spain) were selected for detailed evaluation.

2.3.15. The English and Welsh water services regulator Ofwat has over the past few years rigorously sought effective and accurate methods of predicting future capital investment costs in the water sector. Having a good overview of the likely (and reasonable) costs of capital and operating expenditure is vital for them to ensure that consumer prices remain at an acceptable level.

2.3.16. Ofwat conducts five-yearly reviews of water companies' business plans, as part of which each company must submit information on the typical costs they incur per area of operation or project type. The result is an Ofwat *cost base* against which the relative efficiency of programme delivery and projected levels of capital expenditure are evaluated. It is, therefore, in its own right a good example of a current benchmarking application based on unit costing. The table below is an example of the type of data Ofwat requires the water companies to submit; this particular example is in regards to costs encountered in the installation of a line for a new water treatment plant.

2.3.17. It is worth noting that the categorization of costs by Ofwat has implications for the treatment and unit costing of data. Costs are divided into:

- Base cost;
- Project-specific costs;
- Design and management costs including company overheads; and
- Allowances for design development, construction inefficiency, inflation and risk.

2.3.18. Base costs refer to design and construction costs only, eliminating all factors that introduce uncertainty to cost projections. 'The base costs should be the most likely cost that the work element can be designed and constructed for with no allowances included for change of scope, design development, increase in price for market changes or inflation, constraints, risk or uncertainty or increase in quantity of element required to complete the element'. In other words, anything that introduces an *atypical* aspect to project development is left outside the scope of base cost.

2.3.19. These atypical costs are the ones to actually determine a project's direction, shape and progression. Ofwat dubs them *project specific costs*, examples of which are excavation, landscaping, roads and pavements (locational and site specific costs), phasing/waiting time, abnormal working hours, logistics constraints (operational costs). All of these are what make an infrastructure project 'unique'.

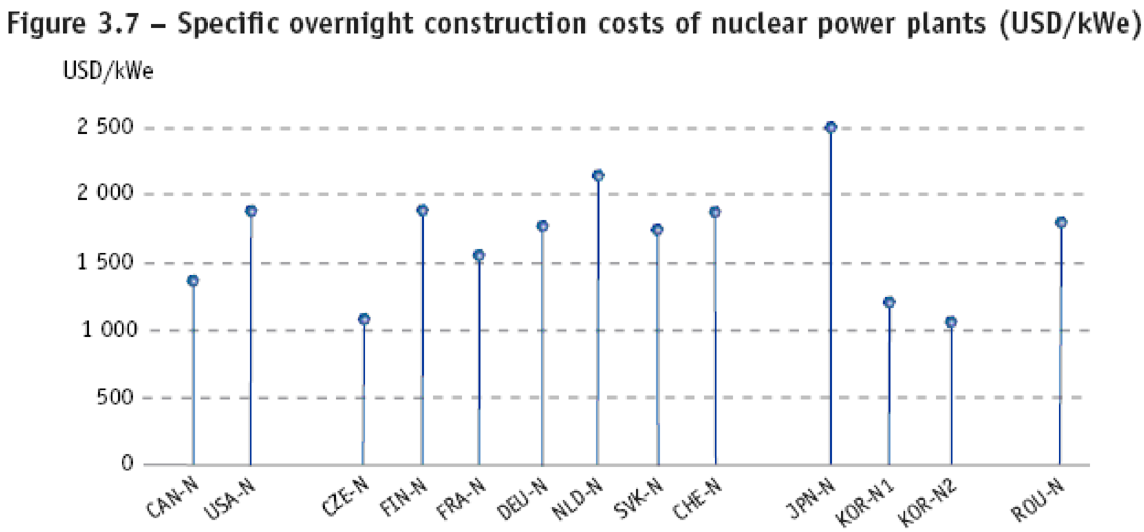
Table 2: Water Company cost submissions required by Ofwat

Company to list main components (e.g. process units, structures, equipment)	size/ capacity	units	Cost (£)	Assumptions/ details
Inlet works - civil structure	220	m3	220000	1 concrete wet well located within a building
DAF tanks	210	m3	270000	Including flow splitter chamber feeding into 3 streams, each with floc tanks preceding the DAFs and civil works for saturated air system. Based on hydraulic de-sludge. Full flow can be treated with one tank off line.
RGF tanks	240	m3	950000	4 prefabricated tanks, based on sand and anthracite media. Full flow can be treated with one tank off line. Includes associated air scour system. Filtration rate 6m/hr.
Interstage pumping station	180	m3	150000	Concrete tank within building
GAC pressure filters	280	m3	1500000	7 pressurised vertical adsorbers based on total vessel volume of 85m3 each (45m3 = media). Only got 2 previous project costs for GAC pressure filters, benchmarked costs using TR61. Filtration rate 6m/hr. Backwash rates based on 20m/h for 10 mins - automatic control based on headloss.
Backwash water holding tanks (clean & dirty) civil works	300	m3	150000	Based on 2 concrete tanks (150m3 each). Complete filter backwashing once/ 24 hours at rate of 170m3/ wash)
Contact tank	625	m3	170000	Based on 30 mins retention time to achieve 1mg/l chlorine residual
Buildings			350000	All process plant, control room and chemical storage is held within buildings, dirty washwater tank is uncovered.
Air saturator plant			120000	Including compressors
Interstage pumps	37	kW	100000	2 pumps - duty/ assist operation
Backwash water pumps	13	kW	140000	4 pumps (2 dirty, 2 clean) duty-assist operation
Chemical dosing	various	various		Includes coagulant (92l/h ferric chloride), polyelectrolyte (520 l/h), chlorination (70kg/h sodium hypochlorite), plumbosolvency control (orthophosphoric acid 1mg/l) and de-chlorination (22l/h sodium bisulphate), and all associated pipework (includes pumping, dosing and mixing plant)
Chemical storage	various	m3		Based on providing 28 days storage for all chemicals
Interconnecting pipework	n/a		400000	Site wide pipework and flow control. Calculated as 1.2% of direct costs
Water quality monitoring	n/a		100000	All sample lines, monitoring equipment and manual taps
Automation and control equipment	n/a		140000	Fully automated plant, based on un-manned works
Control panels and telemetry	n/a		400000	All telemetry is connected to the central (on site) control room

Source: Ofwat

2.3.20. Unit cost definitions and related issues receive a less than extensive treatment in the energy sector. However, it seems sensible to measure the construction cost of electricity plants against their total productive capacity, which would enable cost comparisons between different production technologies and sizes of plant. This is illustrated in Figure 7 below, which shows overnight construction costs of nuclear power plants in a number of OECD countries. These costs appear to include the cost of engineering, procurement, construction, land, cost escalation and inflation.

Figure 7: OECD overnight construction costs of nuclear power plants



Source: "Projected Costs of Generating Electricity", A joint study by the OECD, the International Energy Agency and the Nuclear Energy Agency, 2005

2.3.21. The UK Energy White Paper (2003) provides some indication of the extent to which the construction costs of different electricity producing technologies are thought to vary. This is shown in Figure 8 below.

Figure 8: UK Energy White Paper (2003) unit cost definitions and levels for alternative electricity-producing technologies

Table 4 – Projected capital costs for plant built in 2010 (GBP/kW)

Technology	Low	High
Coal	1 180	1 320
Gas	285	420
Nuclear	1 070	1 400
Coal (capture & storage)	1 450	1 600
Gas (capture & storage)	530	610
Onshore wind	550	750
Offshore wind	860	1 120
Energy crops	1 350	1 620
Small hydro	330	400
Waste	500	600
Marine	960	1 160
Landfill gas	1 220	1 460
Sewage sludge	820	990

Source: UK Energy White Paper (2003)

2.4. Other important issues in achieving comparable unit cost measures

Data normalisation

2.4.1. Once the feasible set of unit cost definitions has been determined, it is necessary to consider what other measures are required to normalise the data and achieve comparability. This is particularly the case in the current context where: (i) projects from a range of different countries are being compared; and (ii) the projects being compared have started and finished at different times.

2.4.2. Where projects from a range of different countries are being compared, normalisation is required to achieve denomination of unit cost benchmarks in a common currency through the use of appropriate exchange rates. This may not be an issue in the current circumstances as most of the countries from which projects were chosen for the sample are members of the single currency, and have been from the beginning of the programming period. However, it may still be necessary to capture input inflationary factors (such as specific wage rate or construction cost inflation) that would not be captured by the exchange rate. In order words, it is important to make appropriate adjustments to reflect purchasing power parities.

2.4.3. Where projects that started and finished at different times are being compared, normalisation is required to achieve denomination of unit cost benchmarks in a common price level, which, in turn, requires use of the appropriate sectoral and geographical price indices.

2.4.4. There are many examples of data harmonisation in the literature. For example, Stalder (2000) undertook the following steps: (i) harmonisation for a common currency (Euro as per January 1st, 1999); (ii) harmonisation for common price level (indexation of cost data to January 1st, 1999); and (iii) compensation for general wage and price differences which were not reflected in the exchange rate, involving the weighting of cost data with OECD purchasing-power parity indices for 1998.

2.4.5. Flyvbjerg et al (2008) undertook three steps to sanitise the data before comparisons were undertaken: (i) costs were compared for similar systems i.e. urban rail, European projects and at least partly underground projects, to ensure homogeneity in the data; (ii) costs were expressed in constant (real) prices, using construction cost indices to discount costs to the same level (year)[13]; and (iii) costs calculated in different currencies were converted into the same currency, typically US$ or €, by applying the appropriate exchange rates.

Ensuring the accurate measurement of cost overruns

2.4.6. Another important element of WP10 will be the identification and assessment of the reasons for cost overruns (which occur when project cost outturns exceed the corresponding cost estimates). The magnitude of observed cost overruns will depend on the unit cost definitions and calculation methods adopted, as well as on the quality and comparability of cost estimates and outturns. Consistency between them is essential to ensure that differences can legitimately be called cost overruns.

2.4.7. The practice in the literature is to make a decision about which specific point in the project life-cycle from which cost estimates are to be drawn for all projects in the sample being analysed. This raises questions as to whether ERDF applications (which, as outlined above, are to form the basis for the cost estimates to be used in this Study): (i) represent an appropriate milestone in the project life-cycle from which to draw cost estimates; and (ii) a common milestone for all projects.

[13] The construction cost indices mentioned in the second step above were from OECD (1997), *Construction Price Index - Sources and Methods.* The base year and currency used in the study were US$ 2002 prices.

2.4.8. There is a variety of views expressed in the literature about the appropriate milestone in the project life-cycle from which to derive cost estimates. For example, Merrow (1988) chose a "commencement of detailed engineering" milestone, while Flyvbjerg et al (2003) noted that it should be possible to identify a specific point in a given project schedule when the formal decision to build was made and that a cost estimate is usually available at this time. As observed by various authors, the later the milestone chosen for cost estimates is in the project life-cycle, the more conservative the estimates of cost overruns will be.

2.4.9. In assessing differences in the levels of cost overruns within and between sectors and countries, the milestone itself is arguably less important than the need to choose a common milestone across all projects. While the ERDF applications generally state the year in which the estimates were made, the stage in the project life-cycle which that year represents is less clear. We are endeavouring to establish these facts through our data gathering exercise. However, to the extent that ERDF applications are used as the basis for cost estimates, some cost overruns might be due simply to later re-forecasting, which will need to be taken into account in our analysis.

2.4.10. Other important technical observations relating to the definition and measurement of unit costs from the literature are:

- That it is standard industry practice to include in project cost estimates escalation factors that inflate estimated costs to the forecast midpoint of construction.
- That costs expended in each year of the project should be converted to a common price base.

2.4.11. On the first, while it appears that this is the standard practice in tendering for construction contracts, it does not appear to be the case in the preparation of ERDF applications. Cost estimates in the applications appear always to be stated in terms of prevailing current prices. On the second, where the stream of expenditures across the project life-cycle is not provided, Merrow (1988) suggested the use of "an empirically derived cosine curve" to spread expenditures across the duration of the project.

2.5. Defining and measuring unit costs for Work Package 10

Types of costs to be included

2.5.1. Our examination of the ERDF applications (which are to form the basis for the project cost estimates to be used in this Study) reveals that, in general, the following categories are included in the cost estimates for major infrastructure projects:

- Construction or 'build' costs: the costs associated with the implementation phase of projects. In some cases, breakdowns for certain aspects of project 'build' are provided. For example:
  - o with some rail projects, the cost of signalling, telecoms or power was separated from the cost of laying track;
  - o with some urban transport projects, the cost of enabling works (like utility diversion) was often, likewise, distinguished from track construction; and
  - o with some water projects, building and construction was separated from plant and machinery.

- 'Soft' costs: the costs associated with planning and public consultation, project design, project management and technical assistance.
- Taxes: the indirect taxes (VAT) levied by contractors on contracting authorities.
- Contingencies: allowances for unforeseen events that can cause actual project costs to be higher than originally anticipated.
- Land acquisition: costs associated with land required for the project. We note that the purchase of land which has not been built on is eligible for part-financing from the Structural Funds provided the transaction does not exceed 10 per cent of the total eligible expenditure for the project. Moreover, an independent expert is required to confirm that the price of the land does not exceed its market value. Costs might also be borne for real estate (buildings and the land on which they are built), which may include compensation for displacement and resettlement and the associated transaction and legal costs.

2.5.2. The development of consistent unit cost definitions will, therefore, require a consistent treatment of these different elements of cost across projects. We consider this for construction ('build') costs in the following subsection, but for some of the other elements of cost, the following issues must be addressed:

- In some Member States and for certain types of projects (for example, local government projects and infrastructure for public use), indirect taxes are refundable to the contracting authority from the national government. For this reason, these costs may need to be excluded altogether or harmonised to take account of different rates across the Member States.[14]
- Contingencies are not always treated consistently. For example, some build them in to the estimates of the other categories of cost, while others include a separate contingency total. Care will be required when comparing projects and when comparing estimated and outturn costs.
- Land acquisition costs above the relevant thresholds may not always be known. This might be relevant if, for example, there was a suspicion that the part of the ERDF funding earmarked for other parts of the project are being used for land acquisition above market rates or above the 10 per cent threshold.

Elements of projects for which to include costs

2.5.3. We have, therefore, sought to distinguish between Level 1, Level 2 and Level 3 project costs. The nature of these distinctions is shown for each of the relevant infrastructure sectors in Table 3 below. Each of the levels is described as follows:

- Level 1 can be thought of in terms of the 'all in' cost of projects. Note that it is also necessary to identify whether these 'all in' costs relate to:
  - For road projects, a single and double carriageway and whether each carriageway consists of 2, 3, 4 or a greater number of lanes.
  - For rail projects, a single track or twin tracks.
  - For urban transport projects, underground metro, tramway or a bus/taxi network infrastructure.
  - For energy projects, electricity, gas, nuclear or wind power.
  - For environmental projects, water or wastewater.

[14] Where public or quasi-public sector organisations are liable, tax costs can have a significant impact on gross construction costs.

- Level 2 costs are designed to distinguish between the key components of projects. For example, in a rail project, we have distinguished between each of trackwork, stations, bridges and tunnels.
- Level 3 distinguishes further between different types of key components. For example, rail track and stations might be at ground level, elevated or underground. Likewise, road and rail projects might involve different types of bridges (for example, beam, cantilever, arch etc.) and tunnels (for example, bored or cut and cover).

Table 3: Project disaggregation and corresponding Levels 1-3 unit cost definitions

Level 1 costs **('all in')**	**Level 2 costs** **(key components)**	**Level 3 costs** **(different types of key components)**
ROADS 1 carriageway / 2 carriageway 2 lanes / 3 lanes / 4 lanes or greater	Pavement construction Bridges Tunnels	Grade of pavement Types of bridge Types of tunnel
RAIL Single track Twin track	Track construction Stations Bridges Tunnels Rolling stock	At grade Elevated In tunnel Types of bridge Types of tunnel
URBAN TRANSPORT Metro Tramway Buses / taxis	Network (track, road) Stations / stops Bridges / tunnels Rolling stock	At grade Elevated In tunnel Types of bridge Types of tunnel
ENERGY Electricity / gas Nuclear / wind	Generation Networks (transmission / distribution) Supply	
ENVIRONMENTAL Water Wastewater	Extraction / treatment Distribution Supply	Gravity or rising mains Pipes or culverts

Source: RGL

2.5.4. DG REGIO has provided us with the ERDF applications (and other information) for the sample projects, which are to be used as the basis for project cost estimates in this Study. An examination of a sub-sample of these applications revealed that they do not, however, provide a level of detail sufficient to facilitate anything beyond Level 1 unit cost definitions. For road, rail and urban transport projects, for example, the cost of bridges and tunnels has not been separated from the cost of 'normal' pavement or track construction.

2.5.5. Likewise, the outturn data received so far suggests that there might only be very limited availability of Level 2 and Level 3 outturn cost breakdowns. Consequently, our statistical analysis of Level 2 and Level 3 costs may be limited. Taking road projects as an example, each project is unique, but anything beyond establishing the number of lanes, the location (urban or rural) and the terrain (flat or mountainous) is likely to be too detailed to expect robust data.

2.5.6. However, these issues imply a role for recommendations on how to improve data collection and availability so that, in the future, the level of detail required for more meaningful comparability, that is, beyond Level 1, can be made available. This should be usefully informed by:

- Council Regulation (EEC) No 1108/70 and the related study by ECORYS Transport and CE Delft (2005) on "Infrastructure expenditures and costs: Practical guidelines to calculate total infrastructure costs for five modes of transport; and
- The IER (2004) study on "Developing Harmonised European Approaches for Transport Costing and Project Assessment (HEATCO)", specifically Deliverable 5 – Proposal for Harmonised Guidelines.

2.6. Conclusions

2.6.1. In an ideal world with full and complete information, exercises like Work Package 10 and analogous preceding studies could be used by planners to better appraise the cost estimates made for similar future infrastructure projects. Moreover, they would provide for appropriate de-biasing adjustments to those estimates. But many authors are sceptical about the usefulness of current benchmarking efforts.

2.6.2. It is clear that, in order to minimise such scepticism about the benchmarking results produced by this Study, it will be necessary to address a range of issues in the development of appropriate unit cost definitions. In this Section, we have tried to summarise those issues and how they are likely to be addressed as the Study develops, including the types of cost to be included in unit cost measures, the elements of projects for which to include those costs and the normalisation measures required to achieve robust comparability.

3. The determinants of infrastructure project costs

3.1. Introduction

3.1.1. The European Commission itself noted that no two infrastructure projects will cost the same no matter how similar they are. This sentiment was aptly reflected in the following statement from EC DGXVI's (now DG REGIO) 1998 Guidance on "Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects":

"Apart from basic technical factors, the wide range of economic and institutional conditions in different Member States will itself always lead to variations. Nevertheless, the fundamental project costs are based on the actual cost of the land, materials, equipment and labour in the region where the project is being procured. These basic costs will vary depending upon a number of factors…"

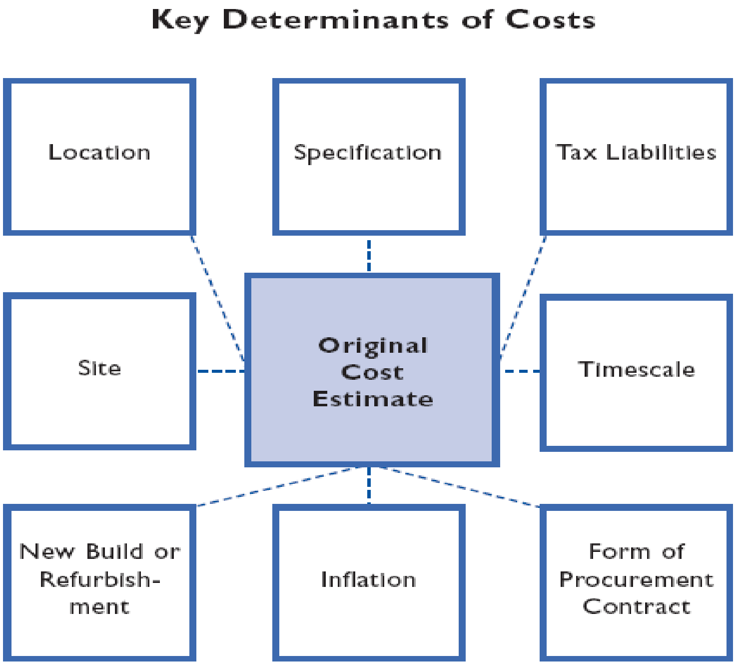
3.1.2. This part of the Report examines the determinants of infrastructure project costs and analyses the reasons for differences between projects within each of the sectors being examined, both within and between countries. There are several categories of project cost determinants (and, therefore, of efficiency differences between projects). These categories are examined in the following Sections of this part of the Report, as follows:

- Section 3.2 examines the technical characteristics of projects and how they influence infrastructure project costs. This Section is particularly concerned with the idea of project complexity.
- Section 3.3 examines the economic determinants of project costs, including tax liabilities, inflation and the competitiveness of procurement and the financial aspects of contracting.
- Section 3.4 examines the institutional determinants of cost, including the stage of country development, including leadership issues, design standards, the influence of private sector involvement and accountability measures.
- Section 3.5 examines the quality of project preparation and management, which incorporates the potential role for early contractor involvement.

3.1.3. Section 3.6 looks at the implications of the analysis in Sections 3.2 to 3.5 for WP10. Section 3.7 concludes.

3.1.4. Before proceeding, however, it is useful to consider the Commission's own thinking on the issue. DG XVI's Guide (1998) provides a framework for the analysis of the key determinants of infrastructure project costs. The diagrammatic form of that framework is re-presented in Figure 9 below.

Figure 9: DG XVI's key determinants of infrastructure project costs



Source: European Commission DG XVI (1998), "Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects", A User's Guide, Brussels.

3.1.5. Each of these factors will be considered in the course of the review and analysis that follows, which categorises the determinants in a manner that we considered would be most relevant for WP10.

3.2. Technical characteristics and their impact on costs

General principles and discussion

3.2.1. It is clear that the more complex a project is, the more it is likely to cost. Project complexity is determined by the set of technical characteristics that define the project. We analyse a range of technical characteristics in the following subsections.

3.2.2. Project specification defines the physical characteristics of the project. For example, with road projects, projections of future traffic will be used to derive a specification of the required length, depth and width of the road pavement, the material to be used in surfacing, the number of carriageways, lanes, bridges, junctions etc. In general, the larger the project, the more detailed the specification needs, and the more expensive the project is likely, to be.

3.2.3. Expectations should, however, be balanced with a consideration of the influence of economies of scale, that is, whether, for example, a 20 km road costs less on a unit cost per km basis than a 10km road. This would depend on the extent to which costs are fixed regardless of the length of the road.[15]

[15] Likewise, it is relevant to consider whether cost-saving advances in technology have been employed in construction / rehabilitation in some projects, but not in others.

3.2.4. For all transport projects, energy and environmental projects, it is likely to be important to distinguish between new capacity, renewals and maintenance. New build is normally more expensive than improvements to existing infrastructure.[16] Some projects might involve a mixture of the two which could distort comparisons with dedicated new build projects or dedicated renewals/maintenance projects.[17]

3.2.5. For rail and urban transport, similar technical characteristics will be relevant but will include things like the number of stations, station spacing and the type of rolling stock to be employed. Another important issue might be vertical positioning, that is, whether track and stations are at ground-level, under ground or elevated. For example, there are significant costs in the digging and utility diversion required to support an underground metro system.

3.2.6. For road, rail and urban transport projects, site characteristics, such as soil and drainage conditions or difficulties in accessing the site can expected to influence the costs of remedial work before the ‘build’ stage commences. If there is uncertainty about soil and drainage conditions, accurate project costing requires soil surveys.

3.2.7. For road and rail projects, the distinction between urban and rural locations and between flat and mountainous terrain will also be relevant. Location affects project costs through institutional factors, such as difficulties in obtaining consents and requirements for public consultation.[18] Location also has an impact on construction and materials costs due to varying distances from suppliers, land costs and design standards and costs, all of which can vary widely across countries (even within the EU). As can climate and weather conditions and these can also have an impact on design standards and standard and cost of materials required to meet those standards.

3.2.8. The importance of distinguishing between the technical characteristics discussed in the previous two paragraphs can be understood by examining Table 4 below. It shows unit costs for a wide range of alternative road project specifications, including distinctions between new build and refurbishment, between widening and strengthening, between routine maintenance and resurfacing and between a range of different surfacing materials and techniques.

[16] This is partly due to the fact that ‘non-building costs’ (such as land purchase, foundations, services provision etc.) do not feature when upgrading existing structures. However, costs borne in the implementation phases of these projects can also be expected to be lower (due to the need for fewer inputs).
[17] This has already been observed for some ERDF projects in the WP10 sample.
[18] For example, where major projects are likely to be strongly opposed on environmental grounds, more cost may have to be allowed for consultation and environmental mitigation measures.

Table 4: Unit cost averages and indicative ranges for selected work activities under ROCKS

Costs per Km Statistics (2000 US$/km)							
Work Class	Work Type	Predominant Work Activity	Average	Minimum	Maximum	St Dev.	Count
Routine	Routine Maintenance	Routine Maintenance 1L Road	336	336	336		1
		Routine Maintenance Unsealed 2L Highway	1037	277	2027	637	12
		Routine Maintenance Block 2L Highway	2731	1506	3956	1732	2
		Routine Maintenance Bituminous 2L Highway	2289	347	5580	1258	52
		Routine Maintenance Bituminous > 2L Highway	3512	3512	3512		1
Periodic	Grading	Light Grading	110	51	205	49	12
		Heavy Grading	522	323	876	195	6
	Gravel Resurfacing	Regravelling	14912	1879	65038	13099	174
	Bituminous Pavement Preventive Treatment	Fog Seal	8946	2805	15783	3614	18
	Unsealed Preventive Treatment	Unsealed Preventive Treatment	4311	2009	8689	1219	99
	Surface Treatment Resurfacing	Slurry Seal or Cape Seal	10337	3526	27520	6400	35
		Single Surface Treatment	18876	5295	38607	7093	52
		Double Surface Treatment	27502	10684	45277	8728	55
	Asphalt Mix Resurfacing	Asphalt Overlay < 40 mm	41676	12878	82320	16394	46
		Asphalt Overlay 40 to 59 mm	68070	21021	126131	26197	166
Rehabilitation	Strengthening	Asphalt Overlay 60 to 79 mm	87306	27473	157984	31351	52
		Asphalt Overlay 80 to 99 mm	142178	38583	553857	74243	116
		Asphalt Overlay > 99 mm	178084	73444	478158	79393	83
	Reconstruction	Reconstruction Unsealed	45113	10046	133003	25259	47
		Reconstruction Block	78307	78307	78307	#DIV/0!	1
		Reconstruction Bituminous	235392	20165	1171406	145929	481
		Reconstruction Concrete	250408	45069	657747	166478	21
Improvement	Partial Widening	Partial Widening to Bituminous 2L	148644	109573	174033	19507	8
	Partial Widening and Reconstruction	Partial Widening to Unsealed 2L and Reconstruction	31936	8219	73334	35978	3
		Partial Widening to Bituminous 2L and Reconstruction	231275	28312	618951	130804	67
	Widening	Widening Adding Bituminous 1L	616548	169059	2678092	467835	27
	Widening and Reconstruction	Widening Adding Bituminous 1L and Reconstruction	283886	182472	564575	105638	31
		Widening Adding Bituminous 2L and Reconstruction	1006078	241875	1714760	360276	39
		Widening Adding Bituminous 4L and Reconstruction	1866207	1568359	2096415	189605	8
	Upgrading	Upgrading Unsealed to Unsealed 2L Highway	54610	12592	93205	28425	17
		Upgrading Unsealed to Bituminous 2L Highway	277001	42147	834428	183164	101
		Upgrading Unsealed to Concrete 2L Highway	314200	92651	469815	161265	5
		Upgrading Block to Bituminous 2L Highway	302378	234061	384392	64667	4
New Construction	New 1L Road	New Unsealed 1L Road	75184	58151	91596	12404	5
	New 2L Highway	New Unsealed 2L Highway	26276	26276	26276	#DIV/0!	1
		New Bituminous 2L Highway	1158357	348876	1875104	375696	41
		New Concrete 2L Highway	1023858	572502	1515835	348569	12
	New 4L Highway	New Bituminous 4L Highway	2755641	2123298	4006131	689576	11
		New Concrete 4L Highway	3249687	2706956	3792418	767537	2
	New 4L Expressway	New Bituminous 4L Expressway	1724473	955701	2469640	468448	15

Results of a sample of studies in the road, rail and transport sectors

3.2.9. A study led by ECORYS Transport on behalf of the European Commission in 2005 found relatively wide indicative ranges for unit costs across a range of project sectors.[19] Those ranges are re-presented in Figure 10 below.

Figure 10: Benchmark unit costs from ECORYS Transport (2005) study

Table 6.5 Indicative unit cost

Type of project	Unit	Spain	Portugal	Ireland	Greece
Motorway[19]	k€/km	-	1190-6500	800-11600	2785-6860
Rail line	K€/km	-	1950-2500	-	3000
Rail electrification and power supply	K€/km	1170	-	900	-
Water supply	€/inhabitant	25-165	127-291	820	-
Water supply	€/m	2000-2060	1300	-	-
Sewage network	€/m	310-360	-	-	105-284
Waste water treatment	€/m3 treated	0.0-0.77	-	-	-
Waste water treatment	€/inhabitant	-	93-177	-	-
Solid waste	€/inhabitant	34-38	20-58	-	-
Solid waste	€/tonne waste treated p.a.	38-285	-	-	-

Source: ECORYS et al. (2005), "Ex post evaluation of a sample of projects co-financed by the Cohesion Fund (1993-2002)", Synthesis Report, Rotterdam.

3.2.10. Blanc-Brude at al. (2006) identified a number of groups of explanatory variables for unit cost differences across road projects. Their model produced coefficients (measuring influence on total costs) on a range (mostly technical) cost determinants. These are shown in Figure 11 (which re-presents Table A1 from their paper).

[19] The Study for DG REGIO employed a sample of 200 projects that were co-financed by the Cohesion Fund in the period 1993-2002, of which 60 transport and environmental projects from CF4 (Greece, Ireland, Portugal and Spain) were selected for detailed evaluation.

Figure 11: Estimated coefficients on the explanatory variables for road unit cost differences

Table A1. Estimation results for all roads (full sample)

	Coefficient	Prob.
(Constant)	1.432	0.000
PPP	0.313	0.000
Labour	0.043	0.000
Dual carriageway dummy	-0.101	0.239
Single carriageway dummy	-0.415	0.097
2 Lanes	-0.504	0.032
6 Lanes	0.401	0.000
Urban Terrain	0.331	0.001
Mountain Terrain	0.129	0.301
Log(length)	-0.241	0.000
Tunnel/road	0.019	0.000
Bridge/road	0.017	0.000
N	227	
Adjusted R2	0.82	

Note: Significant country dummies included in the estimation include Denmark, Finland, Germany, Ireland, Italy the Netherlands, Norway, Spain, Sweden, and the UK.

Source: Blanc-Brude, Frederic, Hugh Goldsmith and Timo Valila (2006), "Ex ante construction costs in the European Road Sector: A comparison of public-private partnerships and traditional public procurement", EIB Economic and Financial Report 2006/01.

3.2.11. Stadler (2000) reports on an international benchmarking study of railway track costs. The technical characteristics that were most influential included location/terrain, proportion of fixed links, new build vs. refurbishment, the number of stations, station spacing, type of rolling stock and the design capacity (scale). The study highlights the importance of assessing not just the up-front investment costs but costs over the whole of the infrastructure asset's entire useful economic life. He also observed the dominance of personnel costs in maintenance expenditures, which are affected by productivity issues like track-access and working methods. Differences in unit cost ranges for different sets of technical characteristics are presented in Figure 12 and Figure 13 below.

Figure 12: Benchmark cost ranges for various types of rail infrastructure projects

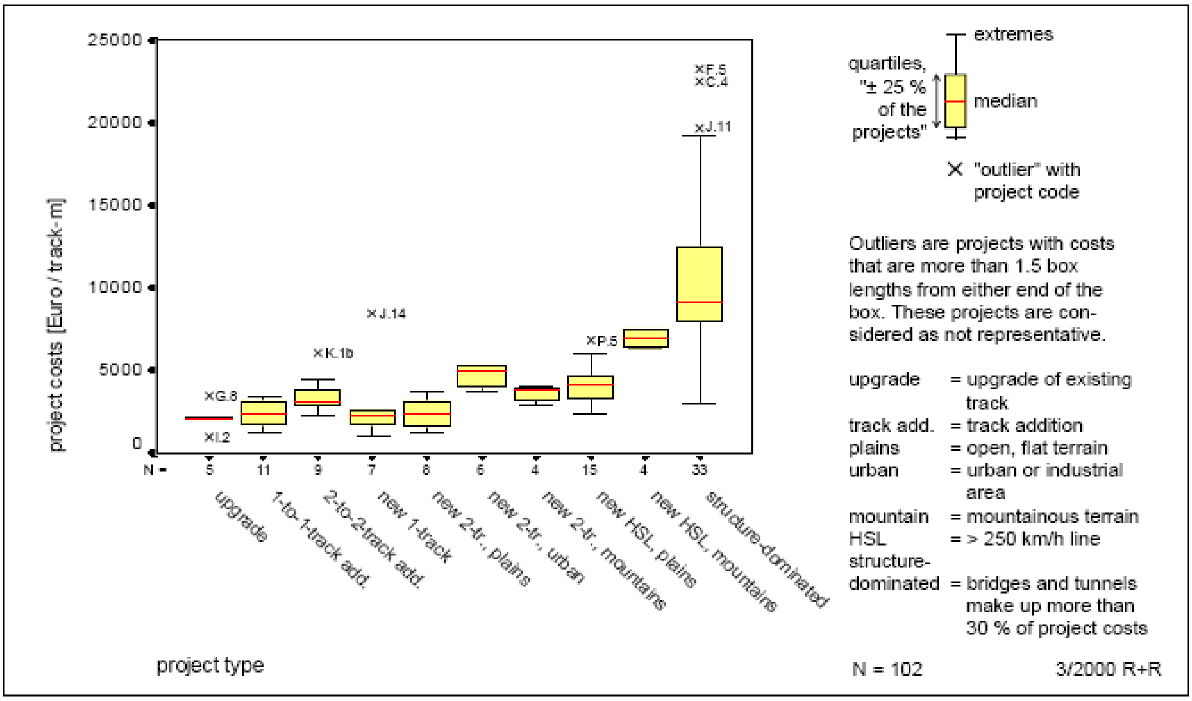
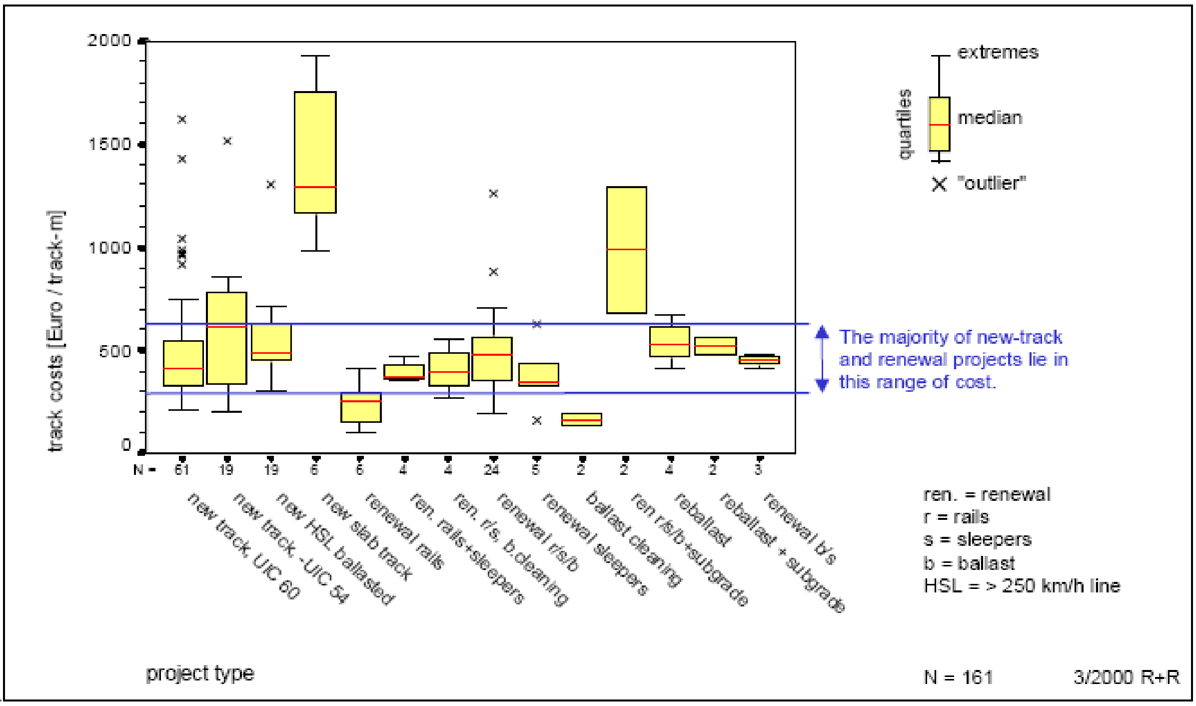


Figure 2.2-1: Cost ranges for various types of projects for new infrastructure

Figure 13: Further benchmark cost ranges for various types of rail infrastructure projects



Figur 2.2-2: Projects for new track and major track renewal

Source: Stalder, Oscar (2000), "International Benchmarking of Track Cost", part of a benchmarking programme by the International Union of Railways (UIC), Germany.

3.2.12. Flyvbjerg et al. (2008) found that capital costs per route-km of urban rail vary highly between projects. Differences were attributed to a wide range of factors, including technology changes, project size and economies of scale, vertical positioning (including the need for utility diversion associated with underground construction and the number and spacing of stops. The differences in technical characteristics that accompanied these unit cost differences are illustrated in Figure 17 below.

Figure 14: Benchmark unit costs for selected urban rail projects (from Flyvbjerg et al., 2008)

Table 1. Capital costs per route-kilometre for selected urban rail projects.

	Opening year	Length km	Vertical segregation	Number of stops. Stop spacing km	Capital costs (million)	Costs/km (million)	Cost/km (million) 2002-US$
Copenhagen Metro Phases 1-3	2002-07	21	48% tunnel 52% elevated	22 1.0	DKK 11,400	DKK 542.9	69.8
London Jubilee Line extension	1999	16	78% tunnel 22% at ground level	NA NA	GBP 3,600	GBP 225	329.9
Madrid Extension 1995-99	1999	56.3	68% tunnel 32% at ground level	38 1.5	NA	US$22.8	26.7
Toulouse VAL Line A	1993	9.7	90% tunnel 10% elevated	15 0.6	FRF 3,700	FRF 381.4	60.9
Toulouse VAL Line A extension	2004	2.2	NA	3 0.7	€ 187.5	€ 85.2	81.1
Marseille Lines 1-2	1977-92	19.6	80% tunnel 12% elevated 8% at ground level	24 0.8	FRF 6,343	FRF 323.7	59.1
Lille VAL RT	1988	29	75% tunnel 25% above	NA 0.7	FRF 8,900	FRF 306.9	56.0
Lyon Ligne D	1991-97	14	NA	15 0.9	FRF 7,300	FRF 521.4	79.5
Paris Meteor Phase 1	1998	7.2	NA	7 1.0	US$ 1,419	US$ 197.1	220.0
Marseille Line 1 extension	2006	2.5	NA	4 0.6	€ 175,4	€ 70.2	68.8
Toulouse VAL Line B	2007	15	NA	20 0.8	€ 968	€ 64.5	63.2
London Victoria Line	1968-69	15.8	100% tunnel	NA 1.3	€ 740.5	€ 46.9	63.1
Vienna Stage 1	1984	NA	NA	NA NA	NA	€ 70	94.2*
Berlin U-Bahn	NA	4.6	100% tunnel	5 0.9	US$ 275	US$ 59.8	88.3*
Hannover U-Bahn	NA	69.0	17% tunnel	110 0.6	US$ 750	US$ 10.9	16.1*
Hannover U-Bahn extension	NA	2.8	100% tunnel	NA NA	US$ 108	US$ 38.5	56.9*
Turin Metro Phase 1	2005	9.6	100% tunnel	15 0.6	GBP 442	GBP 40	71.7

NA: Not available.
*Exchange rate for the indicated year was not available to convert to local currency. Construction cost index has been applied directly in EUR/US.
Note: Taxes were included for Madrid (16%). Status of taxes for London, Vienna, Berlin, Hannover, and Turin was unknown. Other projects: taxes not included.

3.2.13. BB&J (2000) found the following technical issues to be prominent in driving cost differences between urban transport projects:

- Civil works, whether the project involved the extensive use of Earth Pressure Boring Machines (EPBMs), strong geotechnical supervision monitoring and standardised station design concepts; and
- Equipment cost, including a phased approach to power supply, appropriate signalling and communications technology, and whether steel-wheel was chosen instead of rubber-tyre superstructures.

3.2.14. The same study found technical characteristics including total line length, design capacity, the interface with existing lines (including the number of connection points) and the proportions of track and stations that are underground, elevated or at grade.

3.3. Economic determinants of project costs

3.3.1. This category of determinants of infrastructure project costs incorporates tax liabilities, inflation, the financial characteristics of contractual arrangements and the competitiveness of the procurement process. Tax liabilities were discussed in the context of the costs to be included in unit cost definitions in Section 2.2 above. The other issues are discussed below.

3.3.2. The effects of inflation occur when slippage occurs in timescales. Generally, the longer a project takes, the greater the project costs will be. Project timelines are dependent on the specification and the larger a project is the longer it is likely to take. The longer the expected construction period, the more account will need to be taken of expected inflationary price increases over time. Initial cost estimates need to allow for the amount expected to be paid at the time the project goes ahead. Higher inflation rates would be expected in the accession countries.

3.3.3. Procurement and contracting arrangements can alter the estimated cost of projects. The greater the number of allowed tenderers in the procurement process, the more competitive the tendering process is likely to be.[20]

3.3.4. A World Bank working paper on the procurement efficiency for infrastructure (2008) discusses competitive bidding in relation to economies of scale. While it is generally the case, that larger infrastructure projects will lead to savings in unit costs, their scope will also limit the number of contractors who are able to make a bid. Only a limited number of companies will have the necessary resources to complete a project of very extensive scale.

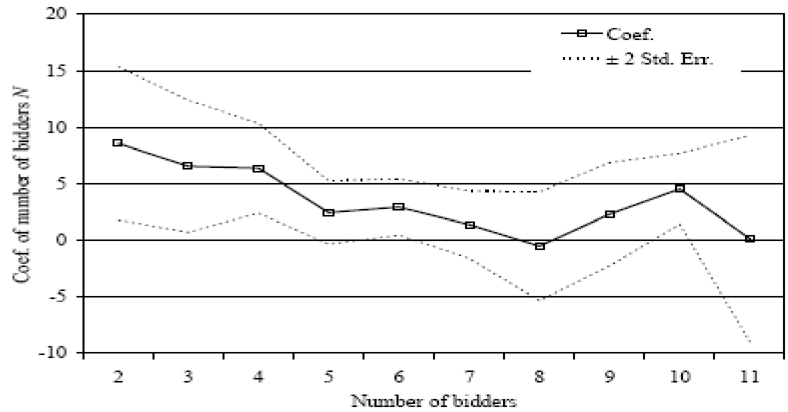
3.3.5. The paper discusses the negative competition effect, laying forth some statistical evidence showing that particularly transport and water projects benefit from increased competition. This seems to remain true at least up until 7 bidders, after which the effect wanes. The electricity sector is less dependent on competitive bidding for affordable offers. Nevertheless, the analysis demonstrates the apparent existence of a trade-off between economies of scale and competitive bidding practices.

[20] Note that a 2008 World Bank working paper on procurement efficiency noted that, while economies of scale can result in unit cost savings on larger projects, the larger scope of these projects will limit the number of contractors who are able to make a bid.

3.3.6. The outputs of their analysis are shown in Figure 15 below, which re-presents figures 8, 9 and 10 from their report.

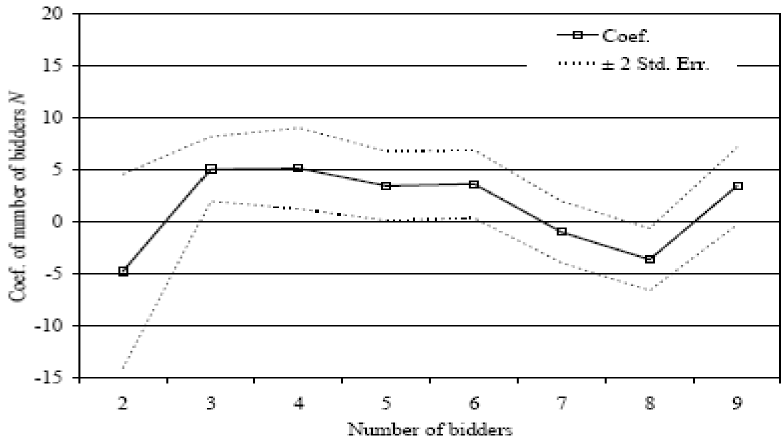
Figure 15: The effects of scale on the competitiveness of procurement

Figure 8. Predicted Competition Effect for Road Contracts



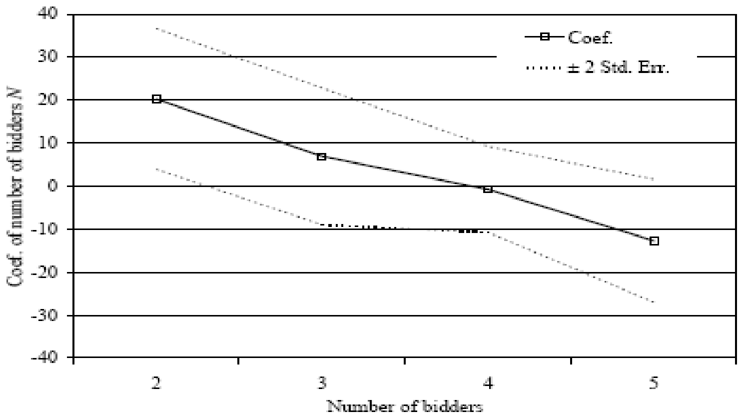
Source: Author's calculation.

Figure 9. Predicted Competition Effect for Water Projects



Source: Author's calculation.

Figure 10. Predicted Competition Effect for Electricity Projects



Source: Author's calculation.

Source: Estache, Antonio & Atsushi Iimi (2008), "Procurement Efficiency for Infrastructure Development and Financial Needs Reassessed'', World Bank Policy Research Working Paper, Washington DC

3.3.7. The policy on contracting has been shown to lead to cost savings through, for example, lump sum contracts (fixed or target), but these savings tend to be marginal relative to total project costs. DBFO contracts seek to transfer the risk of cost overruns to the contractor, which may also result in savings. Other types of contract include progressive payment (according to tasks completed or according to human resources expended) or re-measure. (See NAO, 2007.)

3.3.8. Likewise, contracting arrangements might involve the use of sophisticated systems of incentives for contractors to deliver on time and on budget. In some cases, even if contracts are awarded to the lowest bidder, the absence of contractual arrangements that fairly and effectively distribute risk between contractors and contracting authorities can result in significant unexpected increases in costs.

3.3.9. Other economic and financial determinants of costs include labour and materials costs, the distance from and difficulty in getting to suppliers and the competitiveness of markets like those for the supply and/or rental of plant and machinery. Factors suggested by the independent experts that are part of the WP10 project team included the length of the tender period and the contractual dispute resolution procedures made available (for example, arbitration, dispute boards, expert determination or adjudication).

3.3.10. Halcrow Fox (2000) advocated a "holistic" approach in the design, planning and construction and improvement of mass rapid transit (MRT) systems. The study covered many of the technical and economic factors outlined in this and previous Section. Their importance was summarised by the table shown Figure 16 below.

Figure 16: Factors influencing differences in metro capital costs across projects

TABLE 3.2 FACTORS INFLUENCING METRO CAPITAL COSTS

	Factor	Impact upon Cost
	Organisation and Management	
1	Quality of management/organisation	Dominant
	Physical Factors	
2	New system, or progressive expansion of existing system	Dominant
3	Ground conditions (underground construction, and foundations for elevated viaducts)	Very large
4	Urban constraints and topography (utilities diversions, proximity to buildings, ability to divert traffic, environmental constraints, earthquake protection)	Large
5	System features (long trains, stations as civil defence shelters, AC requirements, special access etc)	Small-moderate
6	Design and safety requirements	Large
	Financial Factors	
7	Financing costs (during construction, influenced by availability of soft loans, and forex movements)	Very large
8	Land costs	Moderate
9	Competition in the equipment supply and construction market	Moderate
10	Labour costs	Small-moderate
11	Taxes and duties	Small
12	Freight costs	Small

Source: Halcrow Fox (2000), World Bank Urban Transport Strategy Review: Mass Rapid Transit in Developing Countries", July, Washington

3.4. Institutional determinants of costs and the stage of country development

3.4.1. Institutional arrangements refer to the allocation of responsibility and risk and system of rewarding success and penalising failure through performance monitoring and accountability processes. Institutional arrangements reflected in the stage of country development can have a significant influence on project costs.

3.4.2. Indicators of institutional arrangements include the perceived level of political commitment, the strength and quality of leadership, design standards and the approach to procurement decisions. For example, contract procurement decisions might be based on a sound rationale related to technical/experience reasons, or they might simply be based on the cheapest bid. These factors were considered prominent in a study by BB&J Consult (2000) on a sample of urban transport projects.

3.4.3. Another determinant of infrastructure project costs that has received some attention is the ownership structure and, more specifically, whether private finance (through, for example, public-private partnerships) or public finance can be expected to lead to more efficient outcomes. However, conflicting views emerge from our examination of this issue in the literature.

3.4.4. A study by the Allen Consulting Group (2007) comparing PPPs to traditionally procured infrastructure projects in Australia found that PPPs perform better in terms of both cost and time efficiency than traditionally procured projects.[21] Moreover, the timeliness of projects was shown to suffer under traditional procurement as the project size increased, whereas the timeliness of PPP projects was found not to be affected by project size. The study also observed that PPP projects were more transparent than traditionally procured projects, as measured by the availability of public data for the study.

3.4.5. On the other hand, a study by Blanc-Brude et al (2006) of ex ante construction costs of road projects from around Europe suggests a number of reasons why PPPs could be expected to exhibit higher costs than traditionally procured infrastructure projects.[22] These reasons were: (i) the fact that the bundling of construction and operations contracts in PPPs gave the private partner incentives to make investments in the construction phase that could lower subsequent operation and maintenance costs; and (ii) the fact that the transfer of construction risk to the private partner can be expected to be explicitly priced in a PPP contract.

3.4.6. Flyvbjerg et al (2003) suggested that the expectation that privately financed projects perform better than traditionally publicly procured projects is an oversimplification and, moreover, that the type of accountability structures mattered more in his sample than the type of ownership. Flyvbjerg et al (2008) concluded that the role of ownership in causing efficiency differences between projects involving private and public finance required further research.

[21] The findings of the study were based on the publicly available data for a sample of 21 PPP projects and 33 traditionally procured projects from New South Wales (19), Victoria (26) and Queensland (9). Projects were grouped into social (24), transport (23), water (3) and IT (4) infrastructure sectors. The projects in the sample were selected according to five criteria (including data availability).

[22] The authors use data on ex ante construction costs (the best estimate of what the project should have cost to build at the point at which the winning bidder was awarded the contract for the project) of road projects in the EU-15 countries plus Norway financed by the European Investment Bank between 1990 and 2005 and covering 6,400 kilometres of road. They find PPP roads to be, on average, 24 per cent more expensive than traditionally procured roads, all other things being equal.

3.4.7. Our examination of a sub-sample of ERDF infrastructure project applications suggests the absence of private finance. However, we have not examined all projects and, in any case, financing arrangements could, in some cases, have changed as projects develop beyond the ERDF application process. Where projects have involved private finance, we will seek to understand the influence that it has had on costs in the context of the varying conclusions from the literature outlined above.

3.4.8. We are also monitoring whether projects involve any element of EIB finance. The use of external debt to finance projects could, in principle, impose a certain level of discipline in the management of costs in order to facilitate speedier debt repayments.

3.4.9. Wiser and Kahn (1996) examined the importance of the capital structure and financing arrangements for energy infrastructure (specifically generating plant). The rate of interest on debt as well as the debt-equity ratio was found to impact on how capital costs are to be recovered. The authors state that:

> "the primary benefits associated with public ownership and finance come from the lack of project-specific minimum debt service coverage ratio (DSCR) requirements, which allows an increased level of debt in the capital structure, reduced debt costs, and an increased debt amortization period. The benefits of IOU ownership and finance come primarily from debt and equity cost reductions, longer debt amortization, and the lack of project-specific DSCR requirements".

3.4.10. Their results on the role of private financing arrangements (which are the most common form in the US renewable energy sector) are summarised in Figure 16 below.[23]

Figure 17: Effects of ownership structure on windpower project costs

Table ES-2. Effects of Ownership Structure on Windpower Project Cost

Ownership/ Financing Scenario	Levelized Cost of Energy (mills/kWh)	% Cost Savings Compared to (1)
(1) Private Ownership, Project-Finance	49.5 (53% equity)	n/a
(2) IOU Ownership, Corporate-Finance	35.3	29%
(3) Public Utility Ownership, Internal-Finance	28.8	42%
a. w/ REPI	43.5	12%
b. w/o REPI		
(4) Public Utility Ownership, Project-Finance	34.3	31%
a. w/ REPI	48.9	1%
b. w/o REPI		

Source: Wiser, Ryan and Edward Kahn (1996), "Alternative Windpower Ownership Structures: Financing Terms and Project Costs", University of California, Berkeley

[23] The authors distinguish between four types of ownership structure: (i) Private Ownership, Project-Finance: Private renewable energy companies develop and finance the project, sell electricity on to utility companies; (ii) IOU (Investor-Owned electric Utility) Ownership, Corporate-Finance: (iii) Investor Owned Utility companies develop and finance project themselves; Public Utility Ownership and Internal-Finance. Project finance differs from internal finance in that debt is claimed against project revenue as opposed to revenue of the firm.

3.4.11. The same study observed that financing terms are particularly influential on the cost of wind power in the US because the particular energy sector is yet at an early stage of development. The associated risks are seen to be relatively high, and these are reflected in higher financing costs. These are illustrated in the Table ES-1 from their report, which is re-presented in Figure 18 below.

Figure 18: Financing and cost differences for alternative windpower ownership structures

Table ES-1. Key Financing and Cost Differences Among Windpower Ownership Structures

Variable	Private Ownership	Iou Ownership	Public Ownership: Internal-Finance	Public Ownership: Project-Finance
Capital Structure	Flexible--Can optimize to minimize cost	50% equity 50% debt	100% debt	100% debt
Debt Interest Rate	9.5%	7.5%	5.5%	7.5%
Debt Amortization Period	12 years	20 years	20 years	20 years
Debt Amortization Schedule	Mortgage-Style Repayment	Straight-Line Declining Rate-Base	Mortgage-Style Repayment	Mortgage-Style Repayment
Debt Service Coverage Ratio Requirements	Minimum 1.4	No project-specific requirement	No project-specific requirement	Effectively, no project-specific requirement
Equity Cost	18%	12%	n/a	n/a
Property Tax	Levied on total value of facility	Levied on total value of facility	Levied only on value of land	Levied only on value of land
Income Tax	5-yr Depreciation	Normalized, 7-yr Depreciation	None	None
Production Credit	PTC for 10 years	PTC for 10 years	REPI subject to yearly allocation	REPI subject to yearly allocation

Source: Wiser, Ryan and Edward Kahn (1996), "Alternative Windpower Ownership Structures: Financing Terms and Project Costs", University of California, Berkeley

3.5. Quality of project planning and management

3.5.1. The quality of project (and programme, where relevant) governance arrangements, including project planning and project management. This, in turn, might be due to poor quality people, little direct presence of top management/officials in the field or simply to inexperience with all or certain types of infrastructure projects. For example, small European countries are beginning to deliver urban rail projects for the very first time.

3.5.2. Poor project preparation and management cause delays due to a range of factors including, for example, satisfying the requirements of the planning process and meeting environmental requirements. This will result most likely result in rising costs due to the effects of input price inflation. Procurement that involves early contractor involvement in the design phase has the potential to provide valuable information like, for example, early indications of cost problems, a basis for monitoring contractors' costs as projects develop and potential areas that require value management/engineering.[24] (This was addressed in Nichols, 2007. See below.)

3.5.3. Effective project management might be expected to include the employment of substantial additional resources in order to accelerate project implementation. However, if the phasing of a project is dependent on other linked projects (that are part of the same programme or part of a larger project), thereby leading to interruptions, the project can be more expensive due to the cost of re-mobilising plant and contractors.

3.5.4. Flyvbjerg (2008) noted that the quality of project management was difficult to quantify for urban transport projects. However, they also noted the prominence of establishing rights and the statistical effect of how new the project was (as opposed to progressive extensions of an existing system).

3.5.5. The Nichols Report (2007) critically evaluated the structure, operations, and performance of the Highways Agency and the Department for Transport in delivering major projects.[25] The report highlights a number of areas with room for improvement and revision. These are grouped in three categories as summarised in Figure 19 below.

[24] Value engineering or management refers to systematic methods to improve "value" by examining costs relative to functionality. Value can be increased by improving functionality or reducing costs. In most cases, it will involve eliminating unnecessary expenditures. Alternatively, it might involve increases in initial capital expenditure in order to decrease, for example, longer term maintenance expenditures through a whole life costing approach.

[25] 43 completed and 62 active road schemes make up the Targeted Programme for Improvement (TPI). Of the active road schemes only 24% had determined construction prices while the remaining 76% were at various stages of development. The analysis is primarily qualitative, reviewing the programme itself rather than the individual schemes that it is composed of.

Figure 19: Nichols' "Template for Change" of the Government Agencies charged with delivering major highway projects

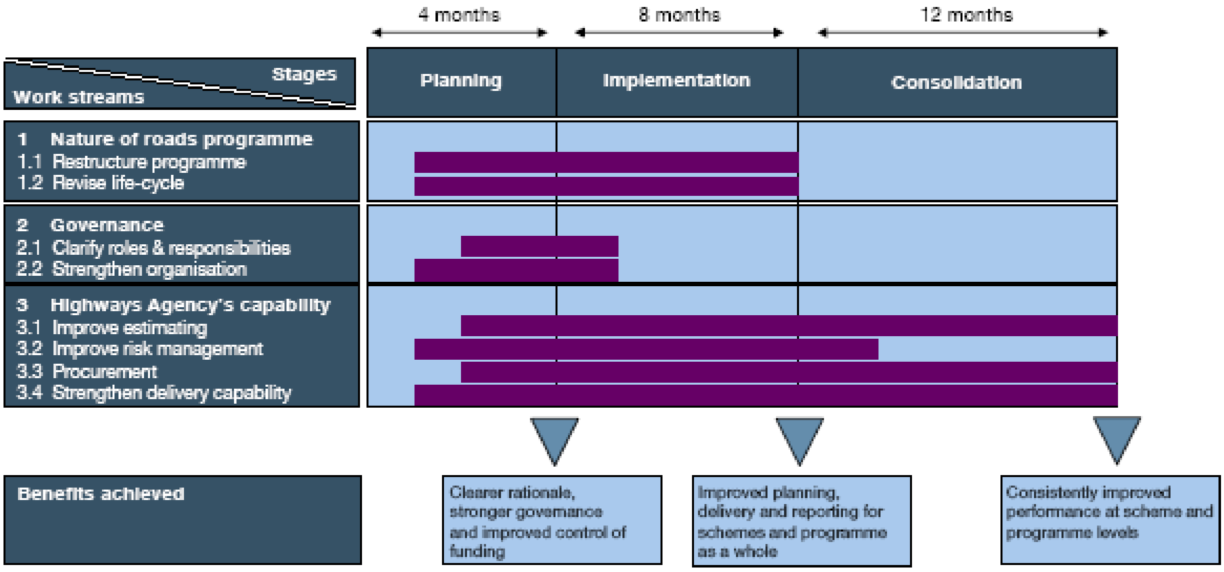


Figure 8 – Template for change

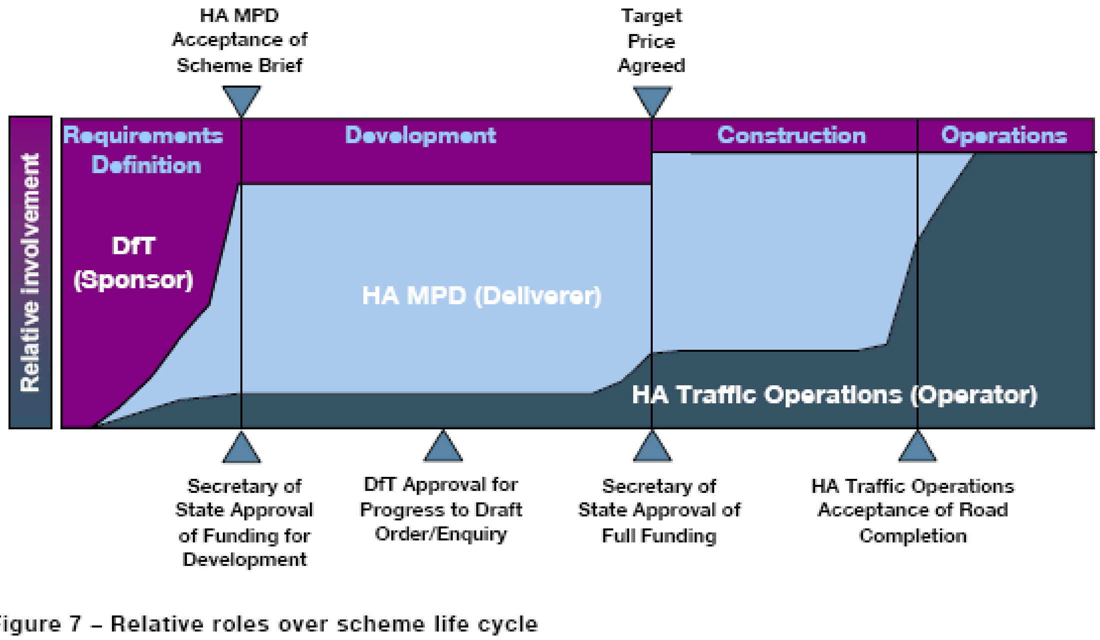
Source: Nichols, Mike (2007), "Review of Highways Agency's Major Roads Programmes: Report to the Secretary of State for Transport", London, March.

3.5.6. The planning and cost estimation processes have been a fundamental weakness of the current TPI programme since its start. Schemes enter the TPI at various stages of preparation, most having far too vague and inadequate project designs to produce cost estimates of reasonable accuracy. This prompts the author to state that "it is not prudent to commit to their full funding until they reach a more advanced stage and hence have a much more robust estimate."

3.5.7. The primary recommendation to achieve this more robust estimate concerns the programme structure. According to the report "the TPI should be replaced by three groupings of schemes, corresponding to three phases in their life cycle: Requirements Definition (responsibility of DfT), Development and Construction (the latter two the responsibility of HA). The first should be funded from a resource budget; the second with individual scheme budgets covering costs to get to the next phase; and the last, which typically is 90-95% of the cost, fully funded through to completion."

3.5.8. Establishing fixed phases would introduce the type of regularity into planning and development that at present is missing in the TPI. Not only would schemes have to fulfil specific requirements at each stage to secure funding, but they would need to produce their estimates at the same baseline. The suggestion, as indicated in Figure 20 below, is that this takes place following the successful completions of the Requirements Definition and Development phases.

Figure 20: Agency roles over the project life-cycle



Source: Nichols, Mike (2007), "Review of Highways Agency's Major Roads Programmes: Report to the Secretary of State for Transport", London, March.

3.6. Implications for Work Package 10

3.6.1. During the process of ranking and evaluating projects, our plan is to consider the full range of infrastructure project cost determinants set out in this Section and in Section 3 of the main Report. Some of these factors are explicitly reflected in our data requests. These are shown in Table 5 below, which shows the general and sector-specific attributes on which we have requested information.

3.6.2. As an example, it appears, from our examination of a sub-sample of ERDF applications, that some projects involve a mixture of new capacity, renewals and maintenance. However, where they do, the costs are not broken down between those elements. In our requests for data, therefore, we have asked providers to indicate the proportions of project expenditures on new build and refurbishment. This can be seen in the first column ('General attributes') of Table 5 below.

3.6.3. Other factors not covered by our data requests are likely to emerge in the course of our analysis. However, note that, if there are too many projects with very specific circumstances, it will become more difficult to establish a systematic database of unit costs, unless those circumstances can be adequately controlled for through appropriate manipulation of the data.

Table 5: General and sector-specific attributes contained in our data requests

General attributes	Rail-specific attributes	Urban transport-specific attributes	Water-specific attributes
Country	Length of Track	Length of Track	Length of Pipe
Contract Type	Design Capacity	Design Capacity	Population Served
Project Complexity	Proportion of Track in Fixed Link	Proportion of Track in Fixed Link	Pipe Diameter
Procuring agency	Average Station spacing	Number of Stations	
Pricing structure	Electrical/Diesel	Electrical/Diesel	
Number of tenderers	Type of Rolling Stock	Type of Rolling Stock	
Tender period	Stops	Proportion of Elevated Track	
Proportion of new build/refurb	Controlled junctions	Proportion of Underground Track	
Conditions of contract	Depots	Proportion of Underground Stations	
Design responsibility	Park-and-ride facilities	Proportion of Surface Stations	
Contractual dispute resolution procedures	Track guage		
Funding structure	Power supply		
Predominant Locality	Platform length		
Predominant Terrain	Platform width		
Predominant Geology	Railway signalling		
Predominant Enviromental			

Source: RGL

3.7. Conclusions

3.7.1. The DG XVI Guidance provides a framework for the analysis of the determinants of infrastructure project costs and the factors that can cause differences between same-sector projects in the same or different countries. Further explanatory factors were provided by our experts and by DG REGIO's previous ex post evaluations carried out by ECORYS Transport. However, we have also endeavoured to draw out the general and sector-specific factors identified in the academic literature as having the potential to cause differences between projects.

3.7.2. In analysing a sample of projects, it is preferable that the set of projects in a sector are dispersed around the average with only a small standard deviation and a high level of confidence. Then it is a matter of assessing whether deviations from the average, where they occur, are acceptable. However, it must also be realised that the scope for within- and cross-country comparability of projects is dependent on not having too many projects with very specific circumstances and, therefore, with widely varying determinants of cost.

4. Understanding time delays and cost overruns

4.1. Introduction

4.1.1. Delays in project implementation and cost overruns occur as a result of inaccurate estimates such that actual timescales tend to be longer and actual costs turn out to be higher than originally anticipated. The tendency for delays and overruns in large infrastructure projects is documented as systematic in the academic literature on the subject. Most notably, Flyvbjerg et al (2003) found that 9 out of 10 projects in a sample of 258 from 20 countries in 5 continents were subject to cost overruns. This conclusion was illustrated in figure 1 of their report, re-presented in Figure 21 below.

Figure 21: Frequency and extent of cost escalations from Flyvbjerg et al. (2003)

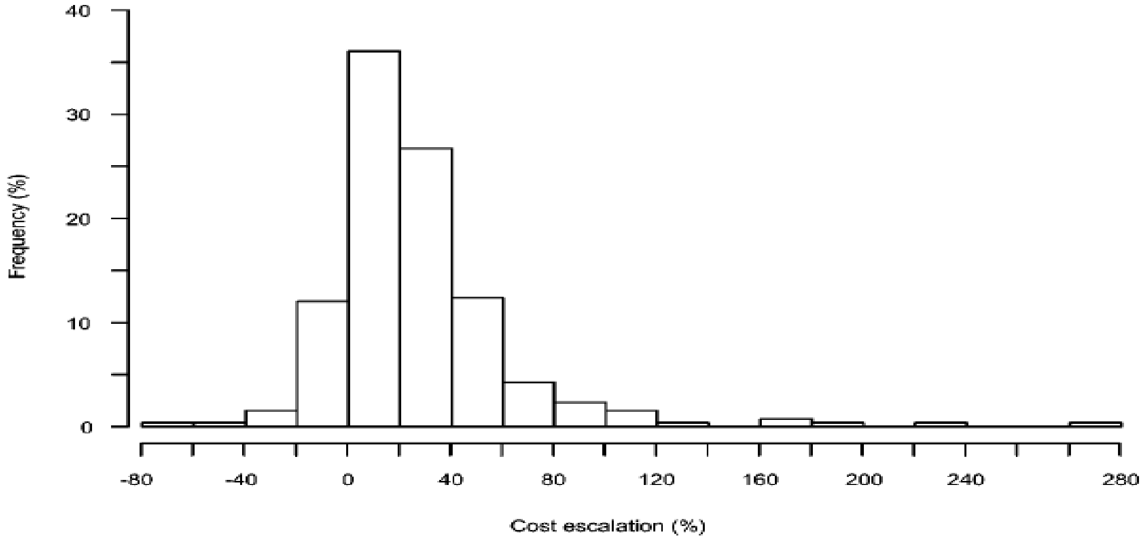


Figure 1. Cost escalation in 258 transport infrastructure projects (constant prices).

Source: Flyvbjerg, Bent, Mette Skamris Holm and Soren Buhl (2003), "How common and how large are cost overruns in transport infrastructure projects?", Transport Reviews, Vol. 23 No. 1.

4.1.2. The 1998 EC DGXVI (now DG REGIO) Guide states that:

"Once implementation begins, a project's costs rarely remain static. As further information becomes available the costs may be further defined. Yet, even when a cost has become firmly fixed, there are numerous factors that can lead to the cost increasing. Delays are a major factor…[and]…almost invariably increase budget costs. Many events may have contributed to the delay – some of which could have been foreseen and other which could not.

"Research carried out in the preparation of this manual has found that many ERDF projects experience a range of problems in both pre-construction and implementation stages. These lead to projects over-running either in time or costs."

4.1.3. Flyvbjerg (2005) advances three categories of explanation for time delays and cost overruns, namely technical, psychological and political-economic. This part of the Report is structured around those categories as follows:

- Sections 4.2 examines work done for and on behalf of the Commission on the technical explanations for delays and cost overruns;
- Section 4.3 examines the results of other non-EC studies, also largely concerned with technical explanations;
- Section 4.4 looks at psychological theories of cost overruns and delays, and is concerned specifically with the planning fallacy and optimism bias;
- Section 4.5 looks political economy theories of delays and overruns and is concerned specifically with the possibility that they are the result of deliberate strategic misrepresentation of project scenarios.

4.1.4. The remainder of this part of the Report is structured as follows:

- Section 4.6 considers the role of ex ante risk assessment;
- Section 4.7 considers the treatment of delays and cost overruns and delays for WP10;
- Section 4.8 considers the measurement in practice of delays and overruns and the implications for WP10;
- Section 4.9 concludes.

4.2. Existing evaluations of the technical explanations for delays and overruns

4.2.1. This category of explanation is the most common and is concerned with things like imperfect forecasting techniques, inadequate data or honest mistakes due, for example, to lack of experience with infrastructure cost forecasting or with forecasting costs for certain types of infrastructure. They might also include inherent problems in predicting the future.

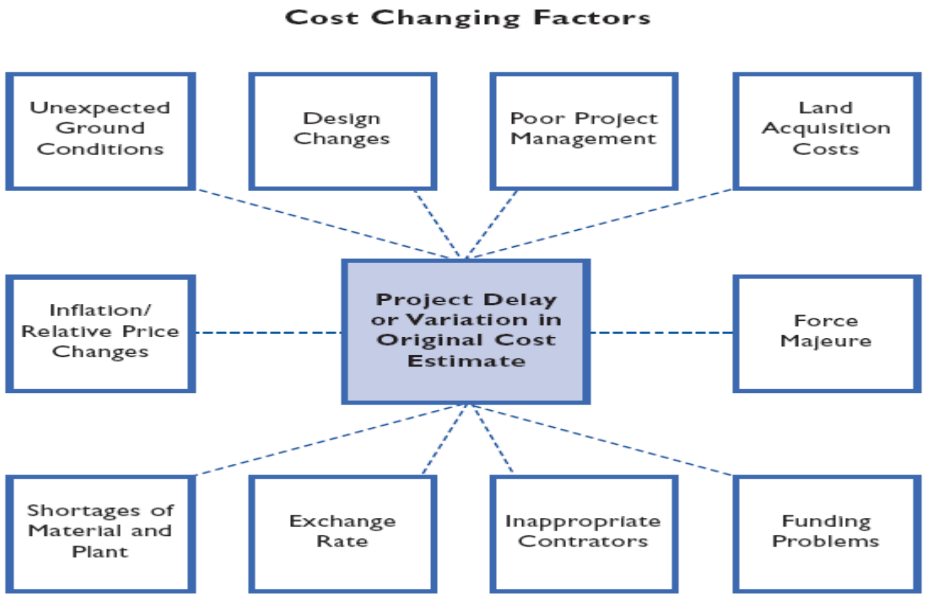
4.2.2. Technical explanations for cost overruns/delays in transport infrastructure are the subject of a growing academic literature inspired by Flyvbjerg et al (2002) and continuing with Flyvbjerg (2008), the latter looking specifically at urban transport projects. They are also the subject of numerous consultancy reports and research by the Commission itself.

4.2.3. Conventional wisdom suggests that the same principles apply to projects in other sectors, including the energy and water/wastewater sectors so the lessons drawn from the available literature have wide applicability for WP10. The applicability of the principles are also accepted for other sectors outside the scope of WP10 such as telecoms and marine transport.

DG XVI's Guide on the technical explanations for delays and cost overruns

4.2.4. As with the determinants of cost, which was the subject of the last Section, DG REGIO's Guide provides a set of key determinants of delays and cost overruns. These are summarised in Figure 22 below, which is re-presented from the Guide.

Figure 22: Key determinants of infrastructure project delays and cost overruns



Source: European Commission DG XVI (1998), "Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects", A User's Guide, Brussels

4.2.5. The lack of effective project management was identified as the most significant cause of failures to contain costs. Other predominant factors included design changes and input price inflation due to delays. Less frequently observed factors included land acquisition problems, unexpected ground conditions and difficulties with contractors.

4.2.6. The Commission's findings are illustrated for different categories of costs in Figure 23 below, where the large circles indicate a major effect and small circles indicate a minor effect.

Figure 23: Common causes of cost overruns and project time delays

Effect of Cost-changing Events on Key Cost Elements; (Major or Minor)(1)

	Cost-changing factors					
Cost Elements	Design Changes	Land Acquisition Problems	Poor Project Management	Unexpected Ground Conditions	Inflation/ Relative Price Rise	Difficulties with Contractors
Planning/Design Fees	●	—	●	—	•	—
Land Purchase	•	●	•	—	•	—
Site Preparation(2)	•	—	•	●	•	•
Building & Construction	●	—	●	•	●	●
Plant & Machinery	●	—	•	—	●	•

Source: European Commission DGXVI (1998), "Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects: A User's Guide", Brussels.

4.2.7. Effective project management was identified in the Guide as the most important factor to get right. Poor project management structures impact on all stages of the project implementation phase, which can lead to poor planning and coordination, poor communication between project teams and project sponsors, a failure to identify problems and institute timely design and programming changes and a lack of control over time and cost inputs.

4.2.8. The Guide makes some important observations on project management issues based on DG XVI's research. These were that:

- Poor project preparation (such as the submission of projects when they are not mature enough or when they lack detailed feasibility studies[26]), which was observed to result in delays in approval procedures, design and scope changes and additional administrative procedures.
- External factors that caused delays and consequent cost overruns could have been foreseen through more detailed preparatory studies.
- Opposition from local communities could be avoided or, at least, lessened through more extensive public consultation, which again pointed to poor project preparation.
- Lack of managerial capability was especially characteristic of smaller municipal bodies that were faced with more complex infrastructure works and administrative procedures than had been the case before the start of the Cohesion Fund.

4.2.9. The report went into more detail for frequently mentioned causes of delays:

- Poor project preparation, including the submission of projects when they are not mature enough (often referred to as 'technical reasons') or lacking in detailed feasibility studies. This resulted in delays in approval procedure, changes in design, changes in the scope of work and additional administrative procedures.
- External factors, which could have been foreseen through better and more detailed preparatory studies, but that included archaeological finds, unexpected geological meteorological conditions and the discovery of habitat areas.
- Community involvement, mainly related to opposition from local communities. The report notes that "improvement in this field could be realised by more extensive public consultation." This again pointed to poor project preparation.
- Lack of managerial capability, which "holds especially for the smaller municipal bodies, which are faced with more complex infrastructure works and administrative procedures than they were being used to before the start of the Cohesion Fund."

[26] NAO (2007) observed wide variations in the phases at which projects entered their respective schemes and, consequently, the varying points in project life-cycles at which initial cost estimates were made. Cost estimates were found to be more accurate the later in the project life-cycle that they were made.

4.2.10. The other important, albeit less prominent, factors shown in Figure 22 above are explained as follows:

- Design changes to the project specification: design changes can result from a desire for additional elements or changes to existing ones. They usually require additional time and cost inputs from the contractor and additional materials.
- Inflation, which can impact costs in a number of ways including: (i) unanticipated inflation will increase the cost above the original estimates; and (ii) factors that delay a project will also expose the project to the risk of further inflationary cost increases not included in original estimations. Inflation may not, however, be the only cause of price rises. Political or technological factors may affect one or more elements of cost, e.g. increased labour mobility between Eastern Europe and the EU, which could lower the labour cost elements.
- Land acquisition problems, which might consist of original owners of the land appealing against the purchasing authority's valuation of the land, leading to long drawn out compensation cases. This can lead to project delays and higher costs than originally envisaged for the land.
- Unexpected ground conditions such as in the sub-surface can require fundamental redesign of projects at great expense. Changes in surface conditions can also cause difficulties in moving machinery and supplies around the site, and in undertaking excavations and laying foundations. These can also increase costs and cause delays.
- Inappropriate contractors, namely whether contracting firms are the most experienced in terms of delivering the project cost-effectively and to a high standard. This might occur if the best contractors are not available or if the tender review process is carried out by personnel with insufficient understanding of the services required. Delays and cost increases can also arise if ineffective or inappropriate labour is hired or if errors are made in calculating how productive the labour will be, which can happen when sub-contractors are used whose quality is not controlled within the project.

4.2.11. The remaining issues from Figure 22 are explained as follows:

- Force Majeure, namely events which are commonly referred to as "Acts of God", such as war, extreme weather, earthquakes, landslip, fire, political and economic instability. Contractors are required to insure against such events, but when they do occur, significant delays and cost increases can be expected.
- Funding problems might be manifested in a lack of finance to complete a project (due perhaps to unanticipated cost increases) and may result in work having to stop until additional funding can be raised. Likewise, slow payment of invoices can cause contractors to commit fewer resources or even cease work if cashflow becomes an issue.
- Exchange rates movements can affect project costs if contracting services or other elements of the project are being purchased from other Member States or from outside the EU.
- Shortages of material and plant, which are more likely to occur during periods where the level of development activity is unusually high in a particular region. If it was not anticipated in original cost estimates, delays and increases in the prices of those elements are likely.

The ECORYS Transport (2005) ex post evaluation of Cohesion Fund projects

4.2.12. A study by ECORYS Transport (2005) of 60 projects that were co-financed by the Cohesion Fund in the period 1993-2000 observed a similar range of factors in explaining cost overruns. Their report noted that the predominant causes of overruns/delays, namely design changes, inflation impacts due to time delays and site/contractor issues such as those identified by DG XVI (1998), all pointed to inadequate project preparation.[27] The report also cites the importance of local community involvement in projects.

4.2.13. The frequency of delays found by the study is shown in Figure 24 below, which re-presents Table 6.1 from their Report. This tabulates the number of times particular lengths of delay were experienced.

Figure 24: Number of sample projects experiencing implementation delays

Table 6.1 Implementation delays

		No delay	Delay < 0.5 year	Delay 0.5-1 yr	Delay 1-2 yrs	Delay 2-5 years	Delay >5 years	No data	Total
Environment	Greece	1	1	3	7	8	4	0	24
	Ireland	2	0	1	3	4	0	1	11
	Portugal	0	1	4	7	8	2	0	22
	Spain	3	1	16	12	15	0	15	62
	Subtotal	22	3	19	24	30	6	15	119
Transport	Greece	2	0	2	5	6	2	1	18
	Ireland	0	0	2	3	4	2	0	11
	Portugal	3	1	7	4	4	0	1	20
	Spain	8	3	7	9	3	0	2	32
	Subtotal	13	4	18	21	17	4	4	81
TOTAL		35	7	37	45	47	10	19	200
Idem (%)		17.5%	3.5%	18.5%	22.5%	23.5%	5%	9.5%	100%

Source: ECORYS et al. (2005), "Ex post evaluation of a sample of projects co-financed by the Cohesion Fund (1993-2002)", Synthesis Report, Rotterdam

4.2.14. The reasons for these observed delays were presented in table 6.1 of the ECORYS report, which is re-presented in Figure 25 below. Unfortunately, no effort was made to quantify (or even qualify) how significant each of these factors were in contributing to observed delays.

[27] The report also discusses factors like the impact of time delays in the implementation phase on costs through input price inflation, country-specific and institutional factors, the size and complexity of projects and whether the project is held in the public sector or includes private involvement. These issues were discussed in Section 3 above.

Figure 25: Reasons for observed implementation delays

Table 6.2 Reasons for delays

		Not enough political commitment	No clear deadlines	Weak management & monitoring	Technical reasons	External factors	Community involvement procedures	Other	Not applicable / no data	Total
Environment	Greece	1	1	2	15	12	5	0	1	37
	Ireland	0	0	0	4	1	0	4	3	12
	Portugal	1	0	3	14	5	4	0	5	32
	Spain	0	0	2	16	13	4	16	32	83
	Subtotal	2	1	7	49	31	13	20	41	164
Transport	Greece	0	0	0	14	6	1	1	4	26
	Ireland	3	4	1	5	7	4	0	1	25
	Portugal	0	0	1	9	6	5	0	7	28
	Spain	1	2	1	15	0	0	6	12	37
	Subtotal	4	6	3	43	19	10	7	24	116
TOTAL		6	7	10	92	50	23	27	65	280
Idem (%)		3%	3.5%	5%	46%	25%	11.5%	13.5%	32.5%	100%

Source: ECORYS et al. (2005), "Ex post evaluation of a sample of projects co-financed by the Cohesion Fund (1993-2002)", Synthesis Report, Rotterdam

4.2.15. The frequency of cost overruns found by the study is shown in Figure 26 below, which re-presents Table 6.3 from the report. This tabulates the number of times particular levels of cost overruns were experienced.

Figure 26: Number of sample projects experiencing deviations from budgeted costs

Table 6.3 Budget deviation

		No overrun	<5% overrun	5-10% overrun	10-20% overrun	20-50% overrun	>50% overrun	No data	Total
Environment	Greece	7	5	0	1	5	4	2	24
	Ireland	0	1	2	2	3	3	0	11
	Portugal	6	5	3	3	2	3	0	22
	Spain	22	5	3	5	4	5	18	62
	Subtotal	35	16	8	11	14	15	20	119
Transport	Greece	4	3	2	3	3	3	0	18
	Ireland	2	4	0	0	2	2	1	11
	Portugal	8	6	1	1	2	1	1	20
	Spain	16	1	0	1	6	1	7	32
	Subtotal	30	14	3	5	13	7	9	81
TOTAL		65	30	11	16	27	22	29	200
Idem (%)		32.5%	15%	5.5%	8%	13.5%	11%	14.5%	100%

Source: ECORYS et al. (2005), "Ex post evaluation of a sample of projects co-financed by the Cohesion Fund (1993-2002)", Synthesis Report, Rotterdam

4.2.16. The reasons for these observed cost overruns were presented in table 6.4 of the ECORYS report, which is re-presented in Figure 27 below. Unfortunately, no effort was made to quantify (or even qualify) how significant each of these factors were in contributing to observed cost overruns. Note that, as well as the factors mentioned in paragraph 4.2.12 above, the report also noted the influence of country-specific and institutional factors, the length of the implementation phase, the size and complexity of projects and whether private finance was involved.

Figure 27: Reasons for observed cost overruns

Table 6.4 Main reasons for cost overruns[17]

		Modifications to project	Time delays	Inadequate cost estimates	Technical reasons	Weak budget discipline	Weak monitoring	Other	Not applicable / no data	Total
Environment	Greece	13	10	3	3	0	3	1	8	41
	Ireland	5	6	4	5	1	0	7	0	28
	Portugal	10	7	7	3	0	1	0	7	35
	Spain	13	5	6	6	0	0	6	42	78
	Subtotal	41	28	20	17	1	4	14	57	182
Transport	Greece	6	12	6	12	0	0	0	3	39
	Ireland	6	8	2	1	1	0	6	0	24
	Portugal	7	5	2	5	0	1	0	8	28
	Spain	5	0	3	1	0	0	0	26	35
	Subtotal	24	25	13	19	1	1	6	37	126
TOTAL		65	53	33	36	2	5	20	94	308
Idem (%)		32.5%	26.5%	16.5%	18%	1%	2.5%	10%	47%	100%

Source: ECORYS et al. (2005), "Ex post evaluation of a sample of projects co-financed by the Cohesion Fund (1993-2002)", Synthesis Report, Rotterdam

The ECOTEC (2003) ex post evaluation of Objective 1 programmes

4.2.17. The 'Ex Post Evaluation of Objective 1 1994-1999' by ECOTEC (2003) briefly compares water infrastructure projects with similar large-scale transport projects as regards the success of their initial project cost and timescale estimates. Based on available project data (drawing of cases from France, Germany, Greece, Ireland, Italy, Portugal, Spain and the UK) the study suggests that environmental and water projects are even more susceptible to delay and cost overrun than their transport based equivalents. Table 6 below depicts 70% of water infrastructure projects going over budget, compared to 60% of transport projects. In addition water projects were noted to be subject to delays of over 12 months; again, somewhat greater than the delays for the transport projects considered.

4.2.18. Unfortunately no attempt is made to identify possible reasons for these findings. An analysis around this type of discrepancy could have provided some very interesting insight into the fundamental errors of project planning for each project 'family'. On a general level it is nevertheless reasonable to assume that water infrastructure planning and implementation suffers from the same type of shortcomings as are so frequently identified in transport projects.

4.2.19. Additionally, some care should be taken when interpreting the below results. For example, no information is given about the stages at which the initial estimates for the projects in question have been produced, making it difficult to compare like with like. Further research and more thorough definitions are required before these findings can be approached with greater certainty.

Table 6: Cost overruns observed by ECOTEC (2003)

Table 4.4: Delivery against budget by project type

Project Type	Completed									
	Under budget		To budget		<10% over		10-30% over		>30% over	
	No.	%	No.	%	No.	%	No.	%	No.	%
Transport Project										
Road[1]	**4**	30.7	**2**	15.4	**1**	7.7	**1**	7.7	**5**	38.5
Rail	**1**	14.3	**2**	28.6	**1**	14.3	**3**	42.9	**0**	0.0
Air	**0**	0.0	**0**	0.0	**2**	100	**0**	0.0	**0**	0.0
Port	**0**	0.0	**0**	0.0	**0**	0.0	**0**	0.0	**1**	100
Environment Project										
Water [2]	**3**	18.8	**3**	18.8	**4**	25.0	**4**	25.0	**2**	12.5
Other	**0**	0.0	**0**	0.0	**1**	25.0	**1**	25.0	**2**	50.0
Industrial Project	**3**	21.4	**3**	21.4	**4**	28.6	**3**	21.4	**1**	7.1
Total	**11**	**19.3**	**10**	**17.5**	**13**	**22.8**	**12**	**21.1**	**11**	**19.3**

Source: Adapted from National Evaluation Reports

[1] Final expenditure details for one road project not available because the project was not completed at the time of this evaluation.

[2] Final expenditure details for two water projects not available at the time of this evaluation.

Source: ECOTEC (2003), "Ex Post Evaluation of Objective 1 1994-1999", Report to DG REGIO, UK.

4.3. Other non-EC evaluations of technical explanations for delays and overruns

4.3.1. The Nichols Report (2007)[28] on 13 of the UK Highways Agency's largest road projects, which found that inflation, inaccurate cost estimation and inadequate project definition as the most important causes of cost increases.[29] The study quantified the relative impact of a range of factors based on data originally compounded by EC Harris. This is re-presented in Figure 28 below, which represents Table 2 from Nichols (2007).

[28] This review was commissioned by the UK Secretary of State for Transport and was prompted by a series of increases in cost estimates for individual road schemes (by up to 300 per cent) since entry into the Targeted Programme for Improvement (TPI) and in the TPI as a whole (over 18 per cent) over a period of 15 months.

[29] The report emphasised the need to use construction cost inflation because the Treasury's use of the retail price index (which was running at lower levels than construction indices) had by default introduced a degree of cost underestimation into forecasts.

4.3.2. While the results in Nichols (2007) are thought to be not entirely representative (because only the 13 largest schemes were examined) they provide a good indication of the variety of aspects that need to be taken into account in order to produce more accurate cost estimates.

Figure 28: Reasons for project cost increases from Nichols (2007)

Reasons for cost increase	% of cost increase
Inflation to Q1 2005	26%
Inflation from Q1 2005	26%
Inaccurate estimating	15%
Project definition	15%
Risk	7%
Time delays (including inflation)	5%
Land	3%
Time delays (excluding inflation)	2%
Statutory Undertakers	1%

Table 2 – Reasons for cost increases

Source: Nichols, Mike (2007), "Review of Highways Agency's Major Roads Programmes: Report to the Secretary of State for Transport", London, March.

4.3.3. A UK National Audit Office (NAO, 2007)[30] report on a more extensive sample of road projects under the Targeted Programme for Improvement (TPI) and under Local Transport Plan schemes. As with the work by and for the Commission, this study observed poor project management, design changes and inflation as the most significant causes of cost overruns.[31] The study also found that:

- While already completed road schemes were noted to surpass their cost estimates, road schemes currently in development were likely to do the same but by an even greater margin. This was due in part to inflation, in part due to an observation that schemes that are easier to complete are generally dealt with first. Difficult projects are more likely to get drawn out and raise the initial estimates.
- Estimates are furthermore likely to increase at each stage of project development, even though conventional logic might suggest that cost estimates should become more robust. Other unforeseen costs enter the picture through time delays, mismanagement and changes made to the scope of the project midway. A breakdown of these extra cost components are shown in Figure 29 below.

Figure 29: Breakdown of cost increases for UK road projects

8 Works costs are the largest contributor to cost increases for major and local road schemes

Cost element	Breakdown of costs by cost elements for a typical TPI road scheme	Average percentage of cost increases on TPI and LTP road schemes by cost element
Works costs	54	48
Costs of preparatory work before construction	23	10
Design and supervision	9	9
Cost of land and paying compensation	7	26
Statutory undertakers	7	7
Total	**100**	**100**

Source: National Audit Office analysis of Highways Agency and Department for Transport data

Source: National Audit Office (2007), "Department for Transport: Estimating and Monitoring the Costs of Building Roads in England", HC 321 Session 2006-2007, London, July

[30] The study views two sets of English project groups: (i) the Targeted Programme for Improvement (TPI), managed on the national level by the Highways Agency. The TPI consists of 103 ventures set to develop or build new trunk roads and motorways, 36 of which had been finalised by September 2006. The TPI projects run in the period 1998-2021; and (ii) Local Transport Plan road schemes, managed by the Local Authorities. These 81 projects, of which 20 had been completed by July 2006, are part of a general objective to improve regional transportation links.

[31] The NAO (2007) study was conducted within the context of observed cost overrun on roadwork and new road development in England. It examines the discrepancies between cost estimates and final project costs, looks at why these discrepancies occur and how to improve the accuracy of future estimates.

4.3.4. Flyvbjerg et al (2004) examined the statistical significance of the length of project implementation, the size of the project and the type of project ownership in explaining cost overruns. Their results indicated that cost overruns could be associated with:

- the length of the project implementation phase, but that the influence was not statistically different for rail, fixed-link (bridges and tunnels) or road projects;
- project size, but that the influence was significant for bridges and tunnels but not for road or rail projects; and
- weak accountability measures for delays/cost overruns (and, perhaps, incentives for avoiding them), and that this was probably more significant than the effect of ownership incentives on efficiency

4.3.5. Bordat et al (2004)[32] made the interesting distinction between excusable delays (due to force majeure) and non-excusable delays (attributable to contracting agencies and contractors and, therefore, preventable). Contracting agency errors centred on planning and design deficiencies, for example, changes in project scope and incorrect estimates of work quantities included in original bid specifications. Contractor errors included unnecessary work, work that did not follow the design plans and work or materials that did not meet contract specifications. Excusable delays due to unforeseen circumstances included site conditions that differed from those described in contract documents.[33]

4.3.6. Mott MacDonald (2002)[34] found no correlation between project size and optimism bias, but that there was a strong relationship between project size and the number of project risks. Finally, Majid and McCaffer (1998) identified 12 main causes of project time delays, of which materials-, equipment- and labour-related delays were pinpointed as the major causes of contractors' performance delays.[35]

4.4. Psychological theories of cost overruns and delays

4.4.1. Psychological explanations are concerned with the concept of the 'planning fallacy', the systematic tendency to be overly optimistic about the outcomes of planned actions. In infrastructure project planning, the planning fallacy leads to 'optimism bias,' that is, the systematic tendency to underestimate costs, completion times and risks and to overestimate the benefits of planned projects.

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[32] This study analysed the extent of and reasons for cost overruns, time delays and change orders in Indiana Department of Transport (INDOT) projects completed in the period 1996-2001. They include road and bridge construction and rehabilitation projects, maintenance projects (with road maintenance and resurfacing contracts), and traffic and traffic maintenance contracts. Detailed weather data over the relevant period and location were also considered, along with data on the frequency and extent of cost overruns from 11 other US State departments in order to assess Indiana's relative performance.

[33] The main conclusions of the study were that: (i) the overall rate for cost overruns of the INDOT projects considered was 4.5%; (ii) 55% of all INDOT contracts experienced cost overruns, and 12% experienced time delays, with an average delay of 115 days; (iii) average cost overrun amounts and rates, and the contributory cost overrun factors differ by project type (bridge projects averaged 8.1%, road construction projects averaged 5.6%, road resurfacing projects averaged 2.6%, traffic projects averaged 5.6% and maintenance projects averaged 7.5%).

[34] The Mott MacDonald (2002) review of large public procurement in the UK aimed at providing guidance to the public sector, in evaluating and reducing excessive optimism in project estimates during appraisals. 60 UK projects were provided by HM Treasury, while Mott MacDonald identified another 20.

[35] Note that Bordat et al (2004) builds on the work in Majid and McCaffer (1998).

4.4.2. This category of explanation is inspired by the Nobel-prize winning work of Kahneman (1979, 2003) and Kahneman and Lovallo (1993), who relate the planning fallacy to biases at the cognitive level or, in other words, 'errors' in planners/promoters' processing of information as a result of "delusional optimism".

4.4.3. The ubiquitous existence of these tendencies is such that cost overruns/delays and optimism bias are, in practice, considered one and the same thing. By examining the technical and political-economic explanations, one can better understand how to resolve or, rather, correct for optimism bias. This is achieved through a more robust understanding and assessment of (i) the determinants of costs; and (ii) the risks involved (see Section 4.6 below).

4.4.4. Kahneman et al's work on decision-making under uncertainty provided the foundation for the concept of Reference Class Forecasting, which is now recognised and used as a way of increasing the accuracy of forecasting. It is based on a presumption that past projects tend to be more similar to planned projects than is normally assumed. Therefore, rather than focusing only on the specific constituents of a planned project (the 'inside view'), there should be equal if not more focus on the outcomes of similar projects that have already been completed (an 'outside view').

4.4.5. Flyvbjerg and Cowi (2004)[36] developed an applied method for Reference Class Forecasting for the UK Treasury, which was built upon by Flyvbjerg (2006) for the UK Department for Transport.[37] This work advocates the use of explicit, empirically-based optimism bias uplifts to produce more realistic forecasts of individual project capital expenditures. The study generated benchmark uplifts by developing probability (frequency) distributions of cost overruns for the various classes of project under consideration. The results are shown in Figure 30 below.

4.4.6. Planners and promoters can, thereby, choose the uplift that corresponds with the level of risk of cost overrun that they are willing to accept. More specifically, the authors stated that they should adopt the 50th percentile uplift if they were willing to accept a high risk of cost overrun or the 80th percentile if such a level of risk was unacceptable.[38]

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[36] The study explored the underlying causes and institutional context for optimism bias in British transport projects and some possibilities for reducing optimism bias in project preparation and decision-making were identified. From the Flyvbjerg database of 258 projects completed between 1927 and 1998, the following were used in the study: (i) 128 UK and 44 non-UK (Denmark, Sweden and the US) trunk road and motorway projects; (ii) 46 rail projects (including urban rail, conventional inter-city rail and high-speed rail), 3 of which are from the UK, and the others from Canada, France, Germany, the Netherlands, Norway, Sweden, and the US; and (iii) 34 fixed link (bridges and tunnels) projects, of which 4 are from the UK, and the others in Denmark, France, Germany, and the US. Data for building and IT projects were taken from the Mott MacDonald July 2002 study for HM Treasury, Review of Large Public Procurement in the UK.

[37] The method is now a requirement for all large transport infrastructure projects seeking government funding in the UK and has also been endorsed by the American Planning Association.

[38] For road projects, the 50th percentile optimism uplift was found to be 15 per cent and 32 per cent at the 80th percentile. For rail projects (including urban transport), the uplifts were found to range from 40 per cent at the 50th percentile to 57 per cent at the 80th percentile. Fixed link uplifts were found to range from 23 per cent at the 50th percentile to 55 per cent at the 80th percentile.

Figure 30: Estimated optimism bias uplifts (Flyvbjerg et al, 2004)

Table 6 - Applicable capital expenditure uplifts for selected percentiles. Constant prices.

Category	Types of projects	Applicable optimism bias uplifts				
		50% per-centile	60% per-centile	70% per-centile	**80% per-centile**	90% per-centile
Roads	Motorway Trunk roads Local roads Bicycle facilities Pedestrian facilities Park and ride Bus lane schemes Guided buses on wheels	**15%**	24%	27%	**32%**	45%
Rail	Metro Light rail Guided buses on tracks Conventional rail High speed rail	**40%**	45%	51%	**57%**	68%
Fixed links	Bridges Tunnels	**23%**	26%	34%	**55%**	83%
Building projects	Stations Terminal buildings	4-51%*				
IT projects	IT system development	10-200%*				
Standard civil engineering	Included for reference purposes only	3-44%*				
Non-standard civil engineering	Included for reference purposes only	6-66%*				

*) Figure based on Mott MacDonald study, p. 32; no probability distribution or percentiles available.

Source: Flyvbjerg, Bent in association with COWI (2004), "Procedures for dealing with Optimism Bias in Transport Planning: Guidance Document", The British Department for Transport, London, June.

4.4.7. The conclusions of the study, apart from establishing the uplifts presented in Figure 30 above, were as follows:

- The optimism bias uplifts presented are on the low side, due to bias in data sampling and collection, largely constrained by the availability of quality data for projects.
- Optimism bias could be caused by a combination of how the decision-making process is organized and strategic behaviour of actors involved in the planning and decision-making processes. (See Section 4.5 below.)

4.4.8. The report also asserts that few of the actors involved in project planning appear have a direct interest in avoiding cost overruns. This resulted in a recommendation to the UK Department for Transport to apply optimism bias uplifts that are supported by:

- an emphasis on establishing realistic budgeting as an ideal and on de-legitimising over-optimistic budgeting as a routine;
- the introduction of fiscal incentives to avoid cost overruns e.g., through requiring local co-financing of project cost escalation where possible;
- formalised requirements for high quality cost and risk assessment at the business case stage; and
- the introduction of independent appraisal.

4.4.9. The study also provided a useful typology of specific technical causes of cost overruns, which is shown in Figure 31 below.

Figure 31: Typology of technical causes of cost overruns

Typology of specific technical causes for cost escalation in transport projects:

Standards (changed requirements such as speed, road width, road type)

Routing (changed routing)

Norms (changed safety norms or building norms)

Environment (tighter environmental standards)

Geo-techniques (complex or extensive works on geo-techniques, water or mountain)

Archaeology (unexpected archaeological finds)

Expropriation costs (under estimated expropriation costs)

Complex interfaces (urban environment, links to existing infrastructure)

New or unproven technology (limited experience base)

Construction costs (business cycle or competitive situation)

Calculation approach (calculations based on everything goes as planned)

Delays due to weather

Source: Flyvbjerg, Bent in association with COWI (2004), "Procedures for dealing with Optimism Bias in Transport Planning: Guidance Document", The British Department for Transport, London, June.

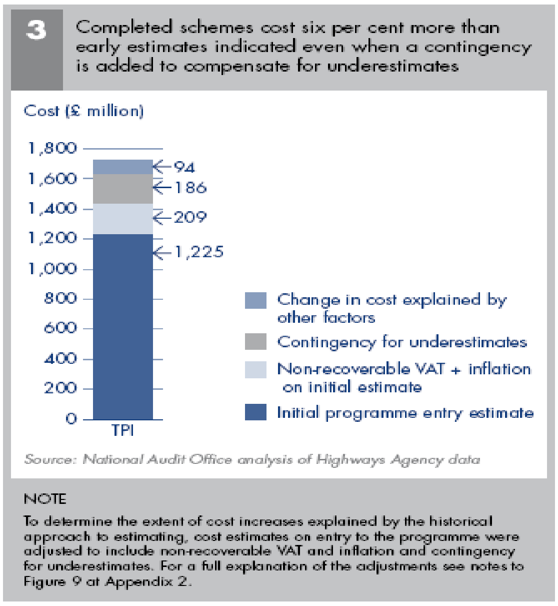
4.4.10. NAO (2007) observed that one of the major problems that UK road projects share is the varying phases at which they entered their respective schemes, and consequently the varying time at which the initial cost estimates were made. Of already finalised TPI projects the study established that "final costs were 17 per cent more than initial estimates for the Agency's schemes entered as outline business cases, compared to seven per cent for schemes where the preferred route had been identified and three per cent for cases approved before the main works contract is let." This goes to show, according to NAO, that the more detailed and advanced the project plan, the more accurate the cost estimate but that, since there is currently no standardised point for entry into the scheme and no defined point for making the initial cost estimate, there will be huge variation in forecasts.

4.4.11. The means of dealing with this issue and improving the accuracy of future cost estimates were outlined as a number of recommendations to the Department of Transport and its constituent levels.

- Define a particular stage of development when schemes are accepted into the national and regional programmes, and have estimates produced simultaneously.
- Research and further define contingency factors which, when applied at the time of cost estimation, can minimise the degree of cost overrun.
- Once completed, make the data on unit costs available to all vested parties, and allow for better information sharing in general between the Department of Transport, the Highways Agency and Local Authorities.

4.4.12. According to NAO (2007), the Highways Agency retrospectively revised the forecasts of their already completed TPI projects in accordance with the new guidelines so that they are comparable with the rest. They found that the inclusion of VAT, inflation and a contingency for under-estimates greatly improved the accuracy of the forecast in relation to actual costs (see Figure 32 below for a graphic depiction). Six percent of cost variation remains unexplained.

Figure 32: Actual vs. retrospectively adjusted forecast costs for UK road projects



Source: National Audit Office (2007), "Department for Transport: Estimating and Monitoring the Costs of Building Roads in England", HC 321 Session 2006-2007, London, July

4.5. Political economy theories of cost overruns and delays

4.5.1. This category of explanation for overruns/delays is more recent and addresses the possibility that delays and overruns are the result of deliberate misinformation. In other words, that project planners and promoters misrepresent timescales and cost/benefit projections in order to win favour for the project and get it started.

4.5.2. Important contemporary studies on the political economy of overruns/delays are reported in Flyvbjerg et al (2002) in respect of project costs and Flyvbjerg et al (2005) in respect of demand forecasts (which determine expectations about future benefits). The tendency for misrepresentation can be reduced but, arguably, never eliminated through accountability measures.

4.5.3. Flyvbjerg et al (2003), in their report on their study of 258 transport infrastructure projects completed between 1927 and 1998, observed that "no learning appears to be taking place" in that cost underestimation and subsequent cost overruns "are allowed to continue unchecked decade after decade". In other words, project promoters, forecasters and decision-makers appear not to be learning from past experience because cost underestimation and subsequent overruns have not decreased over time.

4.5.4. The authors go on to state that:

"The behaviour of promoters and forecasters invite speculation that the persistent existence over time and space and project type of significant and widespread cost escalation is a sign that an equilibrium has been reached where strong incentives and weak disincentives for cost underestimation and related escalation may have taught project promoters that cost underestimation pays off. If this is the case, cost underestimation and escalation must be expected and must be expected to be intentional."

4.5.5. Flyvbjerg et al (2002) tested this explanation of cost overruns and, as reported in Flyvbjerg et al (2003)

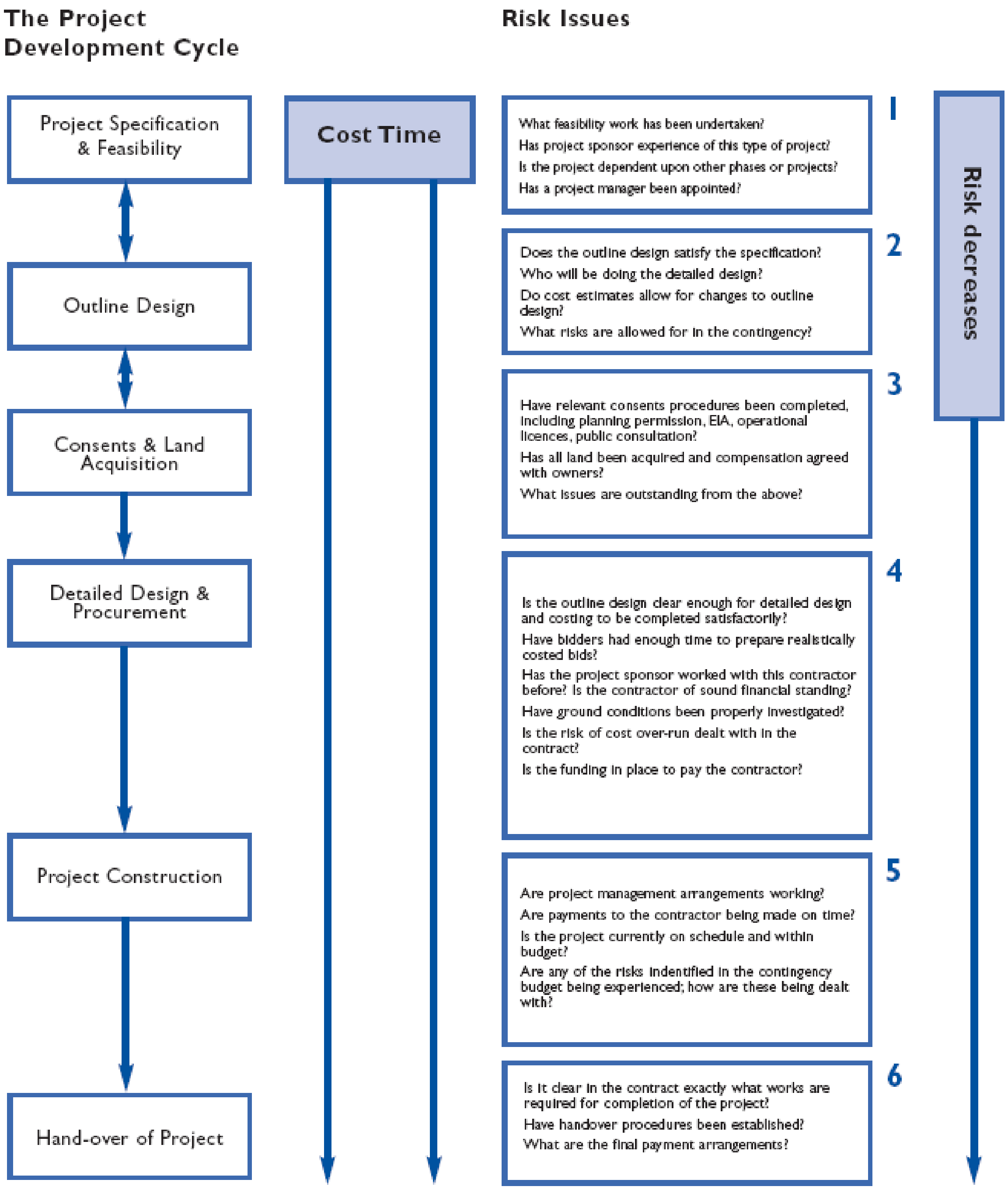
"…found that cost underestimation and escalation indeed appear to be intentional and appear to be part of power games played by project promoters and forecasters aimed at getting projects started. Cost underestimation is used strategically to make projects appear less expensive than they really are in order to gain approval from decision-makers to build the projects. Such behaviour best explains why cost escalations are so consistent over time, space and project type." [39]

4.6. The role of ex ante risk assessment

4.6.1. We already set out the importance of developing more robust understandings and assessments of the risks involved in an infrastructure project as a means of addressing optimism bias. A framework for ex ante risk assessment was also provided in the 1998 Guide by DG XVI (now DG REGIO). This framework tracks risk issues through all of the main stages of the project life-cycle from project specification and feasibility to hand-over. The diagrammatic representation of this framework is re-presented in Figure 33 below.

[39] These findings are consistent with those in Wachs (1986, 1989, 1990) and Flyvbjerg (1996, 1998).

Figure 33: DG XVI's risk assessment checklist



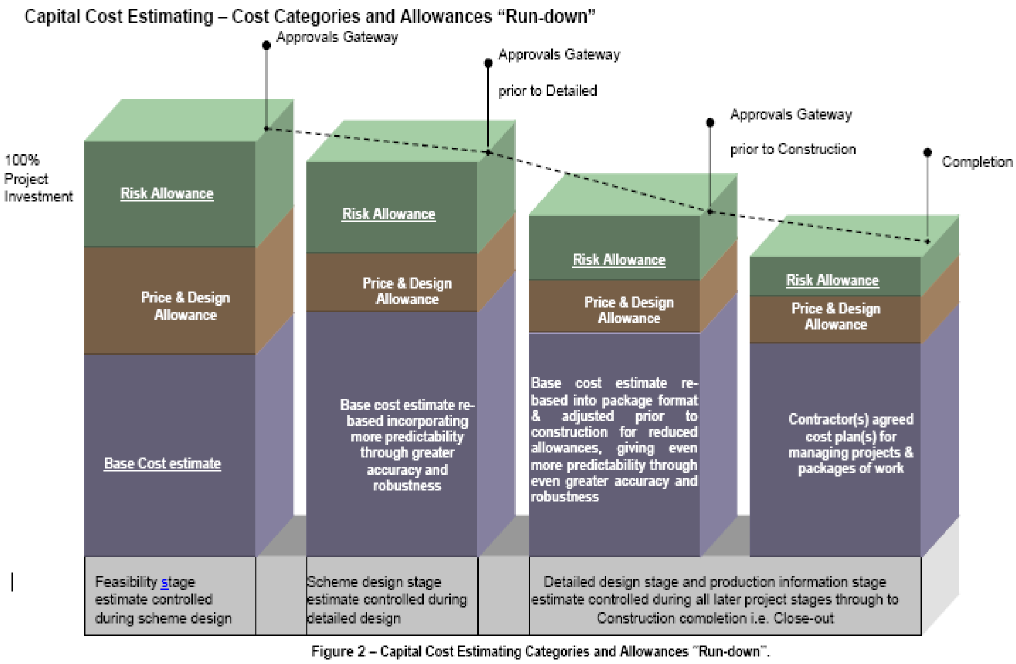
Source: European Commission DG XVI (1998), "Understanding and Monitoring the Cost-Determining Factors of Infrastructure Projects", A User's Guide, Brussels

4.6.2. Mott MacDonald (2002) outlined several critical project risk areas which, their report claims, could form the basis of a useful checklist of areas for risk assessment and management. The top eleven risk areas (along with their magnitudes of influence on observed cost overruns) were identified as follows: (i) inadequacy of the business case (58%); (ii) environmental impact (19%); (iii) disputes and claims (16%); (iv) economic (13%); (v) later contractor involvement in design (12%); (vi) complexity of contract structure (11%); (vii) legislation (7%); (viii) degree of innovation (7%); (ix) poor contractor capabilities (6%); project management team (4%); and (xi) poor project intelligence (4%).

4.6.3. NAO (2007) noted that early projects that used traditional procurement methods were characterised by attractive, low price contractor bids, which turned out to be significantly underestimated over the course of the building phase of projects. This was in contrast to later schemes that were procured on a Design, Build, Finance and Operate (DBFO) basis, where contractors are responsible for design and build, as well as maintenance for 30 years subsequent to completion. Moreover, the use of early contractor involvement (where the final contract cost is only laid out once a detailed design has been completed) was advocated as potentially useful in diminishing cost risk at the planning stage.

4.6.4. Ofwat acknowledges the existence of uncertainty and risk and makes use of tolerance levels within which project costs are expected to fall. For example, a capital investment project might, based on previously attained data of similar completed projects, be assigned a tolerance level of £5m +/- 10%. The nominal amount reflects the likely cost to be incurred. This allowance for risk is built into project estimates, taking into account inflation, optimism bias and overall uncertainty. While the allowance may never be completely eliminated, it is expected to diminish over time as uncertainty is gradually reduced. (See Figure 34 below.)[40]

Figure 34: The Ofwat framework for estimating capital costs



Source: Faithful and Gould (2007), "Development of Capital Expenditure Estimating Assessment", Report for Ofwat, UK.

[40] An interesting question raised by Ofwat is whether uncertainty can be reduced in the future. There are a number of aspects to this. One is the extent to which the industry is 'learning' and, therefore, better able to account for all the factors outlined above. Another is the (efficiency-) incentive regime imposed by the regulator, which has an impact on the willingness of management to better project costs and not to 'lie' about their level.

4.7. Understanding delays and overruns for Work Package 10

4.7.1. In developing the framework to establish explanations for cost overruns and delays in 2000-2006 ERDF co-financed projects, it is necessary to be cognisant of the facts that:

- It is only technical explanations for delays/overruns that are likely to be offered, particularly in the absence of face-to-face meetings
- Political economy explanations are very unlikely to be offered and they would be difficult to establish, also in the absence of face-to-face meetings, but, more importantly, without experience of the system within which the delays/overruns took place.

4.7.2. We have, for the purposes of WP10, adopted and built on the framework for analysing cost overruns formulated by Mott MacDonald (2002), which we found to be the most comprehensive. Their study considered 5 categories of causes of cost overruns and time delays. These were

- Procurement issues, such as disputes/claims, poor planning, methodological errors and poor contractor capabilities.
- Project-specific issues, such as design complexity, site access difficulties, or the degree of innovation.
- Client-specific issues, such as poor project intelligence, inadequacy of the business case or inadequacies of the project management team.
- Project environment, such as location (urban/rural) and terrain (flat/mountainous).
- External influences.

4.7.3. In the following tables, we have used Mott MacDonald's framework to categorise the causes of cost overruns and project delays observed in all of the studies and literature reviewed. This required reconciliation between that framework and those used by other authors and, in doing so, we have endeavoured to preserve the original messages and findings of the other studies. While our system of classification of the significance of different causes under this common framework is not necessarily rigorous or definitive, they do (we hope) reflect the intuitions of the various authors and are intended to be used as a rough indication of the findings of this literature review.

Table 7: Significance of different causes of cost overruns using the Mott MacDonald (2002) framework

Causes of Cost Overruns		European Commission DGXVI (1998)	Mott MacDonald (2002) All project types	Mott MacDonald (2002) Civil Engineering	Flyvbjerg & COWI (2004)	ECORYS Transport (2005)	Mackie & Preston (1998)	Merrow (1988)	Bordat et al. (2004)	Halcrow Fox (2000)
Procurement	Complexity of Contract Structure		**	*				*		
	Late Contractor Involvement in Design	**	**	**	*	*			*	
	Poor Contractor Capabilities	**	**	*					*	
	Government Guidelines		*	*				**		
	Dispute and Claims Occurred	***	***	***	***	***		**	***	
	Information Management	*	**	*						
	Poor Planning/Methodological errors				*		***	**	**	***
Project Specific	Design Complexity		***	**	**	*		**	*	*
	Degree of Innovation		***	**	**	*		***		
	Environmental Impact		***	***	*	*		**	*	
Client Specific	Inadequacy of the Business Case	**	***	***		***	*			
	Large Number of Stakeholders		*	*	**					
	Funding Availability/Problems	*	**	**					*	
	Project Management Team	**	**	**	***	***		*		
	Poor Project Intelligence	**	***	**	***	**		*	**	
Environment	Public Relations		**	**	*	***				
	Site Characteristics	*	**	**	**	*		**	***	
	Permits/Consents/Approvals		*	*				***	*	
External Influence	Political	*	*	*		*	*	**		**
	Economic	**	***	**				**		
	Changes in Legislation/Regulations		***	**	***		*	*		
	Technology	*	***	**			*	**		
	Inflation	*								
	Exchange Rates	*								
	Force Majure	*				*		*	*	

Source: RGL

Key:

*	cause was mentioned or considered in the study
**	cause was considered to be of minor/some significance
***	cause was emphasized as one of high significance

Table 8: Significance of different causes of cost overruns and delays using the Mott MacDonald (2002) framework

Causes of Cost Overruns and Time Delays		ECORYS Transport (2005)	Mott MacDonald (2002)	Mott MacDonald (2002)	Bordat et al. (2004)	Merrow (1988)	Bordat et al. (2004)	National Audit Office (2007)	Mike Nichols (2007)	WSDOT (2005)
Procurement	Complexity of Contract Structure		**	**					*	
	Late Contractor Involvement in Design		**	*			*	***	***	
	Poor Contractor Capabilities		***	***	***	**	*			
	Government Guidelines		*	*				*	***	
	Dispute and Claims Occurred	***	**	***	*	**	***			
	Information Management	*	*	*	*			*	**	
	Poor Planning/Methodological errors				**	*	**	**	***	
Project Specific	Design Complexity		**	**			*	*	*	***
	Degree of Innovation		***	***		***				*
	Environmental Impact	**	***	***			*			**
Client Specific	Inadequacy of the Business Case	***	***	**				**	**	
	Large Number of Stakeholders		**	*						
	Funding Availability/Problems		**	**	*		*	*		
	Project Management Team	**	**	*	*	*		*	**	
	Poor Project Intelligence	*	***	***	*	*	**		*	
Environment	Public Relations	**	**	*						
	Site Characteristics	**	**	***			***			***
	Permits/Consents/Approvals		**	*		***	*		*	*
External Influence	Political	*	***	***		*				
	Economic		**	***				**	**	
	Changes in Legislation/Regulations		**	*		**			*	
	Technology	*	**	**		***				
	Weather					*	*			

Source: RGL

Key:

*	cause was mentioned or considered in the study
**	cause was considered to be of minor/some significance
***	cause was emphasized as one of high significance

Table 9: Significance of different causes of cost overruns and delays using the Mott MacDonald (2002) framework

Causes of Cost Overruns and Time Delays		Langford (2003)	UK Department for Transport (2006)	US Department for Transportation (2003)	Pickrell (1990)	Walmsley and Pickett (1992)	GTZ (2002)
Procurement	Complexity of Contract Structure						
	Late Contractor Involvement in Design	***					
	Poor Contractor Capabilities						
	Government Guidelines		**	*			*
	Dispute and Claims Occurred						
	Information Management	**	***	**	*		*
	Poor Planning/Methodological errors	***		**	***	***	*
Project Specific	Design Complexity	***	*	*	*	*	
	Degree of Innovation			*			
	Environmental Impact					*	**
Client Specific	Inadequacy of the Business Case			*			
	Large Number of Stakeholders	*					
	Funding Availability/Problems					*	
	Project Management Team	**	**		***	**	
	Poor Project Intelligence	*	**		***	*	
Environment	Public Relations						
	Site Characteristics	**		**			***
	Permits/Consents/Approvals			**	*		*
External Influence	Political		*		*		*
	Economic	*	*	**	**	*	
	Changes in Legislation/Regulations		*	**			
	Technology			**		*	*
	Weather						

Source: RGL

Key:

*	cause was mentioned or considered in the study

**	cause was considered to be of minor/some significance

***	cause was emphasized as one of high significance

4.7.4. Our adoption and development of the Mott MacDonald framework is reflected in the relevant parts of our data requests for the sample projects where we have requested respondents to rate what they believe to be the reasons for delays and cost overruns where they occurred. Respondents can rate factors from the list provided in the data request (see Table 10 below) or by indicating and rating other factors that we have not covered.

Table 10: Extract of data request on delays and cost overruns for WP10 sample infrastructure projects

Level 1	Level 2	Examples
Procurement Issues	Complexity of Contract Structure	Eg Multiple contractors and subcontractors
	Design Changes	Extent of changes in design and scope
	Contractor specific difficulties	Contractor financial difficulties, availability of labour
	Disputes with suppliers and subcontractors	Overruns and delays associated with contractual disputes
	Poor Planning/Methodological errors	Include extent of defects/remedials
Project specific	Design Complexity	Eg difficulties in coordinating different project components
	Degree of Innovation	New technologies
	Environmental Impact	
	Site access difficulties	
	Suspension of works	
	Delays by statutory authorities and/or contractors	
	Late commencement of work	
	Construction period	Eg predominantly winter working, project planned to commence close to winter weather
Client Specific	Inadequacy of the Business Case	Eg changes in scope
	Large Number of Stakeholders	
	Funding Availability/Problems	Costs associated with delays in availability of funds, late payments to contractors
	Project Management Team	Performance of resource level, timely issue of drawings and instructions
Project environment	Public Relations	
	Site Characteristics	Eg unforeseen ground conditions
	Permits/Consents/Approvals	
External issues	Political	Change in Government leading to delays/overruns
	Economic	Booming economy increases costs
	Changes in Legislation/Regulations	Tax rates, import duties
	Technology	
	Inflation	
	Exchange Rates	
	Force Majeure	
	Other (specify)	Weather conditions, instructed acceleration measures

Source: RGL

4.8. Measuring cost overruns and delays in practice

4.8.1. In this subsection, we examine issues that arise in the measurement cost overruns and delays. Establishing robust magnitudes of observed cost overruns will depend on the unit cost definitions and calculation methods adopted, as well as on the quality and comparability of project cost estimates and outturns. Consistency between them is essential in ensuring that differences can legitimately be called cost overruns.

4.8.2. When analysing cost overruns across a range of projects, it is vital to establish consistency between the milestone in the project life-cycle at which cost estimates are taken and the milestone at which actual outturn costs are taken. There are varying practices in the literature, such as:

- The Allen Consulting Group defined four project milestones and considered cost and timing developments based on the full period (original approval to actual final) and a shorter period (contractual commitment to actual final);
- Flyvbjerg et al (2003) took cost estimates as the budgeted construction costs at the time of the decision to build and actual costs as the real, accounted construction costs determined at the time of project completion;
- Bordat et al (2004) defined a cost overrun as the percentage difference between the final contract cost and the contract award amount;
- Hinze and Selstead (1991) measured cost overrun rates as the percentage differences between low bid amounts and the actual incurred cost of these projects.

4.8.3. However, the difficulties in procuring data on cost development in infrastructure projects is, as pointed out in the literature, not without its difficulties. For instance, Flyvbjerg et al (2003) claim that it is very time-consuming and often impossible because:

- Funding and accounting procedures for public sector projects are typically unfit for keeping track of multiple and complex changes that occur in total costs as the projects develop.
- Data for private projects are often classified to keep them from the hands of competitors.
- Data may, in general, be held back by project owners because cost overruns are normally considered somewhat of an embarrassment.

4.8.4. Moreover, Flyvbjerg et al (2003) argued that calculations of cost overruns are likely to be conservative for a number of reasons:

- projects that are well-managed with respect to data availability may also be managed well in other respects, resulting in better-than-average (i.e., non-representative) performance;
- the very existence of data that facilitates performance evaluations may contribute to improved performance when such data are used by project management to monitor projects;
- project managers may have ‘wiggle-room’ to choose and give out data that present their project in a favourable light, for example, by choosing forecast costs that best fit actual costs from the several forecasts that were done.

4.8.5. Ideally, original project files should be acquired, but where this is not possible (and it often isn’t), the second-best methodology of surveys must be used according to Flyvbjerg et al. (2003). The Allen Consulting Group (2007) claimed, on the other hand, that by only using publicly available data they avoided the “criticism that data had been modified because it originated from a source with an interest in either of the procurement methods (PPP or traditional) under question.”

4.8.6. In Flyvbjerg and Cowi (2004), projects for the sample were selected on the basis of data availability and quality, which may, according to the authors, almost certainly have biased the data for several reasons, the most important of which were that:

- Managers of projects with particularly bad track records regarding cost escalation have an interest in not making cost data available (and conversely, managers of good projects may have an interest in making this public).
- Even where managers have made cost data available, they may have chosen to give out data that present their projects in as favourable a light as possible (e.g., by choosing the forecast of costs that best fits the actual costs from the several forecasts that were done).
- Projects that are well-managed with respect to data availability may also be managed well in other respects, resulting in better-than-average (i.e. non-representative) performance for such projects.
- The very existence of data that make the evaluation of performance possible may contribute to improved performance when such data are used by project management to monitor projects.

4.8.7. ECORYS Transport (2005) noted that it is difficult to robustly establish cost overruns due to difficulties in establishing a systematic database on unit costs. This was, in turn, attributed to the wide range of project types, the lack of a common base year for costs, insufficient cost detail to arrive at comparable unit cost benchmarks and too many projects with specific circumstances (for example, differences in the numbers of bridges, in geomorphological conditions and location of projects, resulting in wide variability in expropriation costs).

4.8.8. For the purposes of WP10, cost overruns and time delays will be measured as the differences between the estimates contained in the ERDF applications and actual outturn costs and timescales. However, as noted in Section 2.5 above, there is no guarantee that the ERDF applications constitute an appropriate milestone in the project life-cycle for cost estimates, or that the ERDF applications represent a common milestone for all projects. In some cases, cost overruns might be due simply to later re-forecasting, which will need to be taken into account in our analysis.

4.9. Conclusions

4.9.1. The occurrence of cost overruns and delays in large infrastructure projects is well-documented in the literature, and three main categories of explanation are offered, namely psychological theories, political economy theories and technical theories.

4.9.2. Psychological theories explain cost overruns in terms of the planning fallacy and resulting optimism bias in the estimation of costs, completion times and risks. The work on decision-making under uncertainty (by Kahneman et al) has prompted the development of the concept and applied methods of Reference Class Forecasting, incorporating the use of optimism bias uplifts to improve the accuracy of forecasts.

4.9.3. For WP10, it might be possible to derive a set of indicative optimism bias uplifts based on what we observe about the sample projects, which might, in turn, be used in conjunction with Member States to improve future ex ante cost, completion time and risk forecasts.

4.9.4. Political economy theories address the possibility that delays and overruns are the result of deliberate misinformation. While it is unlike to be possible to robustly determine its existence in the sample of projects being examined in WP10, it may be possible to comment on the issue if there is sufficient anecdotal evidence.

4.9.5. Technical theories of overruns and delays are the most common and receive the greatest attention in the literature. The most common technical explanations found in work by and for the European Commission include:

- Design changes (resulting from inadequate project definition in the first place);
- Input price inflation due to delays; and
- Site/contractor issues.

These, in turn, have been traced back to poor project management and preparation and the results are mirrored in studies on UK road projects, namely Nichols (2007) and NAO (2007).

4.9.6. Flyvbjerg et al (2004) also found statistically significant relationships between cost overruns and the length of project implementation phases for all transport project types, between overruns and project size for fixed link projects (bridges and tunnels) and between overruns and weak accountability measures, which , they argue, are more important than the ownership issue.

4.9.7. For WP10, however, we have adopted and developed the framework formulated by Mott MacDonald (2002) for the assessment of cost overruns and time delays in the sample of projects being considered.

4.9.8. Finally, the importance of adequate ex ante risk assessment that builds on an understanding of the technical explanations for cost overruns cannot be stressed enough. Using the frameworks established in EC DGXVI (1998) and Mott MacDonald (2002) and the issues raised in NAO (2007), we hope to examine and draw out lessons for future ex ante risk assessment. A question that might well be explored is the idea of shifting some of the risk of cost overruns onto project promoters, thereby encouraging better forecasting and risk assessment.

5. Defining and measuring “cost per job created”

5.1. Introduction

5.1.1. This part of the Report examines the issues relevant to the assessment of the result efficiency of productive investments. It is structured as follows:

- Section 5.2 considers the notion of cost per job created;
- Section 5.3 examines issues in the measurement of employment effects;
- Section 5.4 looks at available evaluations of job creation programmes in Europe;
- Section 5.5 looks at available evaluations of job creation programmes from the USA;
- Section 5.6 considers the same from Canada; and
- Section 5.7 concludes.

5.2. Cost per job created

5.2.1. “Cost per job created” is analogous to the notion of unit cost used for infrastructure projects above. The box in Figure 35 below is re-presented from DG REGIO’s Working Document No. 6 and sets out the reasoning for calculating costs per job created, as well as high-level options for the approach and high-level measurement issues.

Figure 35: Reasoning for measuring cost per job created

Measuring cost-effectiveness: the Cost per job created

Calculating the cost per job for a Structural Fund programme provides a broad measure of financial efficiency and a basis on which the results likely to be achieved/achieved by different interventions can be compared. There are several ways in which the cost per job can be calculated:

- *On the basis of an estimate of gross or net employment effects;*
- *Taking into account all expenditure and, if relevant, just the Structural Fund element.*

Any benchmarks for the cost per job should be treated with caution. In particular, no two interventions or the circumstances in which they take place are exactly the same. For example, more investment will be needed to create permanent jobs through business support measures in a region where SMEs have a high failure rate than in other regions where good survival rates exist.

It is also important that cost per job benchmarks from earlier periods are reviewed because circumstances may have changed. For example, if there has been a change in economic conditions in a region and benchmarks may therefore no longer be relevant.

Source: DG REGIO (2007), “Working Document No. 6: Measuring Structural Funds Employment Effects”, Brussels, March.

5.2.2. For major infrastructure projects, the denominator of the unit cost measures is relatively certain and most of the analysis was concerned with defining, measuring and accounting for changes in the numerator over the project life-cycle. For example, road or rail projects are concerned with fixed lengths of track or pavement or surface areas of bridges and tunnels, the cost of which might increase or decrease for any number of reasons outlined in the previous Sections.

5.2.3. For productive investments, that is, projects that involve direct support to enterprises, it is the denominator that poses the greatest difficulties in terms of defining, measuring and analysing the unit cost definition. All of the attention is focused on the "outputs" (jobs created) of the investment for a given level of investment. For infrastructure projects, we were concerned with patterns in the levels of investment for given levels of output.

5.2.4. ERDF provides investment aid to private enterprises with the primary aim of improving competitiveness through various instruments such as, for example R&D, technological transfer, investment in more environmentally friendly technologies

5.2.5. Annex IV of Working Document No. 6 sets out the interventions that are most likely to have significant employment effects, while noting that the nature of employment effects will vary according to the nature of the Structural Fund intervention. These interventions are:

- Physical infrastructure;
- Business support;
- Training and skills development;
- Support for R&D, technology transfer, innovation etc.; and
- Community economic development and social economy.

5.3. Defining 'employment effects'

5.3.1. The denominator of the unit cost measure ("cost per jobs created") for productive investments are derived from what is termed in the literature 'employment effects'. The accurate measurement of employment effects poses the greatest challenge in evaluating, on an individual and comparative basis, the financial efficiency of productive investments made through the Structural Funds. Although these measurement issues are beyond the scope of Work Package 10, we considered it useful to briefly set out the issues involved in order to ensure a fuller understanding of employment effects measurement.

5.3.2. Annex I of Working Document No. 6 recommends a relatively limited number of "core" indicators to measure Structural Fund Employment Effects. While some are common, others have to be adapted in accordance with the different priorities of programmes. These core indicators are:

- "**Number of jobs created** – new jobs that are created directly by Structural Fund intervention within three years of the completion of works. These may be temporary or permanent;
- **Number of jobs maintained** – existing jobs that are at risk and would be lost without Structural Fund intervention;
- **Number of beneficiaries finding employment due to intervention** – number of beneficiaries that have found employment within some time after the completion of the intervention (usually 6 months after but other time spans are also possible);
- **Number of beneficiaries whose qualifications have improved due to interventions** – people that benefited from the interventions and upgraded their qualifications leading to better quality of jobs they undertake."

5.3.3. The first, "number of jobs created" are alternatively labelled "green" jobs created. Measuring this in terms of full-time equivalents (FTEs) should, according to the Commission, be a priority for ERDF programmes.[41] The scope of WP10 requires us to focus on this measure.

5.3.4. The second, "jobs maintained" presents difficulties because all jobs in an undertaking tend to be counted rather than just those jobs that were at risk. For the third, the Commission highlighted the importance of capturing the enhancement of the contribution of existing employees to the relevant undertaking (which might be called 'jobs improved'), thereby also improving the future employment prospects ('employability') of those already in work. However, these measures are beyond the scope of WP10.

5.3.5. Other important distinctions that need to be taken into account in measuring employment effects include:

- Permanent and temporary jobs;
- Direct and indirect effects; and
- Gross and net effects.

The distinction between permanent and temporary jobs

5.3.6. It is important to distinguish between permanent and temporary jobs. Annex I defines permanent jobs as "sustainable (or durable) employment (i.e. jobs resulting from an intervention which will continue in the absence of public support)". Temporary jobs are defined as "employment of transitory nature (i.e. jobs which cease to exist when the funding stops)".

5.3.7. The CSES (2006) Report (which formed the basis for Working Document No. 6) added that temporary jobs last for more than six person-months but end with the period of assistance, while permanent jobs must last for two years beyond the programming period in order to be recorded as a permanent employment effect.

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[41] Part-time jobs are defined in Annex I as jobs that provide employment for less than half the working week.

5.3.8. Temporary jobs are, according to the Commission, normal in the implementation phase of projects, while the former are more common in the operational phase. The measurement of employment effects through the product 'life-cycle' (of which implementation and operation can form only part) is described in

5.3.9. If temporary and permanent jobs are reported in the aggregate, Annex I of Working Document No. 6 suggests that it is more accurate to use expected 'job-years' as a unit of measurement, rather than simply counting the number of jobs created.

5.3.10. Cost of job per work-year is a useful measure that aggregates these two kinds of employment effects. Roy and Wong (1998) defined a unit cost measure of the cost of jobs per work-year. This is covered in more detail in the next Section.

The distinction between direct and indirect employment effects

5.3.11. According to the Commission, for all the types of effects defined in section 5.3 above, there is a distinction between direct and indirect employment effects.[42]

5.3.12. Direct employment effects are 'outputs' of a programme and should have a clear first-order causal relationship with the projects. For example, a new manufacturing plant may provide employment for an additional 500 employees – this is a direct effect.

5.3.13. Indirect employment effects are the secondary ('knock-on') effects and should be counted in the 'results' of a programme. Employees may then spend a portion of their income in the local region, boosting demand, encouraging firms to increase output and generating new jobs – these are indirect effects, or more specifically, an income multiplier effect (more on this later).

The distinction between gross and net effects

5.3.14. The body of Working Document No. 6 presents the formulaic relationship between gross job creation and net job creation.[43] This re-presented in the box below.

NET JOBS = GROSS JOBS x (1 – DEADWEIGHT) x (1 – DISPLACEMENT AND SUBSTITUTION) x (1 + SUPPLIER MULTIPLIER + INCOME MULTIPLIER)

5.3.15. The parameters of this formula can be explained as follows:

- *Deadweight*: the proportion of jobs created which would have been created anyway without Structural Fund assistance. The converse of deadweight is 'additionality' (also known as 'incrementality'), the proportion of jobs that would not have been created without Structural Fund assistance.

- *Displacement and substitution*: occurs when the employment effects of Structural Fund assistance have the unwanted side effect of displacing or replacing other non-assisted workers.

[42] This distinction and other related issues are addressed in Annex II of Working Document No. 6.
[43] This analysis is also relevant to the measurement of what are defined in Annex II as "Impacts = mid/long term employment effect". These, along with primary (direct) and secondary (indirect) employment effects help to define the "intervention logic".

- *Supplier and income multipliers*: these relate to the additional non-displacing jobs created by Structural Fund assistance and are defined as "effects which spread throughout the economy, society or environment, beyond the direct beneficiaries of the public intervention". Definitions for each of the multipliers:
    - o Income multiplier – a measure of impact of job creation on incomes, a part of which is spent in the local economy, generating demand for goods and services, encouraging firms to increase or maintain output and, indirectly, further jobs.
    - o Supplier multiplier – where an assisted business or firm puts in an additional order for local goods and services, resulting in a second-round of job creation.

5.3.16. The following table, a re-presentation from the CSES (2006) Study shows a worked example of the calculation of net employment effects.

Figure 36: Worked example of the calculation of net employment effects

Steps	Calculations
Outputs and results:	
Financial inputs	Euro 10 million
Outputs	100 SMEs receive assistance
Results	500 gross jobs created of which 400 are permanent and 100 temporary = 450 gross FTE jobs created
Cost per gross job	Euro 20,000 per gross job (euro 10 million/500 gross jobs)
Impacts:	
Additionality	50% of the SMEs would not have gone ahead with their projects without the Structural Fund assistance. Net additional jobs = 225 (450 x 50%)
Displacement	20% of the net additional jobs created by the SMEs displace jobs in non-assisted firms. Net additional non-displacing jobs created = 180 [(225) – (225 x 20%)]
Indirect effects	Income multiplier of 1.3 (at regional level) means that in addition to the 180 directly created additional non-displacing jobs, a further 54 jobs are created indirectly. Supplier effects of 1.1 lead to further indirect effects equivalent to 18 jobs.
Net jobs created	252 net jobs (225 net additional – 45 displacement + (54 + 18) indirect
Net cost per job	Euro 39,680 (euro 10 million/252 net jobs)

Source: CSES (2006), "Study on Measuring Employment Effects: Final Report", Kent, England, June.

5.3.17. Roy and Wong (1998) found the following in respect of Canadian job creation programs:

- Job creation incrementality is low in the private sector relative to the public and non-profit sectors;
- The role of direct job creation programs in developing skills and improving the employability of program participants after the program ends remains an open question;
- More consistent and new evaluation approaches are needed to assess the net impacts of job creation programs; and
- Incrementality ratios of Canadian job creation programs compare favourably with those reported in other OECD countries, reducing job displacement through more targeted programming.

5.3.18. On the specific issue of incrementality, the authors noted that estimates have usually been based on participant employer and employee surveys, which are subjective and probably unreliable. According to the authors:

"Where possible, macroeconomic analysis should be considered as a way to establish the impact of job creation programs on the total number of jobs. In future evaluations of job creation programs, it is imperative that a standard outcomes approach be adopted that considers four accountability measures: (a) net cost per net job created; (b) net cost per person off the unemployment count; (c) reduction in the unemployment count as a percent of persons supported; and (d) net jobs created as a percent of those supported."

5.3.19. Roy and Wong (1998) also highlighted the tension between competing objectives "embedded in several Canadian programs", while programmes in the UK and US have kept counter-cyclical and (labour market) structural elements distinct and separate.

5.4. Evaluation of job creation programs in Europe

5.4.1. The CSES (2006) Study provided a summary of recent Structural Fund evaluation studies. The cost per job estimates are presented in Figure 37 (copied from the Study) below, which, unless otherwise indicated, relate to the gross Structural Fund cost per job.

Figure 37: Cost per job results from CSES (2006)

Type of intervention	Cost per job estimates	Averages
All types of interventions (jobs created or maintained)	€23,700 per new job/€11,500 per job maintained (Ex Post Evaluation, Sweden 1995-99 Objective 6 Programmes); €13,700 gross new job/22,100 net (Ex Post Evaluation of 1994-99 Objective 2 Programmes); €7,000 per new job/€6,700 per job maintained (Mid Term Evaluation of 2000-06 East of England Objective 2)	€14,800 per gross job created/€8,900 job maintained
Physical infrastructure (temporary construction related jobs)	€25,000 per gross temporary job (Thematic Evaluation of Structural Fund Impacts on Transport Infrastructures, 2000) €123,000 gross temporary job created (DATAR, 2006)	€74,000 per temporary job created
SME support measures (jobs created or maintained)	€17,500 job created (Thematic Evaluation of Structural Funds on SMEs, 1999) €65,000 (DATAR, 2006); €2,000 per job created (Business Incubation - International Case Studies, OECD, 1999); €4,500 cost per job created /€4,000 per job (Benchmarking of Business Incubators, 2002); €7,600 per job created (Evaluation of Regional Grants in England, NAO, 2003)	€19,320 per gross job created
Average		**€36,000 per job**

Source: CSES (2006), "Study on Measuring Employment Effects: Final Report", Kent, England, June.

5.5. Evaluation of job creation programs in Canada

Definitions and measurement of "cost per job created"

5.5.1. Roy and Wong (1998) focused on the cost per job created as an evaluation measure of the efficiency of a program.[44] The ratio of program expenditure to the number of jobs created provides only a crude measure of cost per job, however. Two other factors need to be considered and appropriate adjustments made. They are job duration and employment incrementality.

5.5.2. Recall from above that the 'incrementality' (or "additionality") ratio is the proportion of jobs that would not have been created without Structural Fund assistance. And that this is the converse of the deadweight, the proportion of jobs created which would have been created anyway without Structural Fund assistance.

[44] Roy and Wong (1998) assessed Canadian Federal Government expenditure on job creation. They did not include expenses incurred by employers or sponsors in creating and maintaining a jobs nor programme administration.

5.5.3. Roy and Wong (1998)'s defined employment effects in terms of job-years, which as noted above is favoured by the Commission to take account of the permanent/temporary job creation ratio. They used this to measure an "incremental cost of job creation" (C) as:

$$C = (P \,.\, 52) / (J \,.A.\, \alpha)$$

where

P = program expenditure in time, t
J = number of jobs created in time t, irrespective of job duration
A = average duration of a job in weeks
α = incrementality ratio

5.5.4. Data on P, J, A, and α were obtained from program evaluation studies, and where this information was not complete, program administration data and Departmental Annual Reports were used to supplement the information. Deadweight might be revealed from survey feedback from beneficiaries and quasi-experiments involving comparisons between assisted and non-assisted groups and rejected applications.

5.5.5. Roy and Wong (1998) asserted that the standard and most acceptable methodology that is applied to estimate the incremental program impact consists of using a control or comparison group. However, the application of this kind of analysis requires longitudinal data for program participants as well as comparable non-participants which, unfortunately, is not always available.

5.5.6. A less rigorous method consists of self-assessed incrementality through sample surveys that ask program participants whether they would have found jobs if the program had not existed. This measure of incrementality is necessarily subjective. However, the element of subjectivity can be reduced to some extent by designing survey questionnaires from diverse angles.

Benchmarks

5.5.7. According to Roy and Wong (1998) "precise amounts spent on direct job creation programs are hard to come by and are difficult to construct" but that recent (at that time) OECD studies had helped to fill the gap somewhat.

5.5.8. Figure 38 re-presents Table 5 from Roy and Wong (1998), which is a summary of the estimates of gross costs of direct job creation programs.[45] It also includes incrementality ratios for the various programs.

[45] Direct job creation programs were defined by the authors as those designed "to create jobs that are of a short-term nature to reduce the number of unemployed, reduce dependence on social programs, and to some extent stimulate the economy to create jobs on a longer term basis."

Figure 38: Estimates of gross cost per job and incrementality

Table 5
Estimates of Gross Cost Per Job and Incrementality By Direct Job Creation Program

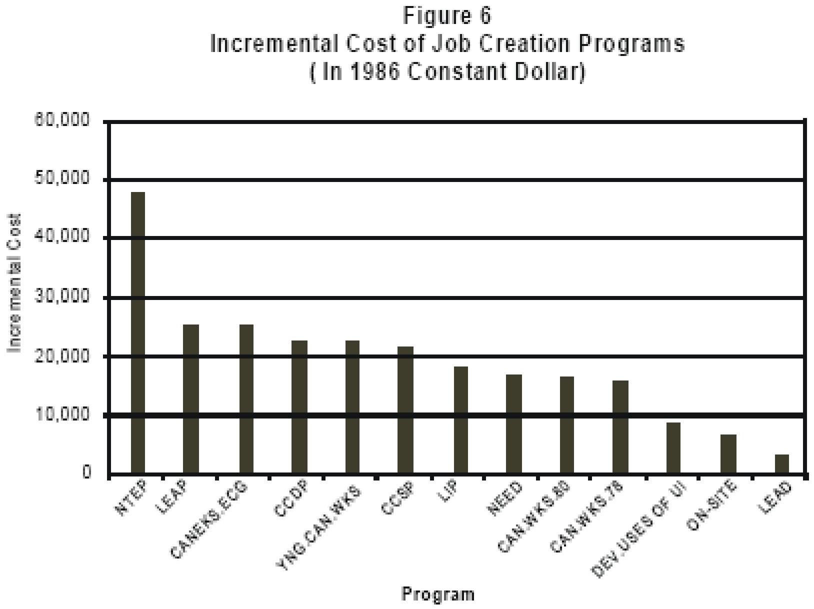
Program	Program Expenditure (current dollars)	Jobs Created	Average Job Duration	Gross Cost per Work-Year (current dollars)	Incrementality
LIP	$80 Million (1974-75)	31,160	20 weeks	$6,675	78%
LEAP	$59 Million (1978-79)	8,877 (1980-81)	33 weeks (1980-81)	$10,600 (1980-81)	65% (average)[1] (1980-81)
Canada Employment Strategy:					
CCDP	$110 Million (1980-81)	20,000	25 weeks	$11,440	63% (average)[2]
CCSP	$11 Million (1980-81)	1,000	56 weeks	$11,000	63% (average)
NTEP	$7 Million (1980-81)	700	48 weeks	$10,000	29%
LEAD	$2.2 Million (1985-86)	1,168	51 weeks	$1,900	45%
Canada Works:					
General (1977-78)	$254 Million	65,900	25 weeks	$8,100	80 to 90%
General (1979-80)	$223 Million	40,000	29 weeks	$10,000	80 to 90%
Canada Works:					
Growth Component	$55 Million (1978-80)	6,300	33 weeks	$13,700	78%[3]
Young Canada Works	$44 Million (1977)	30,000	10.5 weeks	$7,260	Reduced unemployment rate among students returning to school by 2 to 3 percentage points[4]
Employment Tax Credit Program	Not applicable[5]	66,000 (1978-80)	24 weeks	$13,500	29% (average) incrementality factored into cost
Developmental Uses of UI for Job Creation	Not applicable[6]	--	13 weeks	$8,500 (1983)	Incrementality included in cost[7]
On-Site	Not available	Not available	19.5 weeks	$7,540 (1992-94)[8]	76%
NEED[9]	$464Million (1982-83)	88,000	23 weeks	$11,900	74%

Source: Roy, Arun and Ging Wong (1998), "Direct Job Creation Programs: Evaluation Lessons", Canada.

5.5.9. The authors noted wide variations in expenditure, the number of jobs created, the average job duration and the average incrementality ratios across the programs.

5.5.10. Figure 39 re-presents figure 6 from the same paper, which shows net or incremental costs of the programs in constant 1986 Canadian dollar amounts.

Figure 39: Incremental cost of job creation programs in Canada



Source: Roy, Arun and Ging Wong (1998), "Direct Job Creation Programs: Evaluation Lessons", Canada.

5.5.11. The results show, according to the authors, that the cost-effectiveness of direct job creation programs has improved over time. This is attributed to "the continuous process of evaluation and assessment of programs, and modifying them to enhance the elements that worked."

5.6. Evaluation of US EDA job creation programs

5.6.1. Glasmeier (2002) analysed job creation projects (involving public works and "defense adjustment construction") funded by the US Economic Development Administration (EDA), in order to establish whether there were differences in job creation costs between urban and rural areas.[46]

5.6.2. The author examined the incidence of these projects and the cost per job in rural (population < 20,000), small urban (20,001 – 49,999) and urban (> 50,000). The analysis indicated significant differences in cost per job created in different sized communities.

5.6.3. In rural counties, average EDA expenditure per project was over twice that in urban counties, with costs in small urban counties being comparable with that in rural counties.

[46] EDA public works projects included the renovation or construction of buildings, the expansion or creation of industrial parks, the building of roads, the renovation, expansion, or construction of water and sewer systems, and the renovation or construction of marine and tourism infrastructure (i.e., piers, ports etc.). "Defense adjustment construction" appears to have involved infrastructure projects, primarily public works, with some defense adjustment.

5.6.4. Cost per job variations were also observed by year of project completion and by geography:

- In 1993, the cost per job in rural was lower than in urban areas, which contrasts with 1990 cases where the average cost per job in rural areas was nearly three times as high as that for urban areas;
- A detailed regional breakdown highlighted differences across rural areas and between urban and rural areas.

  "For example, average cost per job in the Census Bureau's Mountain States region was almost ten times higher in rural areas than in urban areas."

  However, the author noted that small cell counts and uneven size groupings diminished the ability to make statistical generalisations.
- The author's first look at cost per job comparisons was presented in Table 9 of her paper, which is re-presented below in Figure 40 below.

Figure 40: Average cost per job for US construction projects

Table 9
Average Cost per Job for Construction Projects, Based on Modified Beale Population Designations[a]

County Type[b]	Cost per Job by Funding Type[c]	Projects[d]	Avg. C/J[e]	ANOVA for equality of means[f]
Rural	EDA Funding	150	$6,157	0.052[g]
Small Urban	EDA Funding	48	$5,596	
Urban	EDA Funding	49	$2,982	
Rural	All Funding	150	$11,776	0.103[h]
Small Urban	All Funding	48	$13,886	
Urban	All Funding	49	$6,071	

[a] Data obtained from Rutgers, 1997 and 1999 reports.
[b] Classification of the data by area population size was based on the Beale Code system, developed at the Economic Research Service. This classification scheme has 10 categories. We broke down areas below 50,000 persons to determine whether there were differences in size of place and expenditure patterns. County classification based on a modified Beale classification code = 0–20,000 rural; 20,001–49,999 small urban; 50,000+ urban.
[c] "All Funding" includes EDA funding, in addition to private, local , state, and other federal expenditures on projects.
[d] N=247. Population is drawn from the 1997 and 1999 reports (excluding 13 projects without FIPS codes).
[e] Average cost per job is calculated from the original Rutgers data, using figures from the completion of the project.
[f] ANOVA (Analysis of Variance) compares multiple sample means, to detect significant difference in their values.
[g] Average cost per job is significantly different among the three county types for EDA funding, at the 90% confidence level.
[h] There is no significant difference regarding average cost per job among the three county types for all funding, at the 95% confidence level.

Source: Glasmeier, Amy (2002), "Cost per Job Associated with EDA Investments in Urban and Rural Areas", Economic Development Administration, US Department of Commerce.

5.6.5. The table in Figure 40 shows significant differences in the cost per job created in different sized communities. These could, according to the author, be the result of a number of factors, including:

- Compositional differences associated with the purpose of funding and type of projects funded;
- Conversely, cost per jobs in rural counties may be generally higher due to the compositional differences in investments or wage cost differences.

5.6.6. Further more detailed results are presented in Figure 41 and Figure 42 below, which are a re-presentation of Tables 10 and 11 respectively from Glasmeier (2002)'s paper.

Figure 41: Cost per job procured from Glasmeier (2002)

Table 10
Average Cost per Job by Year of Completion, by County Type[a]

Year of Completion[b]	County Type[c]	Cost per Job by Funding Type[d]	Projects[e]	Avg. Cost per Job[f]	ANOVA for equality of means[g]
1993 Completion	Rural	EDA Funding	34	$6,905	0.919
	Small Urban	EDA Funding	11	$7,441	
	Urban	EDA Funding	9	$7,399	
	Rural	All Funding	34	$12,333	0.855
	Small Urban	All Funding	11	$11,402	
	Urban	All Funding	9	$13,163	
	Total Projects		**54**		
1990 Completion	Rural	EDA Funding	116	$5,938	0.032[h]
	Small Urban	EDA Funding	37	$5,047	
	Urban	EDA Funding	40	$1,988	
	Rural	All Funding	116	$11,612	0.085[h]
	Small Urban	All Funding	37	$14,624	
	Urban	All Funding	40	$4,475	
	Total Projects		**193**		

[a] Data obtained from Rutgers, 1997 and 1999 reports.
[b] Data obtained from Rutgers reports.
[c] County classification based on modified Beale population codes = 0–20,000 rural; 20,001–49,999 small urban; 50,000+ urban.
[d] "All Funding" includes EDA funding, in addition to private, local, state, and other federal expenditure on projects.
[e] N=247. Number of EDA projects in each population category for which geographic data were provided. Excludes 23 projects without FIPS codes.
[f] Average cost per job is calculated from EDA survey data, using figures from the completion of the project.
[g] ANOVA (Analysis of Variance) compares multiple sample means, to detect significant difference between the average cost per job between rural, small urban, and urban places. A value under 0.10 indicates a significant difference in the average cost per job among the three county types, at the 90% confidence level.
[h] Average cost per job values are significantly different among the three county types, at the 90% confidence level.

Source: Glasmeier, Amy (2002), "Cost per Job Associated with EDA Investments in Urban and Rural Areas", Economic Development Administration, US Department of Commerce.

Figure 42: Average cost per job by year of completion, by grant type

Table 11
Average Cost per Job by Year of Completion, by Grant Type[a]

Year of Completion	Grant Category[b]	Average Cost per Job by Funding Type[c]	Projects[d]	Average C/J[e]	ANOVA for equality of means[f]
1993 Completion	Buildings	EDA Funding	14	$12,685	0.016[g]
	Industrial Parks	EDA Funding	3	$16,462	
	Marine/Tourism	EDA Funding	1	$8,815	
	Roads	EDA Funding	5	$1,313	
	Water/Sewer	EDA Funding	31	$4,544	
	Buildings	All Funding	14	$21,228	0.006[g]
	Industrial Parks	All Funding	3	$31,017	
	Marine/Tourism	All Funding	1	$11,754	
	Roads	All Funding	5	$2,102	
	Water/Sewer	All Funding	31	$8,087	
1990 Completion	Buildings	EDA Funding	24	$7,184	0.782
	Industrial Parks	EDA Funding	57	$4,540	
	Marine/Tourism	EDA Funding	10	$6,414	
	Roads	EDA Funding	17	$4,525	
	Water/Sewer	EDA Funding	85	$4,503	
	Buildings	All Funding	24	$20,591	0.370
	Industrial Parks	All Funding	57	$8,445	
	Marine/Tourism	All Funding	10	$12,067	
	Roads	All Funding	17	$8,138	
	Water/Sewer	All Funding	85	$9,795	
Total Projects			**247**		

[a] Data obtained from Rutgers, 1997 and 1999 reports.
[b] Grant categories, as defined by the original Rutgers database (1997 information) with the exception of the 1993 completion programs. The 1993 completion data in its 'raw form' contained an excessive number of grant types (27 types of grant for 57 records). To simplify, the 27 "Grant Types" were synthesized into five broad grant type based on the Public Works Project Grant categories.
[c] "All Funding" includes EDA funding, in addition to private, local, state, and other federal expenditures on projects.
[d] N=247. Population is drawn from the Rutgers 1997 and 1999 reports. Excludes 13 projects without FIPS codes.
[e] Average cost per job is calculated from the original Rutgers data, using figures from the completion of the project.
[f] ANOVA (Analysis of Variance) compares multiple sample means, to detect significant difference between the average cost per job between the grant categories, based on EDA program type. A value under 0.05 indicates a significant difference in the average cost per job among the grant categories.
[g] Average cost per job values are significantly different among the grant categories, at the 95% confidence level.

Source: Glasmeier, Amy (2002), "Cost per Job Associated with EDA Investments in Urban and Rural Areas", Economic Development Administration, US Department of Commerce.

5.6.7. Further results were provided by year of completion and by Census Region. These differences are explained by the author in terms of the differential use of grants by communities depending on their economic base and their geographic location. According to Glasmeier (2002), "this difference significantly affects the measurement of the average cost per job and helps to explain the aggregate pattern previously identified."

5.6.8. Glasmeier (2002) summarised the results as follows:

- Projects completed in 1990 generally exhibit higher costs in rural versus urban areas, while projects completed in 1993 generally exhibit lower costs in rural versus urban areas
- Projects competed in 1990 also show significant differences in cost per job by project type in urban versus rural areas.

  "For example, industrial buildings, industrial parks, and water and sewer projects post different cost per job estimates across the two data sets."

  This difference may be the result of "differences in kind" among the projects as well as spatial variation across location.

5.6.9. The author also found that there appeared to be some evidence that projects in low-unemployment areas were more costly on a per job basis than in high-unemployment areas, which may reflect

> "the difference in labor market conditions and relative tightness of labor markets, thus leading to higher labor costs overall."

5.7. Conclusions

5.7.1. Work Package 10 is also required to measure unit costs per job created by productive investments, that is, projects involving direct support to private enterprises. Literature on the issue is less comprehensive than in the case of infrastructure, especially for European projects.

5.7.2. Likewise, we have only been able to produce limited benchmarking results for this type of investment project. (See Section 6 below.) However, when we calculate costs per job created for our sample, we'll endeavour to find relevant benchmarks against which to compare them.

6. Results of our benchmarking exercise

6.1. Introduction

6.1.1. Cost benchmarks for various infrastructure projects have been compiled from a range of sources, including:

- The World Bank Road Cost Knowledge System (ROCKS) database.
- www.roadtraffic-technology.com – a website offering information on the road traffic industry.
- www.railway-technology.com – a website offering information on the rail industry.
- www.water-technology.net – a website offering information on water infrastructure facilities.
- www.power-technology.com – a website offering information on the power industry.
- www.wsdot.wa.gov – the Washington State Department of Transport website.
- www.lightrailnow.org – a website supporting efforts to develop light rail systems world wide.
- http://lrt.daxack.ca – The Toronto LRT information page.
- www.welfi.info – a wind energy local financing project website
- www.aitricity.com – the website of a company which develops and operates wind farms.
- www.vattenfall.com – a German energy company website.
- UIC – International Union of Railways
- Bent Flyvbjerg et al., Comparison of Capital Costs per Route-Kilometre in Urban Rail, 2008
- Transek Consultants, Comparison of Costs between Bus, PRT, LRT and Metro/rail, 2003
- Data provided by Faber Maunsell – Consultant Engineers
- Data provided by Prof. Bent Flyvbjerg – An expert advisor to this project

6.1.2. Project costs included in this exercise include;

- Level 1 Total Road construction costs
- Level 2 Road construction costs
    - Bridges
    - Tunnels
    - Carriageways
- Level 1 Total Railway project costs
- Level 2 Railway construction costs
    - Tracks
- Level 1 Total Metro/Underground project costs
- Level 1 Total Light Rail project costs
- Level 1 Total Wind farm project costs
- Level 1 Total Water treatment and supply project costs

6.1.3. For a number of reasons, our benchmark data should be used with caution:

- Project cost definitions vary and it has not been possible to ensure compatible definitions are used (e.g. some projects include taxes, others do not)
- Source data is expressed in a number of different currencies and was incurred in different years. We have converted all costs to constant 2007 Euros using a range of different indices and exchange rates.

6.1.4. Unit construction costs do vary significantly with projects, reflecting a number of different factors. So whilst comparing one project's costs against others can be a useful exercise, it cannot be relied on as a basis for testing the accuracy of a particular project cost estimate.

6.2. Existing benchmarks for infrastructure project costs

6.2.1. We have sought to identify and gather data from relevant cost benchmark databases, investigating a wide range of potential sources of databases including government ministries, industry/market organisations and multi-lateral agencies. In most cases, however, where cost databases are maintained, they are for disaggregated input costs, such as concrete, steel or labour rates. These databases are used to prepare bottom-up cost estimates but do not provide any total or component project costs suitable for benchmarking for WP10.

6.2.2. As a result, we have instead compiled a survey of individual project costs from a range of sources. This exercise, whilst limited, has, for some cost categories, yielded useful 'indicative benchmark ranges' against which costs of the sample projects can (as the Study progresses) usefully be compared.

6.2.3. The results for road projects are summarised as follows:

- European road projects indicate a range for new dual two-lane carriageways of between €5 million and €15 million per kilometre.
- American road projects indicate a range for two-lane road widenings of between €2 million and €8 million per kilometre.
- European accession country road projects indicate a range for new two-lane carriageways of between €0.5 million and €2.5 million per kilometre.
- UK, Poland and China road projects indicate a range for new 4-lane carriageways of between €1 million and €5 million per kilometre.
- European fixed link projects indicate a range of between €60,000 and €180,000 per square metre for tunnels and between €5,000 and €25,000 per square metre for bridges.

6.2.4. The results for urban transport projects are outlined as follows:

- European urban transport projects indicate a range of between €50 million and €150 million per kilometre of metro. However, costs of up to €300 million per kilometre were also observed, particularly in the US.
- European and US urban transport projects indicate a range of between €10 million and €30 million per kilometre of light rail/tramways.

6.2.5. Data on rail projects was much less abundant, but the result are outlined as follows:

- High-speed twin-track projects were found to lie in an indicative range of between €20 million and €90 million per kilometre.
- Conventional twin-track rail projects were found to lie in an indicative range of between €3 million and €12 million per kilometre.

6.2.6. We also found some data on energy and environmental projects, the results of which are summarised as follows:

- European wind farm construction costs indicate a range of between €1,000 and €2,000 per kW.[47]
- European, American and Russian construction costs for wastewater treatment facilities indicate a range of between €500 and €2,500 per cubic metre per day.
- American, Australian, Asian and European water treatment and desalination plant construction costs lie in a range of between €400 and €1,000 per cubic metre per day.

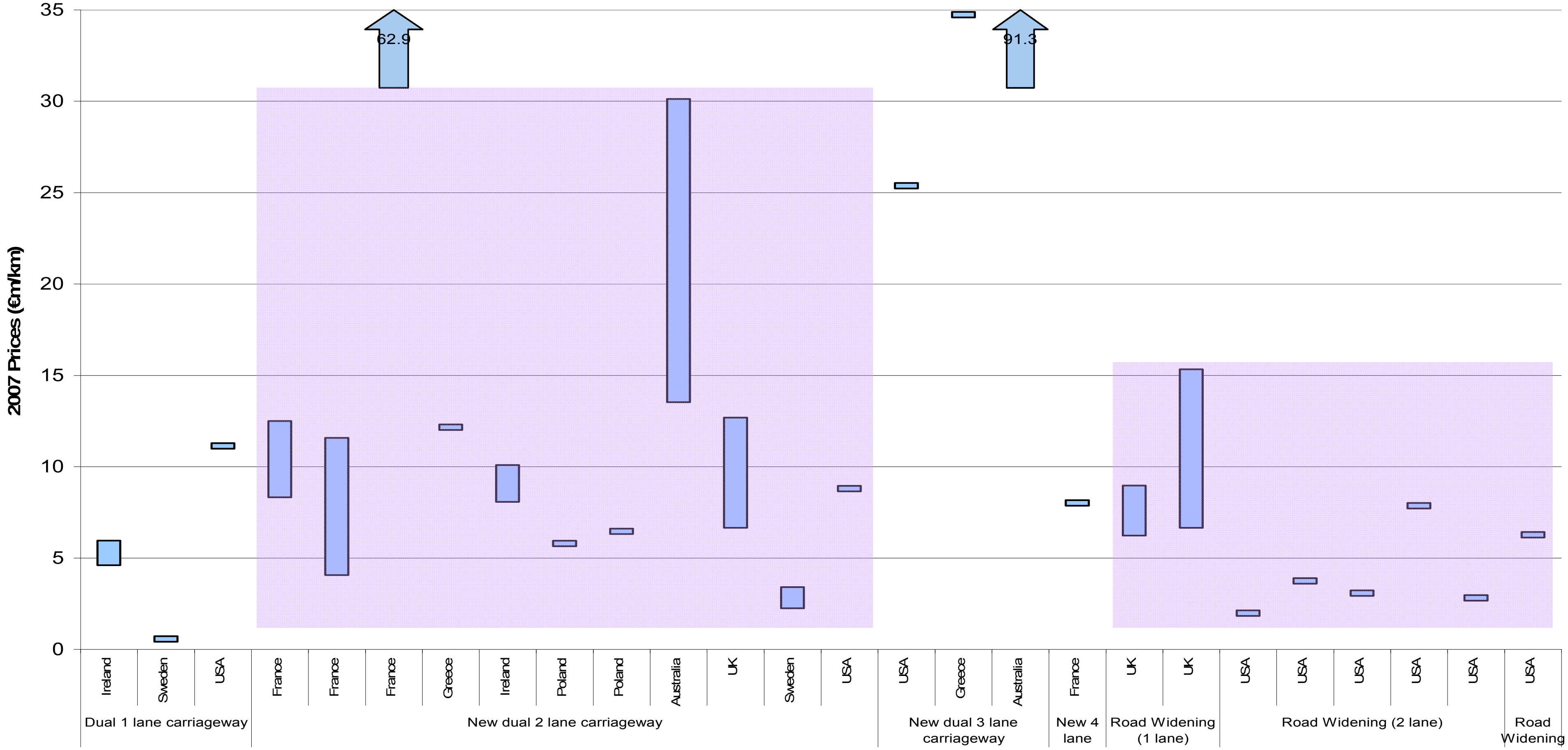
6.3. Benchmark data for infrastructure projects

6.3.1. The following charts show the benchmark data gathered and, where relevant our 'indicative benchmark range' of costs against which other projects can usefully be compared.

[47] The data also indicates some relationship between the capacity to be delivered by projects and the observed unit costs, that is, economies of scale. However, there were also exceptions.

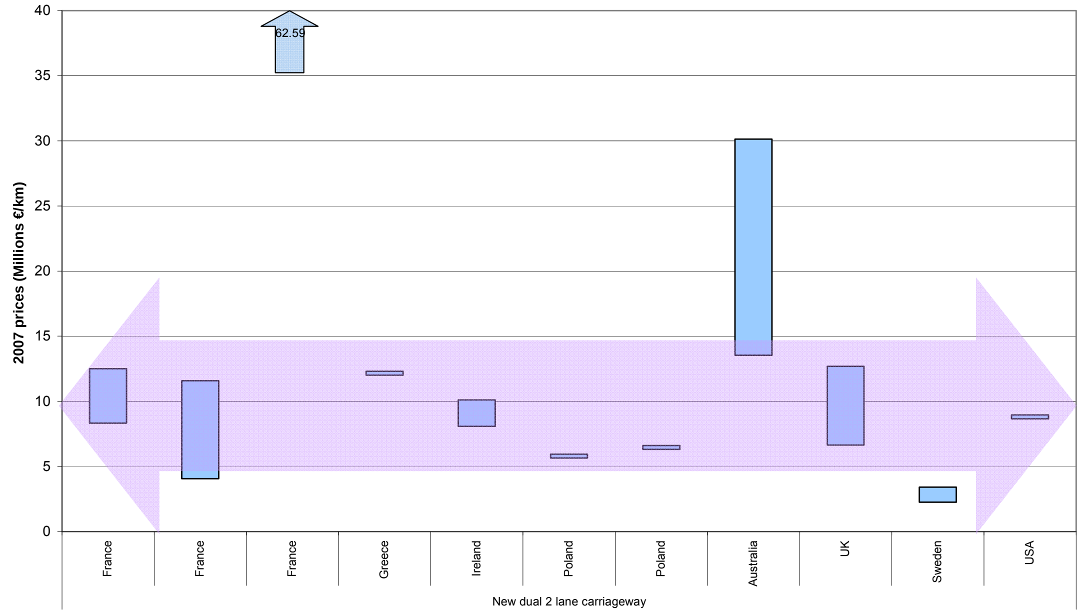
6.3.2. Figure 43 shows total unit project costs for different types of road. Not surprisingly, these costs vary hugely and further classification of project types is needed. Figures 2 and 3 show how analysing costs for specific road types can yield more useful information.

Figure 43: Level 1 Road Costs



Sources: www.wsdot.wa.gov, www.roadtraffic-technology.com, Data from Faber Maunsell, Data from Prof. Bent Flyvbjerg.

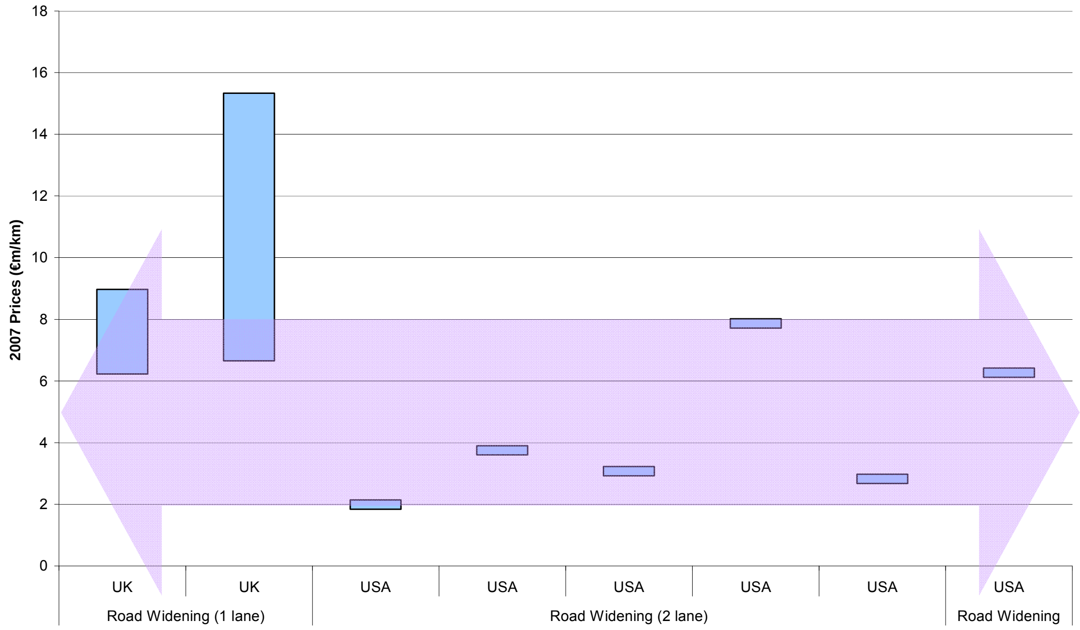
Figure 44: Two-lane carriageway level 1 construction costs



Sources: www.wsdot.wa.gov, www.roadtraffic-technology.com, Data from Faber Maunsell, Data from Prof. Bent Flyvbjerg

6.3.3. Figure 44: Two-lane carriageway level 1 construction costs shows level 1 costs for two lane carriageway construction. The chart shows an indicative benchmark range for this category of cost of €5m to €15m.

Figure 45: Road widening level 1 construction costs



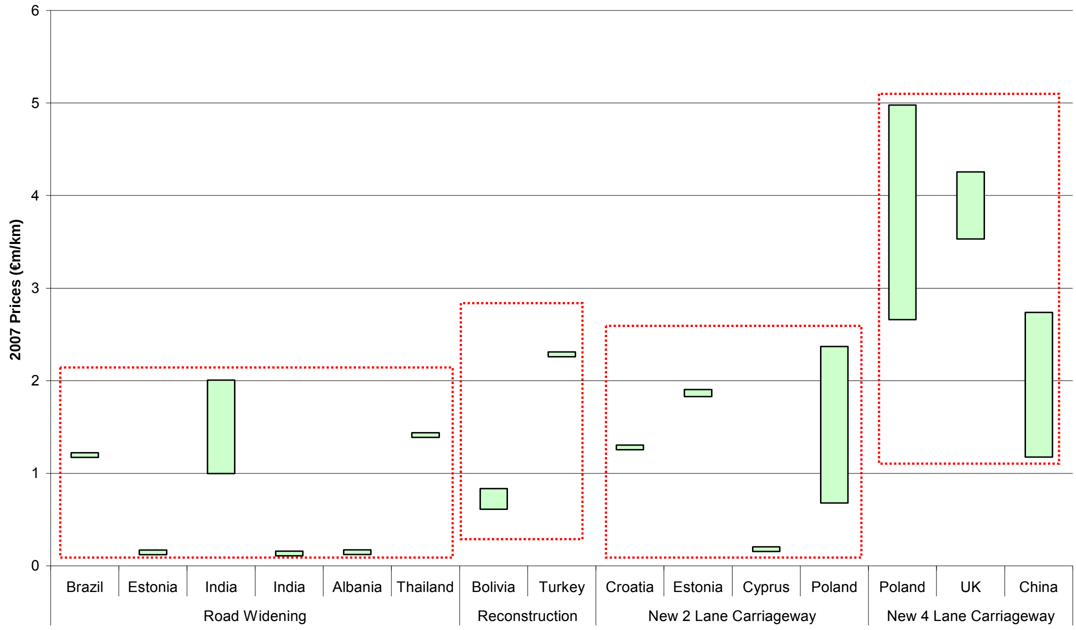
Sources: www.wsdot.wa.gov, www.roadtraffic-technology.com, Data from Faber Maunsell, Data from Prof. Bent Flyvbjerg

6.3.4. Figure 45 shows unit construction costs for road widening projects. The indicative benchmark range lies between €2m and €8m per km.

6.3.5. The following charts show level 2 costs for carriageways, bridges and tunnels.

6.3.6. Figure 46 shows the carriageway costs for new constructions, reconstruction and widening projects, grouped by project type. As one would expect, the most expensive of these is the construction of wider lane roads and the least expensive is the cost of road widening.

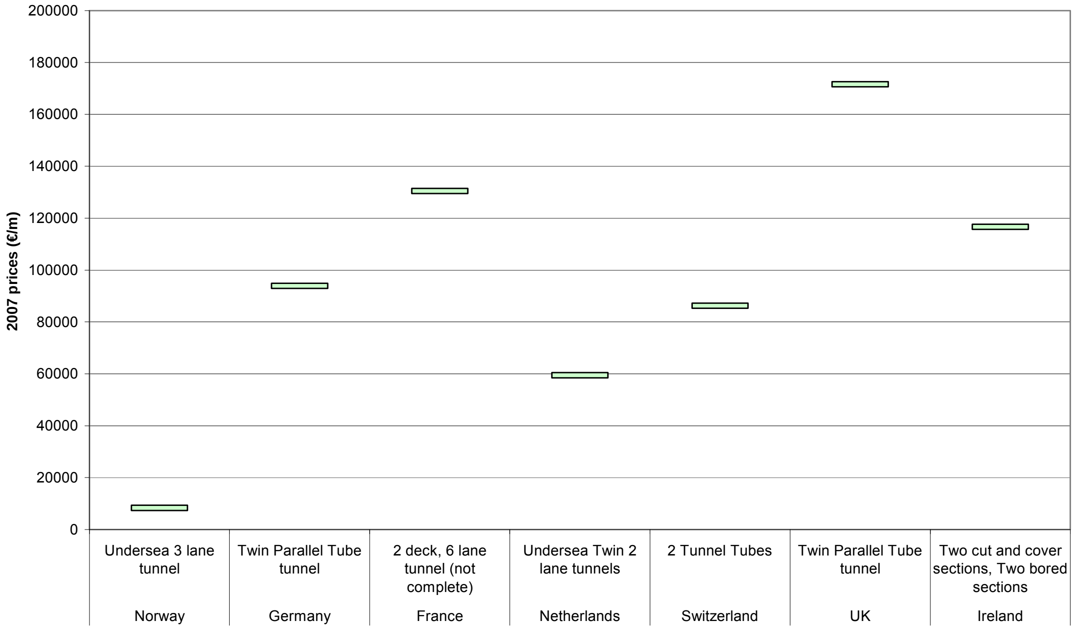
Figure 46: Level 2 construction costs for carriageways



Sources: World Bank ROCKS database, Data from Faber Maunsell

6.3.7. Figure 47 shows that unit tunnel construction costs vary widely depending on project specific factors.

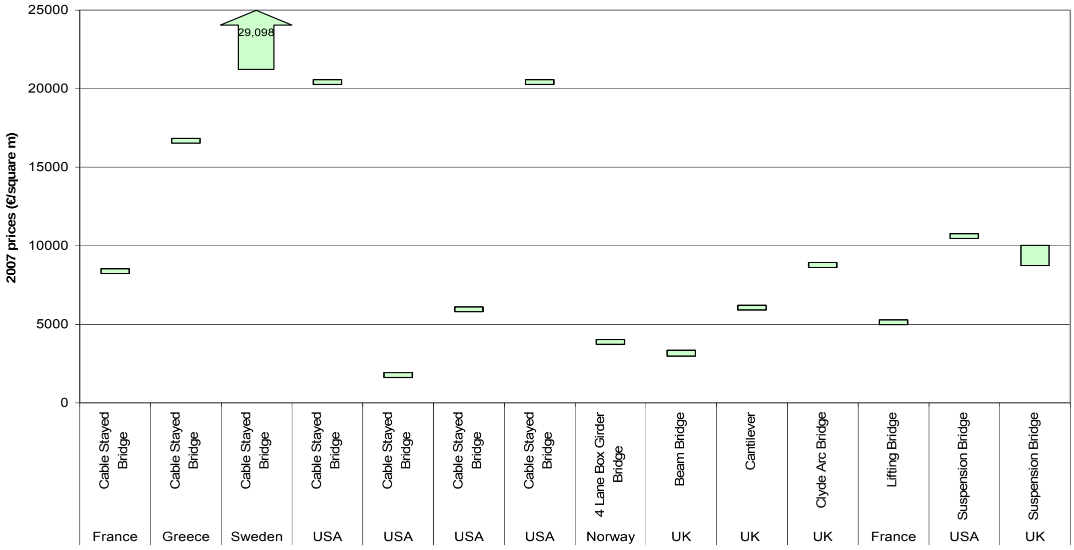
Figure 47 Level 2 construction costs for tunnels



Sources: www.roadtraffic-technology.com

6.3.8. Figure 48 shows bridge construction costs. As with tunnels, these vary significantly.

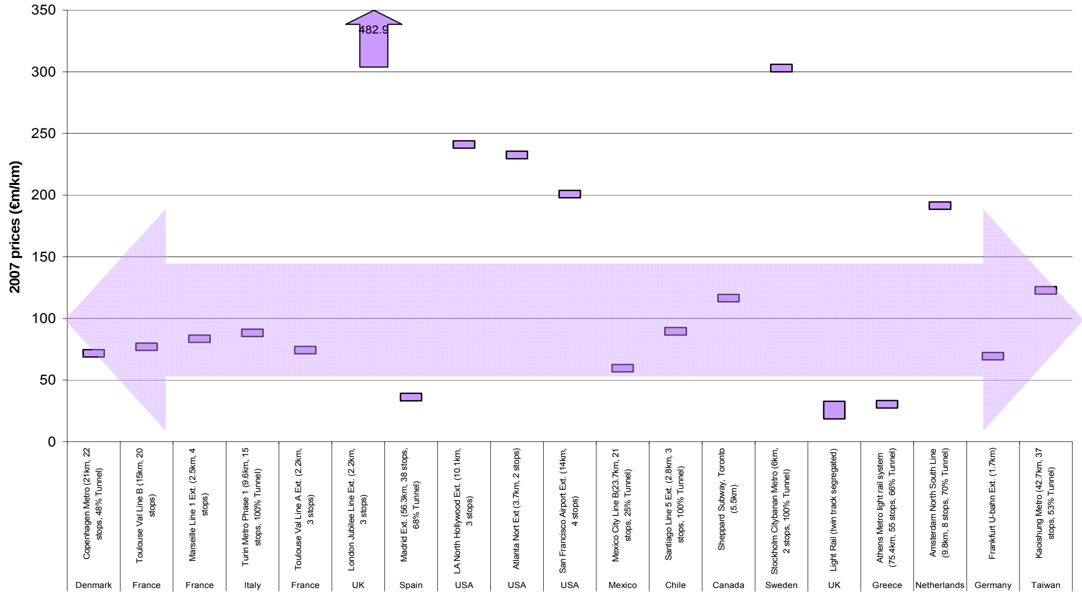
Figure 48 Level 2 construction costs for bridges



Sources: www.roadtraffic-technology.com, Data from Faber Maunsell

6.3.9. Figure 49 shows unit construction costs for metro services. The indicative benchmark range lies between €50m and €150m.

Figure 49 Metro construction costs

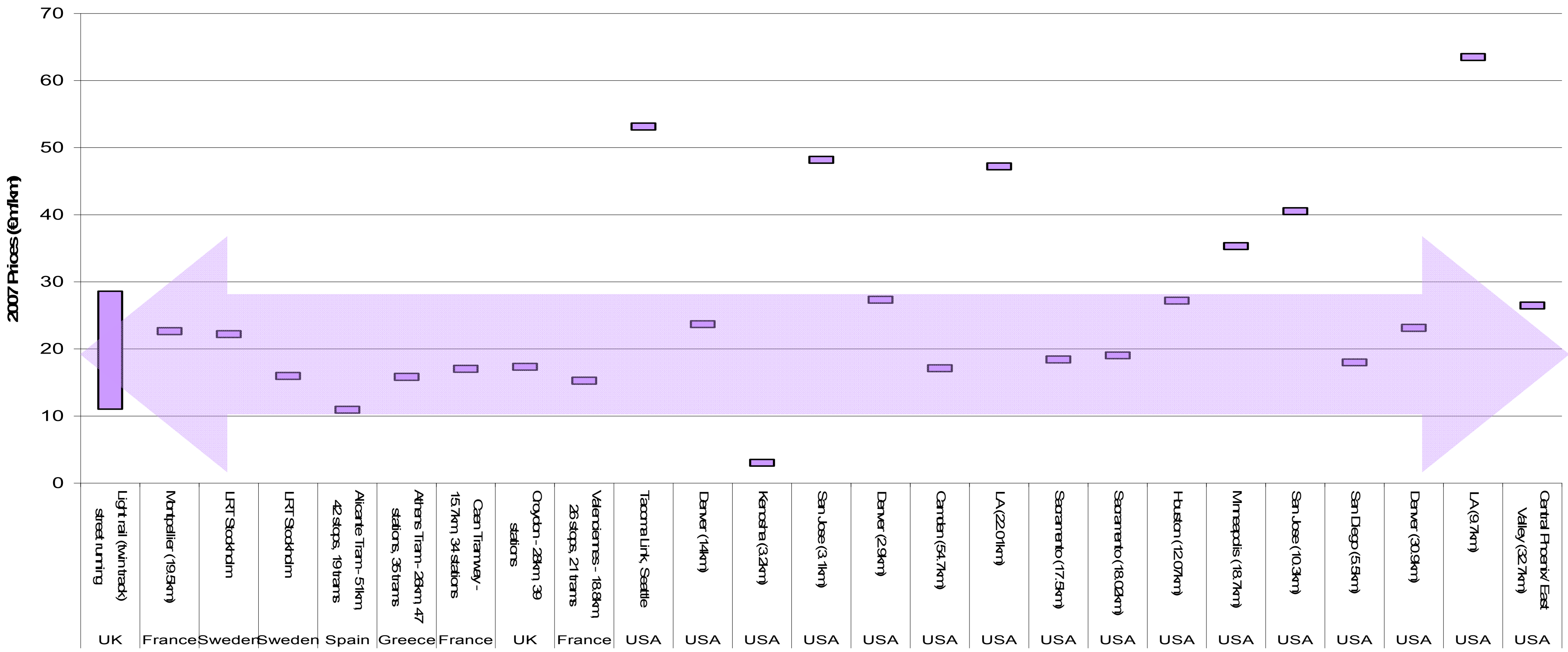


Sources: http://lrt.daxack.ca, www.railway-technology.com, Data from Faber Maunsell, Bent Flyvbjerg et al., Comparison of Capital Costs per Route-Kilometre in Urban Rail, 2008

6.3.10. Figure 50 shows Light Rail and Tram service construction costs in millions of Euros per km. The indicative benchmark range lies between €10m and €30m per km.

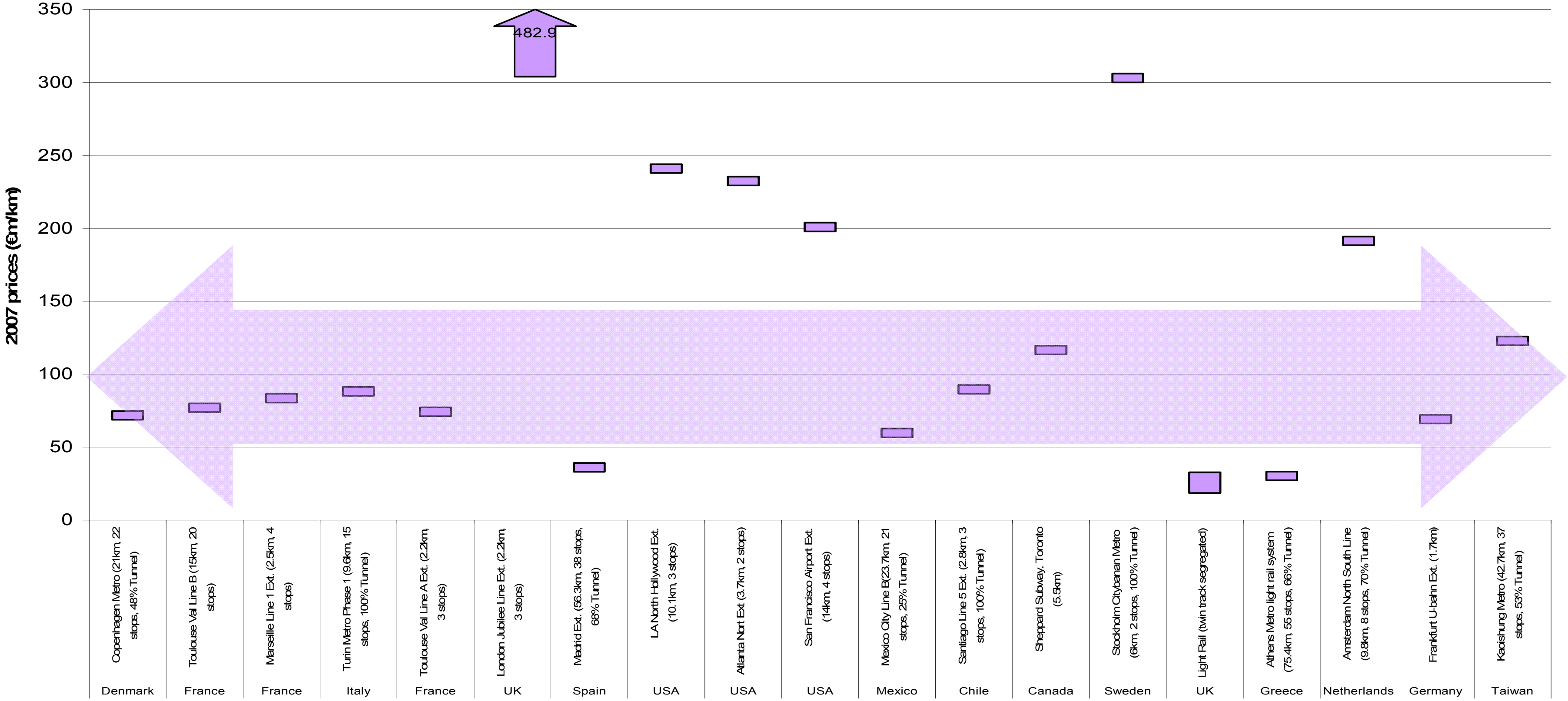
6.3.11. Figure 51 is based on data provided by Prof. Bent Flyvbjerg for level 1 total urban rail project costs. Whilst this dataset lacks any detailed information, the quantity of data means this chart is of some interest. The indicative benchmark range for all metro lies between €50m and €150m per km

Figure 50: Light Rail and Tram construction costs



Sources: www.railway-technology.com , www.lightrailnow.org, Transek Consultants, Comparison of Costs between Bus, PRT, LRT and Metro/rail, 2003

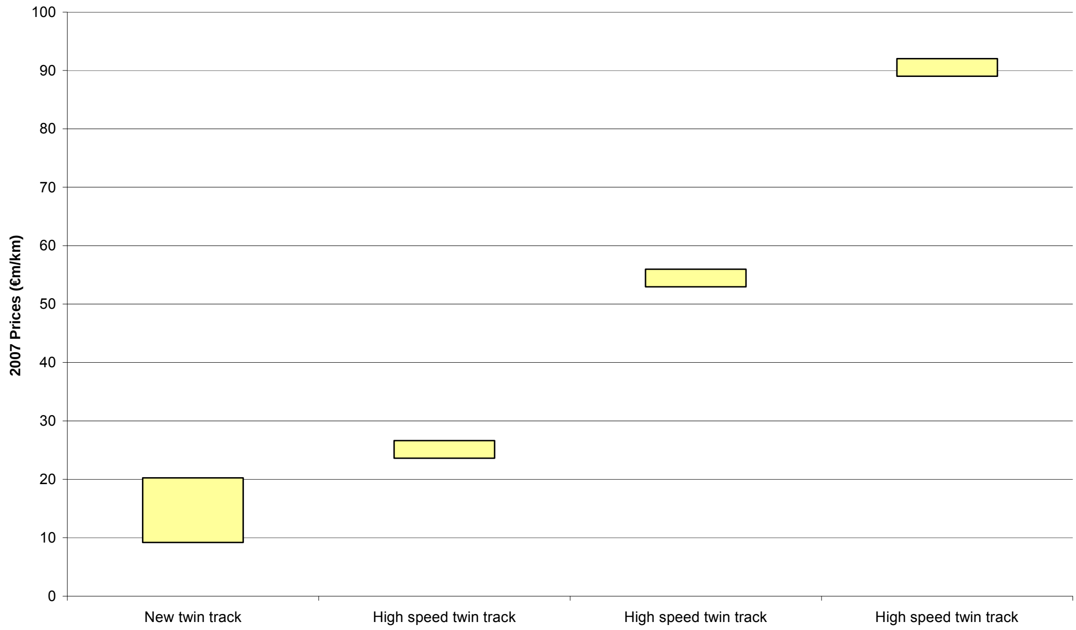
Figure 51 Metro services cost of construction from Prof. Bent Flyvbjerg's research



Sources: Data from Bent Flyvbjerg

6.3.12. Figure 52 shows the total costs of different types of rail projects.

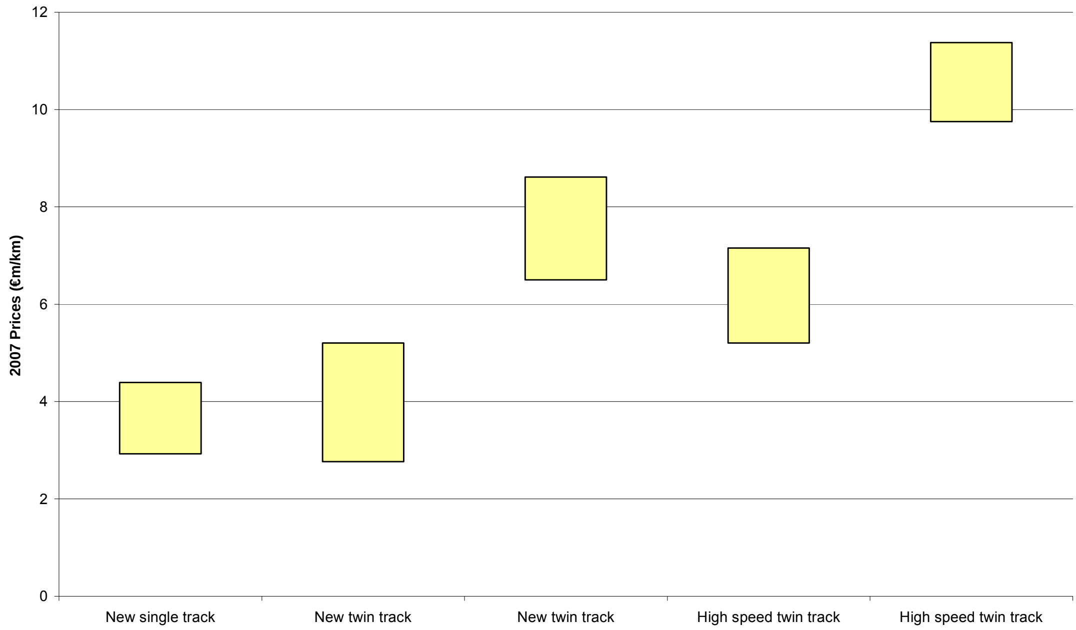
Figure 52 Level 1 Rail Costs



Sources: Data from Faber Maunsell

6.3.13. Figure 53 shows the track costs for different types of rail projects.

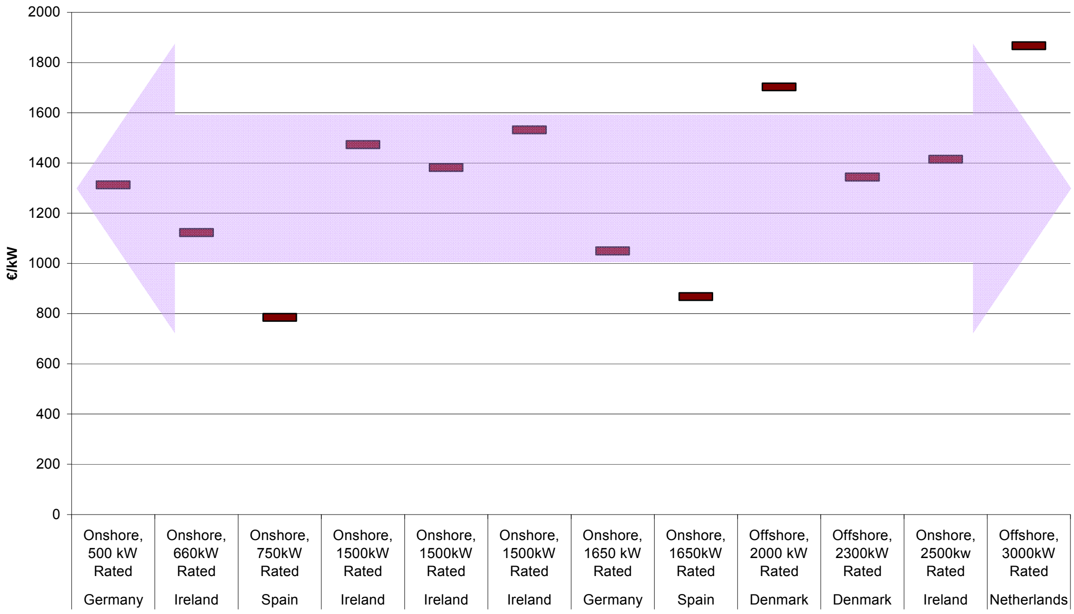
Figure 53 Level 2 Rail Costs – Tracks



Sources: Data from Faber Maunsell

6.3.14. Figure 54 shows the cost of construction of various wind farms across Europe. The indicative benchmark range lies between €1000 per kW and €1600 per kW as this is where the majority of the data falls.

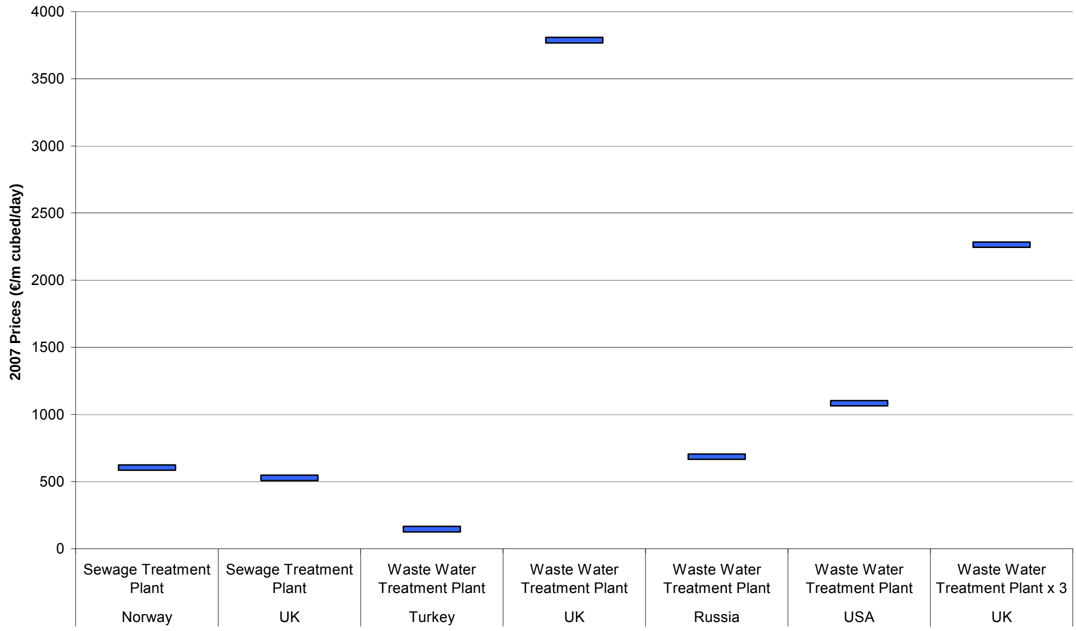
Figure 54 Wind farm construction costs



6.3.15. Figure 55 and Figure 56 show the cost of construction of water treatment and supply facilities in various countries.

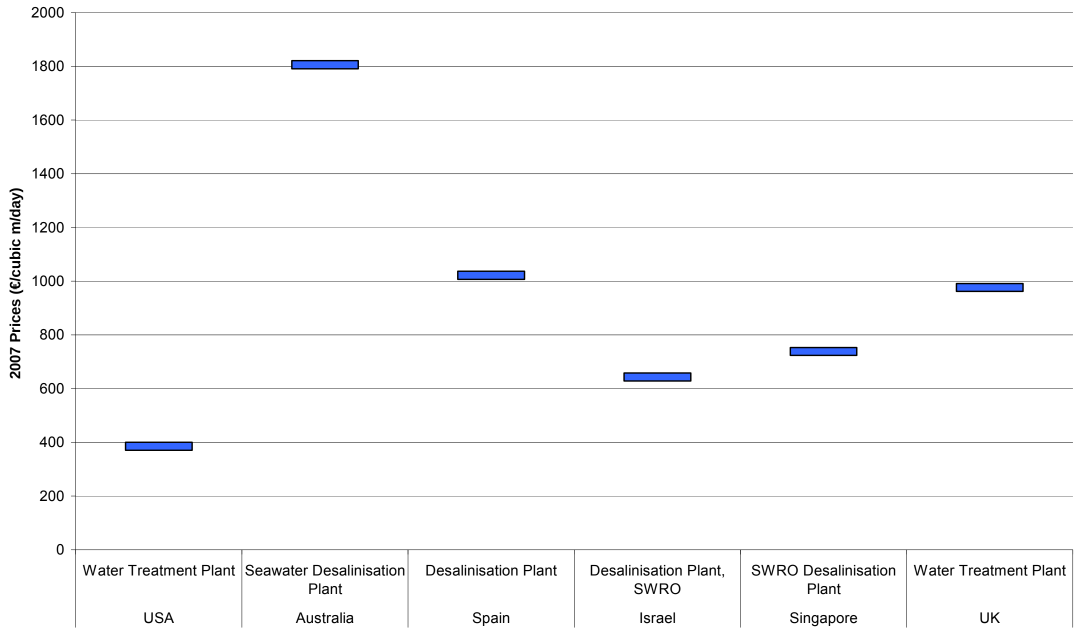
6.3.16. Although we only have a small number of benchmarks, Figure 55 and Figure 56 suggest that water projects vary significantly in costs, perhaps suggesting that project specific features have a particularly significant impact on costs.

Figure 55 Water treatment facilities' construction costs



Sources: www.water-technology.net

Figure 56 Water supply facilities' construction costs

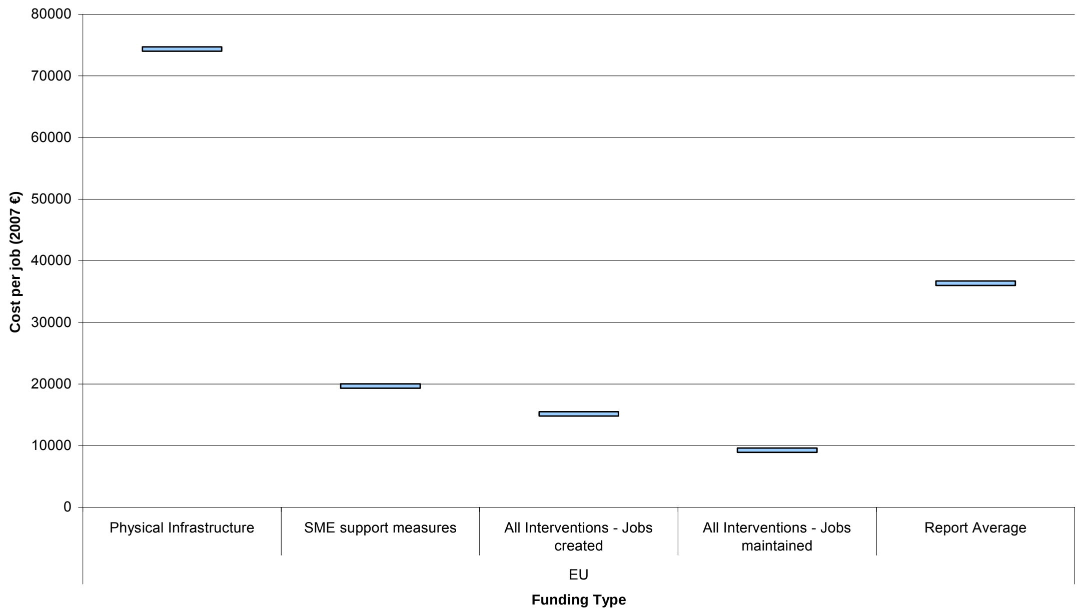


Sources: www.water-technology.net

6.4. Benchmark data for productive investments

6.4.1. The sources for our first two sets of benchmarks are the studies set out in Section 5 above. Figure 57 shows physical infrastructure projects as involving the highest cost per job created at between €70,000 and €80,000 per job. Other types of productive investments were found to be less expensive.

Figure 57: Cost per job created benchmarks from the EU



6.4.2. Figure 58 shows benchmarks from various types of job creation programmes in the USA, also from the studies discussed in Section 5 above.

Figure 58: Cost per job created benchmarks from the USA

6.4.3. Figure 57 shows data contained in Figure 57 and Figure 58 above and includes benchmark data from Canada.

Figure 59: Cost per job created benchmarks from Europe, US and Canada compared

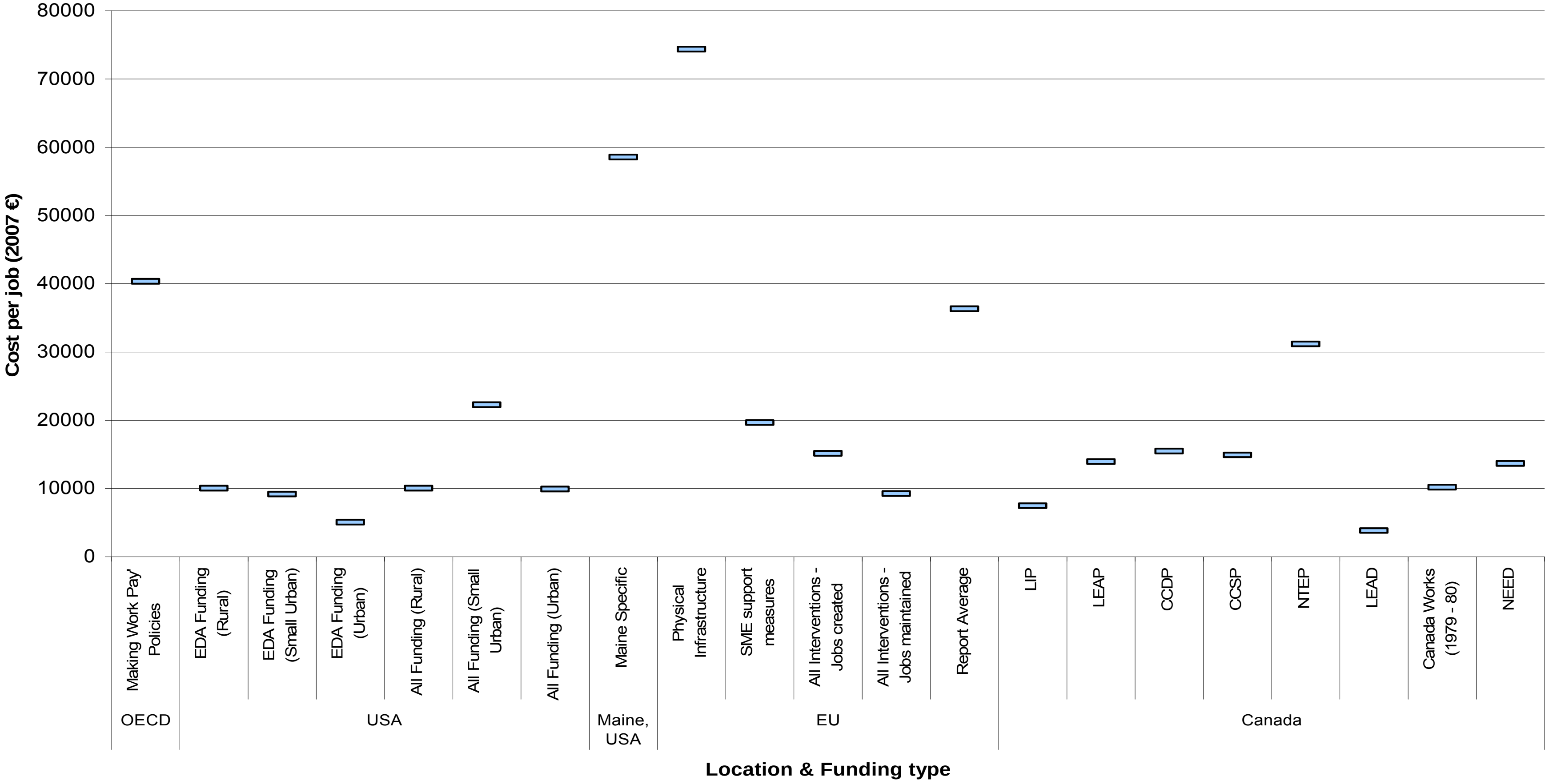
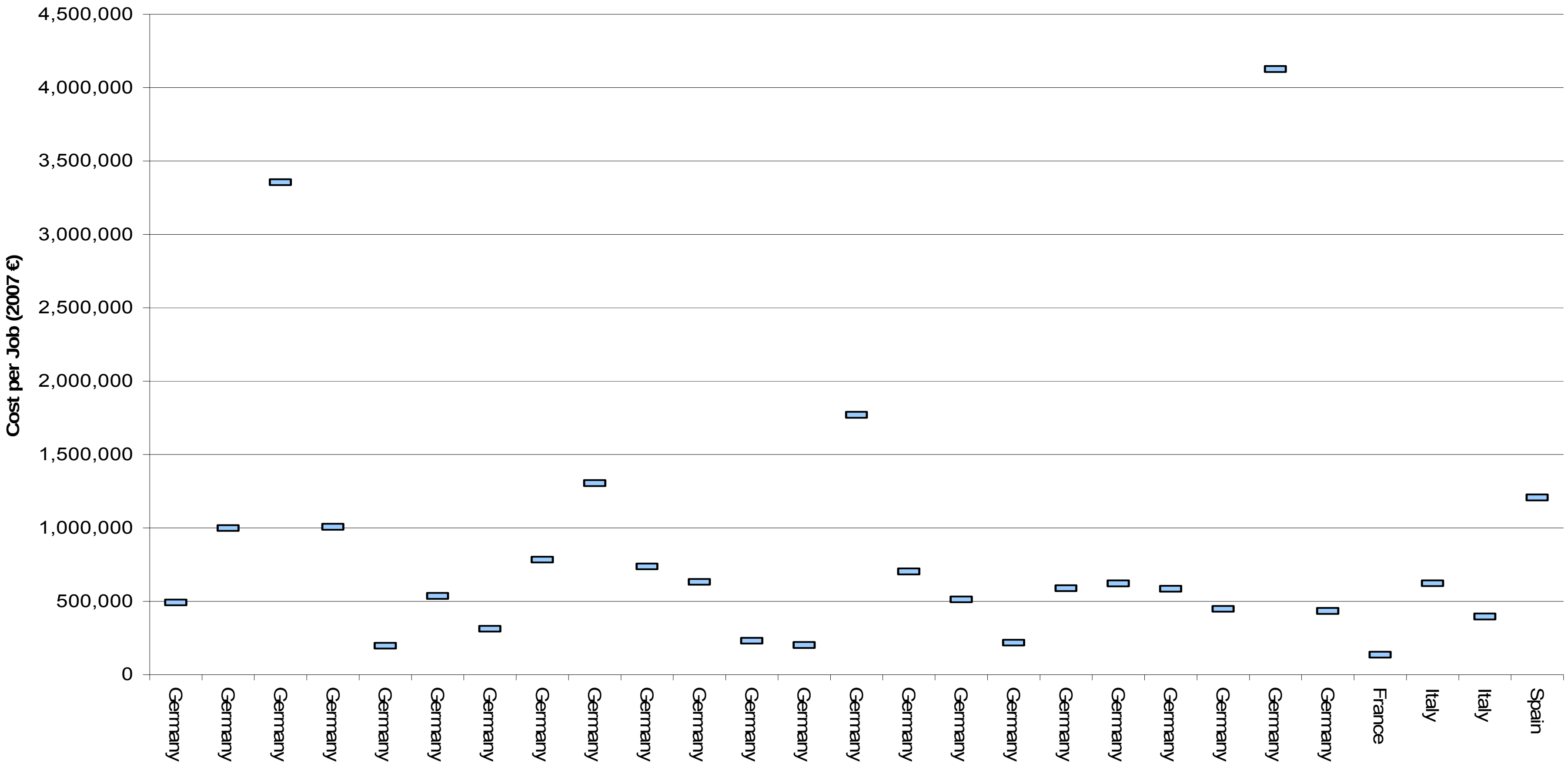


Figure 60: Cost per job created from DG Competition approved state aid decisions



6.4.4. Figure 60 presents data from approved state aid decisions sourced from EC DG Competition, which had introduced a dependency between aid intensity and the number of jobs to be created by investments from the German State. The data shows significantly higher costs per job created than indicated in the other benchmark findings above. The reliability of the data is, therefore, questionable, particularly since it was the responsibility of Member States to find out if job creation promises had been met, and there is little indication of whether they were or not.

6.4.5. The benchmarks were gleaned from letters published by the European Commission informing various companies of their decision to accept their request for state aid with certain investment projects. The investment opportunities included such projects as the establishment of research and development facilities, the expansion of an MDF production firm into the production of laminate flooring, the construction of a new Earth Observation Service for agricultural and cartographical uses, the construction of a new production site for microchips and the establishment of a new plant for the production of a fungicidal active ingredient, amongst others.

6.4.6. Within these letters of acceptance, the Commission set out its calculation of the level of aid the companies were entitled to for their investment project. The multi-sectoral assessment framework included a competition factor, a capital labour factor and a regional impact factor.

6.4.7. As part of the Capital-Labour factor calculation, which aims to adjust aid to favour projects with more effective job creation or the safeguard of existing jobs, the total cost of the project is divided by the number of jobs it creates or secures. All the data is gleaned from these figures which, as they are calculated prior to the project, are estimates and, as such, do not allow for budget overruns or for the employment circumstances of the firm to change (although some consideration was given to the financial health of the company).

7. Data gathering progress for the sample projects

7.1. Introduction

7.1.1. The data collection strategy was summarised in our Inception Report by the following set of steps:

- the starting point involved making telephone or email contact with the relevant parties listed on the ERDF project application forms, beginning with the contact listed for the organisation responsible for project implementation (usually local government in the case of infrastructure projects) and/or the organisation empowered to issue certificates;
- where this is a private firm (as in the case of some productive investments) or a contractor (as can be the case with infrastructure projects) and the contact cannot be located (either due to staff turnover or dissolution/acquisition of the firm itself), we are reverting to a relevant government department or agency[48];
- otherwise, where necessary, we are elevating our information requests to the relevant national government department or agency, which often need to be notified in any case when the local government authority or private firms are reluctant to provide the required information;
- we are in discussions with the EIB, a co-funder on a number of projects, on the possibility of making use of their information (in the form, we believe, of reports) to identify actual project costs and timetables for those projects which have been co-financed by the EIB.

7.1.2. Having found a contact that is willing and able to assist in the provision of information, we have proceeded to describe the objectives of the project and the information we are seeking.

7.2. The pilot tests

7.2.1. At the seventh meeting of the Steering Group for Objective 1 and 2 programmes, we undertook to carry out some pilot testing of the approach to gathering and analysing the data and other information by utilising initial data returns. So far, our pilot tests have involved establishing contact with the relevant agencies in 11 Member State countries covering the entire sample of projects that are the subject of this Study and determining with them the most appropriate approach to data gathering exercise.

7.2.2. Once the data were in a comparable format, we hoped to compare the actual unit costs and completion times to the benchmarks identified in our review of the literature, previous studies and databases in Task 1. This would allow us to check whether the unit costs calculated appear plausible and whether it would be necessary to further interrogate the data through further contact with the provider.

7.2.3. This has, however, not been possible because the contact details were, in almost all instances incorrect or no longer valid and, therefore, establishing contact with someone prepared to assist was problematic and has taken time to resolve.

[48] This is also useful and may be necessary in any case to verify the accuracy of the information provided.

7.2.4. The problem is more severe for the set of projects for which we have not received ERDF application forms from the Commission. Consequently, we have asked the Commission to provide the applications for about 26 projects, and assistance with establishing contact for about half of these. We have not received these yet, however, so data gathering on these projects has inevitably been delayed.

7.2.5. In some of the cases where information has been received, it is of insufficient quality to facilitate a meaningful analysis. We are continuing to work on this aspect of the Task and can report fully in due course.

7.3. Progress

7.3.1. Our starting point was to request official project completion reports and/or progress reports. However, it appears that few countries have official project reporting processes in place. In the case of one country (Ireland), it was indicated that ex post audits of certain road projects that form part of the sample for this Study were being prepared for submission to the European Commission.

7.3.2. Where completion reports have been prepared and submitted to us, they lack the level of detail sufficient to facilitate a robust and comprehensive analysis. Germany provides a case in point. Some of the reports submitted to us appear to be 'glossy' commercial reports prepared by the contractor. For some others, the report appears to be of a more official nature. However, both suffer from the same deficiencies.

7.3.3. We have, therefore, changed our approach and developed questionnaires to serve as a more detailed guide to our data requirements and to assist in gathering data from what could be a number of disparate sources within a relevant organisation. The questionnaires are based on the project templates that were outlined in our Inception Report.

7.3.4. Table 11 below provides an overview of the progress made for each country included in the sample. In addition, we provide a brief summary overview of that progress in the following paragraphs.

7.3.5. Some projects are being reported as incomplete, in which case more up-to-date forecasts are being provided on a revised basis or simply on the same basis as that contained in the ERDF application forms. At present, we are unable to determine whether the issue of project completion can be anticipated as a major problem.

7.3.6. The submissions received so far contain only Level 1 'all-in' costs and in many countries, the type of detailed information we are seeking is not collected by the responsible agencies at the member-state level. It looks unlikely, therefore, that we will receive the level of detail required to facilitate the use of robust and sufficiently comparable unit cost measures. This will limit the degree to which we can produce reliable results with meaningful conclusions.

7.3.7. As outlined in 2.5 above, these issues imply a role for recommendations on how to improve data collection and availability so that, in the future, the level of detail required for more meaningful comparability, that is, beyond Level 1, can be made available. This should be usefully informed by:

- Council Regulation (EEC) No 1108/70 and the related study by ECORYS Transport and CE Delft (2005) on “Infrastructure expenditures and costs: Practical guidelines to calculate total infrastructure costs for five modes of transport; and
- The IER (2004) study on “Developing Harmonised European Approaches for Transport Costing and Project Assessment (HEATCO)”, specifically Deliverable 5 – Proposal for Harmonised Guidelines.

Table 11: Data gathering progress

Quality rating for data received: n/a = no information received to date; 0 = irrelevant data received; 1 = partial relevance; 2 = all relevant and appropriate

Country	Sector	Relevant contact(s) identified	Contact established	Format for information agreed	Information received	Information quality rating	Next steps/ expected timetable
Germany	Road	Yes	Yes	Yes	Yes	0 Commercial reports by contractors. Detail insufficient.	Referred by Ministry to responsible contractor, but our deadline mis-communicated to them. We hope information can be provided by mid-January.
	Rail	Yes	Yes	Yes	Yes	1	Questionnaire responses expected before end-December
	Energy	Yes	Yes	No Unclear whether relevant project falls into the infrastructure or productive investment category	No	n/a	Assistance from the Commission required to clarify
	Productive investment	Yes	Yes Central contact in Federal Ministry	No	Yes A few still outstanding and a couple incomplete	1	
Greece	Road	Yes	Yes	Yes	4 out of 9 outstanding	1	Contact with the various organisations is proving problematic. At least one project, we were informed is not infrastructure and some others are not complete. Assistance from the Commission required to ensure correct
	Rail	Yes	Yes	Yes	No	n/a	
	Urban transport	Yes	Yes	Yes	Yes	1	
	Energy	Yes	Yes	No	1 out of 2 outstanding	1	

Country	Sector	Relevant contact(s) identified	Contact established	Format for information agreed	Information received	Information quality rating	Next steps/ expected timetable
	Water	Yes	Yes	Yes	No	n/a	classification.
Spain	Road	Yes	Yes	Yes	1 out of 2 outstanding	1	The contact details were, without exception, no longer valid and the initial response was, at best, slow. However we have made better progress more recently and anticipate a satisfactory outcome in the next few weeks.
	Rail	Yes	Yes	Yes	1 out of 6 outstanding	n/a	
	Water	Yes	Yes	Yes	9 out of 13 outstanding	n/a	
	Productive investment	Yes	Yes Ministry to local government to companies	Yes Questionnaire sent and has been circulated	No	n/a	Responses were expected 8-10 days from 24th October. Nothing received to end-December.
France	Road	Yes E-mail only, a live phone number cannot be found	Yes But only implied by "read" receipts to emails	No But questionnaire sent	No	n/a	Contact details and application being sought from Commission
	Urban transport	Yes	Yes	Yes	Yes Only for 1 of 3 urban transport projects	1 Where provided	Follow-up queries on information received. Unknown timetable for the other two projects
	Energy	Yes	Yes	Yes	Yes	0	Follow-up on information provided. Review and further follow-up required.
	Water	No	No	No	No	n/a	Contact details and application being sought from Commission
	Productive investment	Yes	Yes	Yes	Yes For 1 of 2 projects, although they may be the same project	1	Some data to be clarified No analysis of causes of delays and cost overruns provided.

Country	Sector	Relevant contact(s) identified	Contact established	Format for information agreed	Information received	Information quality rating	Next steps/ expected timetable
Ireland	Road	Yes	Yes	Yes	No	n/a	Data was due to be provided by end-November/ early December. Nothing received to end-December
	Rail	Yes	Yes	Yes	Yes	0	Bespoke report provided for one rail project but of little relevance. Questionnaires sent but no response
	Urban transport	Yes	Yes	Yes	Yes	2	Good data received. Follow-up required on a few minor issues.
Italy	Road	Yes One main contact at the national government level	Yes	Yes Questionnaires sent	No	n/a	Data was expected to be received mid-late November. Nothing received to end-December.
	Rail	Yes	Yes	Yes	No	n/a	Data expected to be received mid-late November. Nothing received to end-December.
	Urban transport	Yes	Yes	Yes	No	n/a	Data expected to be received mid-late November. Nothing received to end-December.
	Energy	No	No	No	No	n/a	No ERDF application form provided. Request assistance from Commission.
	Water	Yes	Yes	Yes	Yes	1 For one project, data provided inconsistent	Follow-up queries have been sent to establish the proper breakdowns.

Country	Sector	Relevant contact(s) identified	Contact established	Format for information agreed	Information received	Information quality rating	Next steps/ expected timetable
						with breakdowns in the ERDF application form	1 of the 2 water projects reportedly not completed yet (due September 2009). The other completed in September 2008
Poland	Road	Yes	Yes	Yes	Yes	0 Missing costs/ times/overrun/ procurement details	Follow-up queries sent to secure data omitted from initial responses
	Rail	Yes	Yes	Yes	Yes	0 Missing costs/ scheme details/ overrun details	Follow-up queries sent to secure data omitted from initial responses
	Urban transport	Yes	Yes	Yes	Yes	1 But one missing length of track, times, procurement info	Follow-up queries sent to secure data omitted from initial responses
Portugal	Rail	Yes	Yes	Yes	Yes	1	
	Urban transport	Yes	Yes	Yes	Yes Only partially completed	1	
	Energy	Yes	Yes	No	Yes	1	
	Productive investment	No	No	No	No	n/a	We have requested assistance from the Commission to identify the relevant contact.
Slovakia	Road	No	No	No	No	n/a	Further effort required to establish contact
UK	Urban transport	Yes A new computer system and a change of telephone number have	No	No	No	n/a	Contact to be established and format for information to be agreed.

Country	Sector	Relevant contact(s) identified	Contact established	Format for information agreed	Information received	Information quality rating	Next steps/ expected timetable
		prevented contact up to now.					
	Energy	No	No	No	No Contact details no longer valid and alternative contact not yet established	n/a	Further effort required to establish contact
	Productive investment	No	No	No	No Contact details no longer valid and alternative contact not yet established	n/a	Further effort required to establish contact

8. Selected bibliography

Infrastructure costs literature

Title	Author	Date of Publication
Comparison of Capital Costs per Route-km in Urban Rail	Flyvbjerg et al.	February 2008
Performance of PPPs and Traditional Procurement in Australia	The Allen Consulting Group	November 2007
Policy and Planning for Large Infrastructure Projects: Problems, Causes, Cures	Flyvbjerg	December 2006
Ex Ante Construction Costs in the European Road Sector: A Comparison of Public-Private Partnerships and Traditional Public Procurement	Blanc-Brude et al.	January 2006
Ex Post evaluation of a sample of projects co-financed by the Cohesion Fund (1993-2002)	ECORYS Transport	January 2005
ROad Costs Knowledge System ROCKS	Nogales et al.	December 2004
Procedures for Dealing with Optimism Bias in Transport Planning – Guidance Document	Flyvbjerg & COWI	June 2004
What Causes Cost Overrun in Transport Infrastructure Projects?	Flyvbjerg et al.	January 2004
An Analysis of Cost Overruns and Time Delays of INDOT Projects	Bordat et al.	2004
How common and how large are cost overruns in transport infrastructure projects?	Flyvbjerg et al.	January 2003
Review of Large Public Procurement in the UK	Mott MacDonald	July 2002
Implementation of Rapid Transit	BB&J Consult, S.A.	December 2000
World Bank Urban Transport Strategy Review – Mass Rapid Transit in Developing Countries	Halcrow Fox	July 2000
Understanding and Monitoring the Cost-Determining Factors of Infrastructure	European Commission DGXVI	April 1998
Twenty-one sources of error and bias in transport project appraisal	Peter Mackie, John Preston	1998
Analysis of WSDOT Construction Cost Overruns	Jimmie Hinze and Gregory A Selstead	July 1991
Understanding the Outcomes of Megaprojects – A Quantitative Analysis of Very Large Civilian Projects	Edward W. Merrow	March 1988
International Benchmarking of Track Cost	Oskar Stalder	2001
Choice of Mass Rapid Transit System	Deutsche Gesellschaft für Technische Zusammenarbeit	2002
Comparison of construction costs on motorway projects using measure and value and alternative tendering initiative contractual arrangement Construction Management and Economics, Volume 21, Number 8, December 2003, 831 - 840.	D. A. Langford, P. Kennedy, J. Conlin, N. McKenzie	2003

Review of Highways Agency's Major Roads Programme, Report to Secretary of State for Transport	The Nichols Group	2007
Department for Transport: Estimating and monitoring the costs of building roads in England	National Audit Office	2007
Urban Rail Transit Projects: Forecast Versus Actual Ridership and Cost	Don Pickrell, US Department of Transportation	1990
The Estimation and Treatment of Scheme Costs: Transport Analysis Guidance	UK Department for Transport	2006
Predicted and Actual Impacts of New Start Projects: Capital Cost, Operating Cost and Ridership Data. Draft report.	US Department of Transportation, Federal Transit Administration with support from SG Associates	2003
The Cost and Patronage of Rapid Transit Systems Compared With Forecasts Research Report 352	D. A. Walmsley and M. W. Pickett Crowthorne, UK: Transport Research Laboratory	1992
Are WSDOT's Highway Construction Costs in Line with National Experience?	WS DOT	2005

Costs of job creation literature

Title	Author	Date of Publication
Study on measuring employment effects	CSES	June 2006
Measuring Structural Fund Employment Effects	DG REGIO	March 2007
Direct Job Creation Programs: Evaluation Lessons	Arun S. Roy and Ging Wong	December 1998
Direct Job Creation Programs: Evaluation Lessons on Cost-Effectiveness	Arun S. Roy and Ging Wong	2000
Active Labor Market Programs: A Review of the Evidence From Evaluations	Amit Dar and Zafiris Tzannatos	January 1999
Cost Per Job Associated with EDA Investments in Urban and Rural Areas	Amy K. Glasmeier	2002