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1 INTRODUCTION

Investment decisions are made in the face of uncertainty over future impacts. Minimising this uncertainty plays a large part in any case for funding - for example in the effort to produce robust demand forecasts, benefit estimates and costings. Cost Benefit Analysis (CBA) is one tool that is used to provide evidence for decision makers to inform these decisions. Odgaard et al. (2005) identified that in most countries (in the EU) CBA undertaken at a national level is used to help choose between alternative options; to determine whether a project is efficient and /or viable and as an aid for the prioritization of projects. Boardman et al. (1994) describe four different stages that a CBA: ex ante, ex post, in media res and finally a comparison of ex ante and ex post. They argue that ex ante vs ex post studies of CBA are the "most useful for learning about the accuracy and efficacy of cost-benefit analysis to decision-makers and evaluators" (Boardman et al., 1994). Despite this assertion only a few authors to date have considered the pattern of error and bias that arises between ex ante CBA and ex post CBA in transport (e.g. Mackie and Preston; 1998 and Flyvberg; 2007).

Undertaking an ex post CBA evaluation of a sample of projects is one way of identifying errors and biases that were present in the ex ante CBA in order to determine whether there are any lessons that can be learnt for future investment decisions. Flyvberg identified a pattern of optimism bias, in which costs were systematically underestimated and transport benefits systematically overestimated. This arises partly due to information deficiencies and partly due to strategic behaviour. Lessons from this study have now become embedded in ex ante appraisal (e.g. DfT, 2014). Alternative ex post methods have been employed in the literature ranging from descriptive methods (e.g. Preston and Wall, 2008) to quantitative methods. The latter attempt to isolate the impact of the transport project on a specific or range of outcomes such as: property prices, GDP, employment or productivity (e.g. Rietveld and Bruinsma, 1998 Chapters 7-10; Gibbons and Machin, 2005; Fan and Chan- Kang, 2008; Gibbons et al., 2012; Duranton and Turner, 2012).

Ex post CBA studies have typically analysed stand alone transport interventions (Boardman et al., 1994; de Rus and Inglada, 1997; NAO, 2012; Franco, 2012. However, there are a few examples in England, France and Norway where multiple schemes have been analysed together in the transport sector. In England the Highways Agency evaluates all major trunk road schemes (capital cost > £10m) and a large number of smaller schemes using a process known as POPE (Post Opening Project Evaluation). POPE collects Pre-opening Baseline Data and data at 1 and 5 years post- opening (such as Annual Average Daily Traffic; journey times; accidents; and environmental data). 1 and 5 Year After Study reports document the changes and the schemes are summarized as a collective through a series of Meta Reports (Highways Agency, 2014). This process has identified a number of inconsistencies between ex ante and ex post appraisal providing recommendations including that "risk analysis of traffic forecasts should be undertaken, similar to that usually associated with cost forecasts" (Atkins, 2009).

In France the Internal Transport Act 1982 (Loi d'Orientation des Transports Interieurs) introduced the requirement for an ex post evaluation of any major (> €82m) transport project 5 years after opening. One of the issues raised when this process was started was the issue of how ex post CBA could be compared with the ex ante CBA when the values and in some cases methods used had changed in the intervening years. In France to account for this a dual approach is employed whereby the ex post evaluation is calculated using the same methods and unit values as used in the original ex ante CBA and separately an examination is undertaken to compare how the results would change if the evaluation is conducted using current day values and methods (Boiteux and Baumstark, 2001). The two different approaches can sometimes have a significant effects on the results (e.g. by increasing the appraisal period from 20 to 40 years, different discount rates). Kjerkreit et al. (2008) focused on the post-opening evaluation of road investment schemes in Norway. They identified a number of differences including that deviations between forecast and actual impacts varied greatly between road schemes and identified that the national road traffic forecasts used in the appraisal had been too coarse to predict actual demand growth at the level of an individual project. Positively they found that traffic growth was higher than forecast and the

resulting Net Present Values (NPV) were higher than predicted.

At a European level an ex post evaluation is conducted for 15% of European Investment Bank projects (Chevroulet, 2008). The EC DG REGIO also has a programme of evaluations in progress, based on a representative sample (Evaluation Plan 2009). This process has provided the Commission with benchmarks for use in the appraisal of future project financing requests, as it identified serious gaps in the data and ex ante CBAs weak in methodology.

The literature identifies a number of findings from comparisons between ex ante CBA with ex post CBA - optimism bias, inaccurate forecasting and the manner that the values used in the appraisal (e.g. values of time) may change. This paper expands on this literature by describing the results of research where ex post CBA evaluations of 10 large transport projects (benefiting from EU Cohesion and ISPA funding during the period 2000 - 2006) were undertaken. It therefore allows us to understand how well past lessons from previous comparisons ex ante ex post have been learnt. The research was not only concerned with project- and programme-level outcomes, but also the following two more general questions about ex post appraisal. Firstly, how ex post CBA can contribute to the practice of ex ante CBA, and secondly what the potential is and what the limits are of using ex post CBA to identify the impact of infrastructure projects. The latter two research questions have a particular policy interest.

Following this introductory section, section 2 describes the data and methodology used in this research. Section 3 sets out the key findings from the ex post analysis, whilst section 4 considers the lessons learnt for both ex ante appraisal and ex post evaluation. Finally, section 5 draws conclusions on the research questions and highlights areas for future research.

2 DATA AND METHOD

The study was based on 10 transport schemes (4 rail projects and 6 road projects)

covering eight European Member States (shown in Table 1). The projects opened between 1999 and 2010, whilst the ex ante appraisals for the projects were undertaken between 1995 and 2004. These projects were drawn from an initial list of 40 transport infrastructure projects that had benefited from EU Cohesion[1] and ISPA (Instrument for Structural Policies for Pre-Accession, aimed at accession countries) funding during the period 2000-2006. The decision by the EC as to whether to fund the projects was based on a range of information of which the cost benefit analysis is part. In applying for funds a member state has to set out the project's objectives, presents the project costs, the level of funding required, a financial analysis, a cost benefit analysis, direct employment impacts from construction and operation of the project as well as demonstrate compatibility with European Community policies and consistency with other measures financed by the European Community. A full environmental impact statement is also provided. Projects that receive funding do not therefore have to have a strong Net Present Value from the cost benefit analysis to receive funding, as the funding criteria is based on more than just the CBA. Although the 10 projects we case studied all had positive Net Present Values in principle projects could have a negative Net Present Value and still receive funding – though in such situations the other aspects of the elements in the appraisal must be performing strongly.

From the initial list of 40 schemes that had benefitted from Cohesion and ISPA funds the selection of the 10 studied was based on the feasibility of undertaking the research – primarily data availability – as well as ensuring a balance of projects between road and rail and new member states and more established member states. The criteria considered included whether baseline data was readily available; the likely level of support from key contacts involved in the evaluation process; availability of primary / secondary data from existing sources; and the amount of new ex post evaluation primary data required to support evaluation. Clearly this selection process is not random. The results of the ex post analyses

[1] The Cohesion Fund was established in 1993 to strengthen the economic and social cohesion of the European Union.1 The eligibility criterion is that the GNP per capita in the applicant country is 90% or less than the EU average.

undertaken and the ex ante and ex post comparisons cannot therefore be taken as representative of the performance of the EU Cohesion Fund or the ISPA fund. They do however present us with a snapshot of the performance of some of the major projects funded by the EU. By doing so they also allow us to understand if issues with ex ante CBA evident in the literature remain, as well as allowing us to understand the benefits and challenges of undertaking an ex post programme.

<<insert Table 1 here>>

A variety of sources were utilised by the study to collect the data required. These included the EC Funding Decision documents, Final Reports, which provided information about project objectives, outcome of ex ante CBA analysis and completion data, contact with DG REGIO, desk officers and contacts in member states. Whenever possible, the study relied on publicly available information, such as traffic count databases and accident data, but also commissioned traffic and journey time surveys where relevant (see Table 2).

The ex post CBAs were undertaken using standard transport cost benefit analysis methods with actual traffic demand data, accident data and capital cost data. The parameters (values of time, etc.) used in the ex post analyses were those currently used in the country in question. The EC discount rate (5.5%) and appraisal period (25 years) were used in each study. Standard economic appraisal indicators of Present Value of Benefits (PVB), Present Value of Costs (PVC), Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) were determined for each of the 10 case studies. These indicators provide an indication of value for money for the projects. In the cost benefit analysis literature a project is considered to have value for money if the NPV is greater than zero. With an NPV greater than zero the BCR is greater than 1.0 and the IRR is greater than the discount rate. These appraisal indicators therefore allow for an assessment of the value for money of a project. In England, for example, a BCR greater than 4.0 is

viewed as giving very high value for money, between 2.0 and 4.0 high value for money, between 2.0 and 1.5 medium value, between 1.5 and 1.0 low value for money and less than 1.0 poor value for money (DfT, 2013).

The long appraisal period relative to the amount of time the projects had been open, meant that some traffic forecasting was necessary. For each case study a low and high growth scenario was calculated relating to low and high forecasts for future traffic / passenger growth. These forecasts were constructed using data consistent with economic and traffic forecasts in the localities/regions in which the projects were located.

The wider socio economic benefits of the project were described from the data collected from the qualitative stakeholder interviews. Stakeholders are those who have an interest in the project. This is unfortunately only a limited assessment of the realised wider economic benefits. A more sophisticated evaluation of wider economic benefits along the lines of Gibbons et al. (2012) or Duranton and Turner (2012) is therefore left for further research. The limited data we had also made it challenging to identify the "counterfactual" (i.e. what would have happened in the absence of the project). Many of the projects were implemented as part of wider transport investment strategies and against a backdrop of rapid economic growth. In this situation, the attribution of wider economic impacts to a specific project is particularly challenging and careful attention to the type of baseline data and ex post data has to be made early in the project cycle – and such good quality data was not available to us.

The stakeholders interviewed were the funding agencies, the relevant transport authorities and some local politicians or council officers (see Table 2). The focus of the stakeholder interviews was threefold. Firstly it was to discuss the role and usefulness of the ex ante CBA in the decision-making process of the project in question and projects more generally in the country in question; secondly to identify missing data needed for the ex post analysis and make agreements relative to the provision or sourcing of this information; and thirdly, and as already mentioned, to discuss the project's wider economic, social and environmental impacts. Generally

it was found that sufficient ex post transport data existed and could be supplied (e.g. traffic count and accident data)[2], but that in some instances journey time data particularly on competing routes did not. Some journey time data was therefore collected as part of this research (see Table 2).

The final data input to the method were the discussions held at a dissemination workshop. This workshop focused on the provisional ex post findings and the provisional comparisons between the ex ante and ex post evaluations. The workshop was attended by the stakeholders who had been involved in the study along with representatives from other national transport authorities in other member states.

<<Insert Table 2 here>>

The project undertook two pilot projects (A2 Motorway in Poland and the Lisbon to Algarve Railway) to confirm the framework for analysis and allow its refinement. In the main it was found that the proposed framework was fit for purpose. These pilots did however identify problems in understanding the ex ante CBA where key officials in the country were no longer in position or external consultants had undertaken the analysis. They also identified difficulties in the identification of the wider economic benefits due to a lack of baseline and ex post data. The experiences from the pilot studies therefore resulted in more efforts being made at speaking to a wide range of local stakeholders and meant that the wider economic benefit assessment took on a more descriptive role.

[2] As the evaluation of the transport investment is a condition for receipt of EU Cohesion Fund or ISPA Fund funding baseline and ex post traffic data should be available for the projects in receipt of this funding. Furthermore our project selection procedure ensured that the projects selected were viable as case studies for ex post analyses.

To facilitate a comparison between the ex ante and ex post CBAs it was necessary to convert the ex ante CBA to the same price base as the ex post CBA. Clearly differences existed between the two CBAs and the final part of the method was to identify the source of these differences. This was undertaken by adjusting the inputs to the ex post CBA (in terms of transport related inputs, investment cost inputs and CBA parameters) for each of the 10 projects. This process then allowed the identification of the key sources of error in the ex ante CBA. The results are described in section 3.

3 A COMPARISON BETWEEN THE EX ANTE AND EX POST ANALYSIS

3.1 Review of ex ante analysis

This study identified that whilst the overall approach to the CBA was broadly similar and in line with CBA good practice there was a large variability in the parameters used across the different projects (and countries) and in the impacts included in the CBA. This is consistent with the findings in Odgaard et al. (2005). All projects included an assessment of the core impacts to users (time savings and reduction in vehicle operating costs), as well as the safety benefits. However in only four cases were the environmental impacts monetized and other impacts such as congestion benefits were only considered in two of the cases. This is in part a result of when they were undertaken (1995-2004) and the CBA requirements of the funding body.

CBA parameters where differences between projects occurred included discount rates (e.g. the rail project in Slovkia used a 10% discount rate compared to 8% for the motorway in Poland) and the lengths of appraisal periods (ranging between 20 years for the A2 motorway in Poland to 36 years for the Thriassio – Kiato railway in Greece). There were also differences in the values of time applied, which is expected as value of time depends on variables such as income and preferences – the latter of which can vary culturally. The unit cost of an accident varied significantly between countries – again these would be expected to vary given

differences in income and also in attitudes to risk, however, the observed variation was very large. For example the value for preventing a fatality in Ireland was 10 times the value in Spain and more than four times higher than in Lithuania.

The ex ante CBA analyses reviewed included various sensitivity tests as part of the risk analysis undertaken in all ten projects (see Table 3). The number of sensitivity tests for every project ranged from two to four, with the exception of the M1 Northern Motorway in Ireland which included 27 sensitivity tests. The capital cost of the project was the risk factor most frequently considered in the risk sensitivity analysis (eight out of ten projects included this factor). Travel demand was considered as a risk factor in only 2 of the 10 projects. Aside from sensitivity tests no other form of risk analysis had been undertaken.

Insert <<Table 3>> here

Drawing from the discussions with the stakeholders the role of the ex ante CBA in the decision-making process mainly relates to complying with EC requirements, though for 6 of the projects, the ex ante CBA was used by the member countries to ensure value for money when making choices about project implementation. In most cases the ex ante CBA was not used for strategic decision making, but had been used to aid choice between design standards, alignments, and to prioritise elements of the national transport strategy. In no cases was ex ante CBA used to allocate limited budgets between projects or to optimize the timing of project implementation.

3.2 Results of ex post evaluations

The results of the ex post evaluation of the ten projects are summarized in Table 4. The majority of projects have yielded a positive NPV, indicating that the economic

benefits of the projects have exceeded their costs. In the AVE Madrid – Barcelona project the NPV is negative for both the High case and the Low case. Non-quantified wider economic benefits were cited by the stakeholders to the project as a reason for this. For this scheme such wider economic impacts would need to be very large relative to the direct benefits and the capital costs for the project to start giving value for money (with present values between €1.9 billion and €2.7billion). As discussed earlier we have not been able to validate whether such benefits are realistic. The literature on the topic is unfortunately ambiguous, with some authors advocating significant benefits of high speed rail additional to the direct transport benefits (the user benefits) (Rosewell and Venables, 2013; KPMG, 2013) and others arguing the opposite. That is whilst high speed rail will give rise to changes in the economy user benefits measure the majority of this benefit (Graham and Melo, 2011).

<<Insert Table 4 here>>>

Figure 1 presents the benefit distribution for the 10 projects. Overall, it can be observed that most of the benefits for the railway projects arise from additional revenues from fares and travel time saving. On the other hand, for road projects, most of the benefits come from travel time saving and vehicle operating cost savings. This confirms the importance for rigorous demand modelling, especially when appraising road projects. Amongst the road projects we can also see quite a lot of variation in how the benefits comprise. For the Polish and Hungarian road projects travel time savings form the major component of benefit – as the new motorways bypass congested areas (some congested towns in the case of the Polish case study and Budapest city centre in the case of the Hungarian case study). In contrast for the Spanish motorway project time savings are less important and safety benefits become more relevant as the inter-urban route that has been upgraded did not experience much congestion. Vehicle operating cost savings are negative for the road schemes that give rise to longer road journeys

(Spain and Hungary) and form significant components of benefit where the road surface in the existing situation was very poor and imposing additional maintenance costs on the vehicles or where journey lengths have significantly decreased (Greek road case study). Variation in sources of benefit also occur amongst the rail projects where the benefits for the Spanish high speed rail project and the Slovakian rail project are driven primarily by fares, whilst non-user benefits (e.g. de-congestion on the road network) are more relevant to the Portuguese rail case study and the Greek case study.

<Insert Figure 1 here>

As discussed in Section 2 we made qualitative assessments of the wider benefits. In all instances some wider economic benefits were identified including impacts on: land use, the supply chain, GDP or output, employment, social inclusion, and the environment. However, aside from local land use and environmental effects we generally found it difficult to establish a direct causal link between the transport infrastructure investments and the observed effects. This is especially relevant for the impact on the GDP of the region/country. Future research is needed in this area.

3.3 Comparison of ex ante and ex post analyses

We can compare, using the various economic indicators, the results of the ex ante analysis with that of the ex post evaluation. The findings suggest that overall, the NPV was overestimated in the ex ante compared with the ex post evaluation. With the exception of the M1 Northern Motorway (Ireland), IX B Corridor (Lithuania) and Bratislava Railway Upgrade (Slovakia), the ex ante NPV of all of the other projects exceeded the ex post NPV, as shown in Figure 2.

<Insert Figure 2 here>

With the exception of the Hungarian M0 Budapest Ring Road project, the ex post capital costs exceeded ex ante figures in all projects. With an overall average cost overrun for the ten projects of 13.5%. This fits with the previous findings of Flyvberg (2007). Figure 3 shows the comparison between ex ante and ex post capital costs for each project.

<Insert Figure 3 here>

When focusing on the BCR indicator Figure 4 shows that ex ante and ex post BCRs differ. However, the evidence here is more mixed: for half of the projects, the ex post BCR is higher than the ex ante BCR. There is also no clear pattern between road and railway projects. The lack of systematic variation between ex ante and ex post BCRs, unlike the systematic bias evident in the NPV and capital cost estimates results, from the relative rates of change in user benefits and capital costs between the ex ante and the ex post.

<Insert Figure 4 here>

The study identified a number of key differences between the ex ante and the ex post results. Realised investment costs were the main source of difference in 5 projects, while it played a secondary role in another 4 projects (as shown in Figure 3). Travel demand was a primary factor for the discrepancy between ex ante and ex post results in 8 of the 10 projects. The discount rate was an important factor in

all 10 projects. In addition the opening year was found to be a contributing factor to the differences in 9 of the 10 projects. Other contributing factors included differences between actual and forecast economic growth (the period of study was particular turbulent time for economic growth across Europe), errors in population growth forecasts and the marginal values used for the analysis (e.g. values of time). Whilst these latter differences could explain some of the difference between the ex ante and the ex post results, the main contributors were as identified above differences in capital costs and travel demand.

4 LESSONS LEARNT

4.1 Ex ante appraisals

Overall, the ten case studies examined in this report demonstrate an acceptable or good value for money from the perspective of the European taxpayer (NPV>0 and BCR>1). The exceptions are the two Spanish studies. The A23 road project is marginal in terms of value for money and the AVE Madrid Barcelona high speed line offers poor value for money (NPV<0 and BCR<1). Whilst these general findings represent positive news, there is some concern regarding the fact that two substantial and expensive projects are not giving good or even acceptable value for money. Additionally our findings suggest optimism bias is present. Seven out of the 10 case study projects yielded an NPV that was lower ex post than expected ex ante.

In the main the scope of the ex ante CBAs undertaken were quite narrow with most not including environmental externalities, network effects or disaggregating between business and non-business traffic. Whilst the environmental externalities do not have a big impact on the NPV, network effects can. In only 5 out of the 9 projects where re-routed/re-assigned traffic was relevant was it modelled. Only four projects accounted for modal shift and generated traffic – and these are significant infrastructure investments. Transport/economy network effects including land use effects and second order impacts on travel demands were not modelled in any of

the projects. Related to this is the definition of the counterfactuals, which were sometimes inadequately defined. For example in only four of the ten projects were other expected changes in the transport network included in the analysis. For rail and toll motorway projects it is essential that the pricing policy is defined correctly. Not only does the pricing policy affect the distribution of benefits between operators and users but it also strongly influences the demand for a project. A better modelling and forecasting exercise would have gone someway to improve the discrepancies between the realised and ex ante expected travel demands.

As mentioned earlier the average difference between ex ante and ex post capital costs across the ten projects is 13.5%. Five projects experienced significant cost overruns with the most significant occurring on the Ireland M1 motorway. Four projects experienced slight cost overruns. Interestingly there was also a significant under-spend in Hungary (M0 motorway). A number of factors seem to be at play here. As is typical in the literature: project delays, alterations in scope and other unforeseen circumstances all increased capital costs. We did not investigate whether the procurement process and the management of the maintenance contract (i.e. different forms of public-private partnership) influenced the level of construction cost overrun. This would be a subject for further research.

The average cost overrun of 13.5% is low compared to other ex post findings (e.g. Flyveberg, 2007), but is high compared to findings for projects which are at and advanced planning stage. For example Flyberg (2004 cited in DfT, 2014) and Mott MacDonald (2002 cited in DfT, 2014) found that for projects at the work commitment stage in the UK cost over runs were in the region of 3% for roads, 6% for rail and 6% for fixed links. Our discussions with stakeholders indicated that aside from the Ireland M1 motorway the ex ante costs were updated at the time EU funds were applied for. The ex ante costs contained in the applications for funds to the EC are therefore fairly advanced cost estimates. As this updating process did not happen for the Ireland M1 motorway it is unsurprisingly that the largest cost overrun of the 10 projects occurred there. In the Hungary case, despite an update in capital costs immediately prior to submission for Cohesion Funding, there was a large over estimate in the ex ante costs due to the uncertainty of the impact of

international construction firms bidding at very competitive rates for work in the old Eastern Block. We therefore conclude that optimism bias in capital costs remains prevalent.

Clearly it is almost impossible to forecast the future with precision – accounting for risk and uncertainty in the appraisal is therefore essential. While some of the risk bearers were identified in the ex ante risk analysis, not all of them were. As has been discussed above the main sources of difference between ex ante and ex post economic analyses were differences in capital costs and travel demand. For eight of the projects capital costs were identified as a risk bearer but in only two of the ten projects were travel demands identified. The risk analysis undertaken was also of the more basic sensitivity test form. None of the studies undertook a quantitative risk analysis using Monte Carlo simulation via comprehensive software packages such as @RISK or Crystal Ball. A more comprehensive risk analysis that paid greater attention to variations in travel demand and the sources of that (economic growth, development impacts and other transport projects in the locality) would have improved the robustness of the ex ante appraisals.

Our interviews and final dissemination workshop identified the limited use that CBA and other forms of appraisal (e.g. multi-criteria analysis) play in decision-making in the eight countries considered. In the main CBA appears to be treated as a hoop that is jumped through to achieve funding, though there was some recognition that CBA does offer a value for money test. This raises a number of issues of which the two most pertinent are that if CBA is just a procedural issue and has no input into the project development then few resources will be invested in ensuring the analysis is robust. This is undoubtedly one of the main contributors to the travel demand models used in the appraisals being weak and the risk analysis limited. A second problem with applying formal appraisal procedures late in the project development cycle is that by this time political momentum has built up and there is therefore an incentive to be overly optimistic regarding the benefits of the project in the appraisal. Bringing robust appraisal methods into play earlier in the project development cycle can therefore help minimise the number of poor decisions made.

4.2 Challenges with ex post analyses

We experienced a number of technical challenges in undertaking the ex post analysis – some of these are not pure ex post related but were an outcome of a desire to learn lessons on ex ante analyses. The first challenge is, what we have termed, a loss of institutional memory. In terms of planning and design, most of the projects we considered date back to the late 1990s. Due to the time elapsed, some of the institutional memory regarding the ex ante analyses has inevitably been lost – for example, it was not possible in all the projects to identify all the assumptions underpinning the original analysis. Related to this was the need to engage with different stakeholders and the provision of information. This is particularly the case for rail projects, where national railway organizations are split between network and train operations. Here the information underpinning the ex ante analysis may be split between different companies.

The impacts of transport projects typically take some time to feed through into all aspects of both travel behaviour and land use and have long lives. Whilst undertaking ex post studies within several years after project completion gives accurate information on outturn project costs and existing traffic levels, there is a need to make assumptions about future traffic levels over the remainder of the project life. The ex post CBA analysis that can be undertaken therefore has some uncertainty about it – as it is more of an update of the ex ante analysis. Some of the case studies had only been operational for 12 months and therefore travel behaviour was still adjusting. This can lead to a further degree of uncertainty in the calculation of the "ex post" project benefits, especially in the context of the global economic downturn. Wider socio-economic impacts generally take a significant period of time to emerge. For this reason, it can be difficult for an ex post analysis to consider all the effects since some of them may have not yet materialised.

There clearly exists a dilemma regarding the best time to undertake an ex post CBA analysis. On the one hand, it needs to undertaken as soon as possible to minimise institutional memory loss, maximise the value of feedback into the ex ante

planning, modelling and appraisal processes and to make the definition of the counterfactual as easy as possible. On the other hand, there may be a desire to wait until the transport impacts have fully fed into the wider economy and land use patterns have settled down. Drawing from the experience of existing ex post programmes, our experiences and the considered opinion of attendees at the workshop scheduling ex post CBA 3-5 years after project opening was considered an appropriate compromise.

Wider social and economic benefits are typically regarded as a key outcome of Cohesion Funded transport projects. However, the lack of a project monitoring frameworks, implemented at or before project opening, makes the identification of these wider impacts almost impossibly challenging. This is especially the case for projects being implemented as part of a wider modernisation strategy, against a backdrop of rapid economic growth in the early 2000s and other infrastructure investments.

A perennial challenge with ex post studies is the definition of the counterfactual. Any change that occurs simultaneously with the opening of the transport project makes it difficult to identify the effects of the project. In these case studies, economic change and changes to the transport network were the two biggest confounding factors. Rapid economic growth in some EU accession countries before 2008 and the economic recession have influenced the general pattern of economic growth in the EU. All of the projects studied suffered from this in one form or another. Another problem, that is most evident with the Hungarian road project, is that impacts are confounded with that of other transport projects. With respect to the M0 Eastern Sector several other transport initiatives of a similar scale to the M0 Eastern Sector affected traffic flows within weeks of the M0 opening.

5 CONCLUSIONS

Despite much attention being placed on the issue of optimism bias over the last

decade our research identifies that it remains prevalent. In the ten major transport projects we have reviewed there has been a systematic bias towards an underestimation of costs and higher NPVs than can be justified from outturn impacts – this is despite most of the ex ante analyses being revisited fairly close to construction beginning.

From a policy perspective this is of concern as it can be evidence that poor decisions are being made. There is a clear need to improve the quality and consistency of ex ante analysis – particularly in the areas of capital cost estimation, travel demand modelling and risk analysis. Ex post analysis can make a valuable contribution to this. With an ex post evaluation program, patterns and best practices can be identified. These can be fed back into the ex ante planning, modelling and appraisal processes.

An ex post program should not be confined to just the practicalities of undertaking an ex ante analysis, but should also concern itself with the processes that lead to decisions being made as these can also lead to poor decision-making. Our research identified that formal cost benefit or multi-criteria analyses do not routinely form part of the decision-making processes in the majority of the countries in which the case studies were undertaken. Typically they do appear in these processes as either a final value for money check or as a hurdle that has to be crossed to obtain funding. Bringing robust appraisal strategies earlier into the project development cycle would identify strong and weak projects at a time when significant political momentum has yet to develop behind any particular project.

The cost of obtaining data, defining the counterfactual and institutional memory loss are the key challenges associated with undertaking ex post appraisal. Taking these issues into account our view, based on our research, is that the ex post analysis needs to be conducted between 3 and 5 years of scheme opening. This of course means that many of the benefits of the projects are yet to be realised, so some forecasting is necessary to generate an „ex post" cost benefit analysis. Additionally it is necessary that monitoring frameworks are put into place before opening and maintained after opening. If these monitoring frameworks can be

incorporated into the infrastructure (e.g. automatic traffic counters) this will also minimise the costs of undertaking ex post appraisal.

Ex post analysis is relatively infrequent – despite the noted programmes in Britain, France and Norway. There therefore remains substantial scope for further research. A meta-analysis of international ex post studies would provide a rich data source – as too often a national meta-analysis is confounded by the fact that the same forecasting and appraisal process is used for all schemes. There also remains the challenge not yet fully addressed in the literature of identifying ex post the scale of wider impacts in an econometrically robust manner. This would require monitoring programmes that included household and business surveys before and after scheme opening.

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GLOSSARY

CBA	Cost Benefit Analysis
PVB	Present Value of Benefits. The PVB is the sum of the discounted benefits over the appraisal period.
PVC	Present Value of Costs. The PVC is the sum of the discounted costs over the appraisal period.
NPV	Net Present Value. The NPV is the sum of discounted benefits minus the sum of discounted costs: PVB – PVC. A positive NPV means that discounted benefits outweigh discounted costs.
BCR	Benefit Cost Ratio. The BCR is calculated by PVB / PVC. It calculates how much benefit is obtained for each unit of cost, with a BCR greater than 1 indicating that the benefits outweigh the costs.
IRR	Internal rate of return. The IRR represents the discount rate at which the NPV is zero. If the IRR> discount rate used then it is an indicator of good economic return.
Ex ante	Pre implementation
Ex post	Post implementation
POPE	Post Opening Project Evaluation

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Table 1. Overview of projects considered

	Opening date(s)	Date of Ex ante appraisal	Capital costs - €million (% Cohesion Fund contribution)
AVE Madrid – Barcelona (Spain)	2003 – 2008	2001	1,719 (61%)
A2 Motorway (Poland)	2006	2003	476 (82%)
Algave Railway (Portugal)	2003-2006	1999	419 (77%)
A23 Motorway (Spain)	2001-2005	1999 and 2003	203 (83%)
Agios Konstantinos Bypass (Greece)	2008	2002	441 (55%)
M1 Northern Motorway (Ireland)	2003	1995	232 (66%)
Railway Thriassio- Kiato (Greece)	2005-2007	2000	619 (47%)
IX B Corridor (Lithuania)	2006-2009	1999	154 (79%)
Bratislava Railway Upgrade (Slovakia)	2003-2009	2001	234 (39%)
M0 Budapest Ring Road (Hungary)	2008-2010	2004	367 (74%)

Table 2. Stakeholder interviews

	Organisations interviewed/consulted	Information on the interviews (number of interviews)	Data collected to supplement data provided by national agencies
AVE Madrid – Barcelona (Spain)	Ministerio De Fomento, Adif, Renfe	One interview for each (3)	No additional data collection was necessary as all data was provided by Adif
A2 Motorway (Poland)	European Investment Bank Generalna Dyrekcja Drog Krajowych Autostrad (GDDKiA) Lodz Special Economic Zone Centre for European Transport Projects Ministry of Infrastructure Gmina of Strykow Konin County Council	One interview for each (7)	Journey time surveys along the scheme section and parallel alternative routes were undertaken to complement count data provided by GDDKiA
Algarve Railway (Portugal)	Comboios de Portugal, REFER, Ministério da Economia e do Emprego	One interview for each (3)	No additional data collection was necessary as all data was provided by REFER
A23 Motorway (Spain)	Ministerio de Fomento (Direccion General de Carreteras), Gobierno de Aragón	One interview for each (3)	No additional data collection was necessary, as all data was provided by the Direccion Nacional de Carreteras
Agios Konstantinos Bypass (Greece)	Ionia Odos (Concessionaire) Ministry of Economy Ministry of Transportation PATHE Mayor of Agios Konstantinos	One interview for Mayor of Agios Konstantinos. Workshop covering all other stakeholders	Journey time surveys were undertaken

	Organisations interviewed/consulted	Information on the interviews (number of interviews)	Data collected to supplement data provided by national agencies
M1 Northern Motorway (Ireland)	National Roads Authority (NRA) Department of Finance (EU Cohesion Fund), Representative of Fingal County Council AECOM – Consultants Road Safety Association (RSA) Ireland,	One round table with all organisations present plus 2 separate interviews with NRA staff	No additional data collection was necessary, as all data was provided by the National Roads Authority and the Road Safety Agency
Railway Thriassio-Kiato (Greece)	Prefecture of West Attika ERGOSE Ministry of Economy TRENOSE	1 meeting with Prefecture of West Attica. Group workshop with remaining stakeholders.	No additional data collection was necessary as all data was provided by TRENOSE/ERGOSE
IX B Corridor (Lithuania)	Transport Investment Directorate, Ministry of Finance, Ministry of Transport, Municipality of Vilnius	One interview for each (4)	No additional data collection was necessary as all data was provided by the Ministry of Finance and the Municipality of Vilnius
Bratislava Railway Upgrade (Slovakia)	Železnice Slovenskej Republiky (ŽSR) Bratislava Regional Chamber of Commerce Národná diaľničná spoločnosť, a.s (NDS) Ministry of Transport, Posts and Telecommunications	The representative from the Ministry of Transport, Posts and Telecommunications was present in the meeting with the highway authority	All data provided by ŽSR and NDS
M0 Budapest Ring Road (Hungary)	Nemzeti Fejlesztési Ügynökség (NFU) (National Development Agency), KIKSZ Közlekedésfejlesztési Zrt. (KIKSZ) (Transport Development Ltd), Nemzeti Infrastruktúra Fejlesztő Zrt. (NIF) (National Infrastructure Development Ltd), Csömör Municipality	1 roundtable discussion with NFU, KIKSZ and NIF. 1 interview with the mayor of Csömör Municipality	Journey time surveys along 2 routes previously used by transit traffic through Budapest city centre in the AM peak.

Table 3. Risk analysis. Sensitivity tests run and risk factors considered

	Sensitivity Tests Run	Risk Factors considered			
		Travel Demand	Fuel Prices	Capital Costs	CBA Parameters
AVE Madrid – Barcelona (Spain)	2			X	
A2 Motorway (Poland)	4	X		X	
Algave Railway (Portugal)	2				
A23 Motorway (Spain)	2			X	
Agios Konstantinos Bypass (Greece)	4			X	X
M1 Northern Motorway (Ireland)	27	X	X		X
Railway Thriassio-Kiato (Greece)	2			X	
IX B Corridor (Lithuania)	3			X	X
Bratislava Railway Upgrade (Slovakia)	3			X	X
M0 Budapest Ring Road (Hungary)	4			X	X

Source: Ex ante CBAs

Table 4. Ex post evaluation – economic appraisal indicators

	PVB (€m) High Low	PVC (€m) High Low	NPV (€m) High Low	BCR High Low	IRR High Low
Rail Projects					
AVE Madrid – Barcelona (Spain)	5,744 4,856	7,692 7,593	-1,948 -2,736	0.7 0.6	3.7% 2.6%
Algave Railway (Portugal)	410 379	331 331	79 48	1.2 1.1	7.4% 6.7%
Railway Thriassio- Kiato (Greece)	583 358	326 326	258 32	1.8 1.1	9.3% 6.1%
Bratislava Railway Upgrade (Slovakia)	443 291	231 231	98 40	2.0 1.4	10.4% 7.8%
Road Projects					
A2 Motorway (Poland)	1,168 791	268 268	900 523	4.4 3.0	22.8% 18.2%
A23 Motorway (Spain)	253 198	225 225	28 -28	1.1 0.9	6.3% 4.6%
Agios Konstantinos Bypass (Greece)	488 438	206 206	283 233	2.4 2.1	13.4% 12.6%
M1 Northern Motorway (Ireland)	4,140 4,040	235 235	3,905 3,805	17.6 17.2	53.0% 53.0%
IX B Corridor (Lithuania)	300 288	88 88	212 200	3.4 3.3	56.0% 53.0%
M0 Budapest Ring Road (Hungary)	1,187	213	974	5.6	24.8%

Note: Factor prices for all schemes except for Bratislava Railway Upgrade (Slovakia) and Railway Thriassio – Kiato (Greece) where figures are in market prices.

Figure 1. Sources of benefits

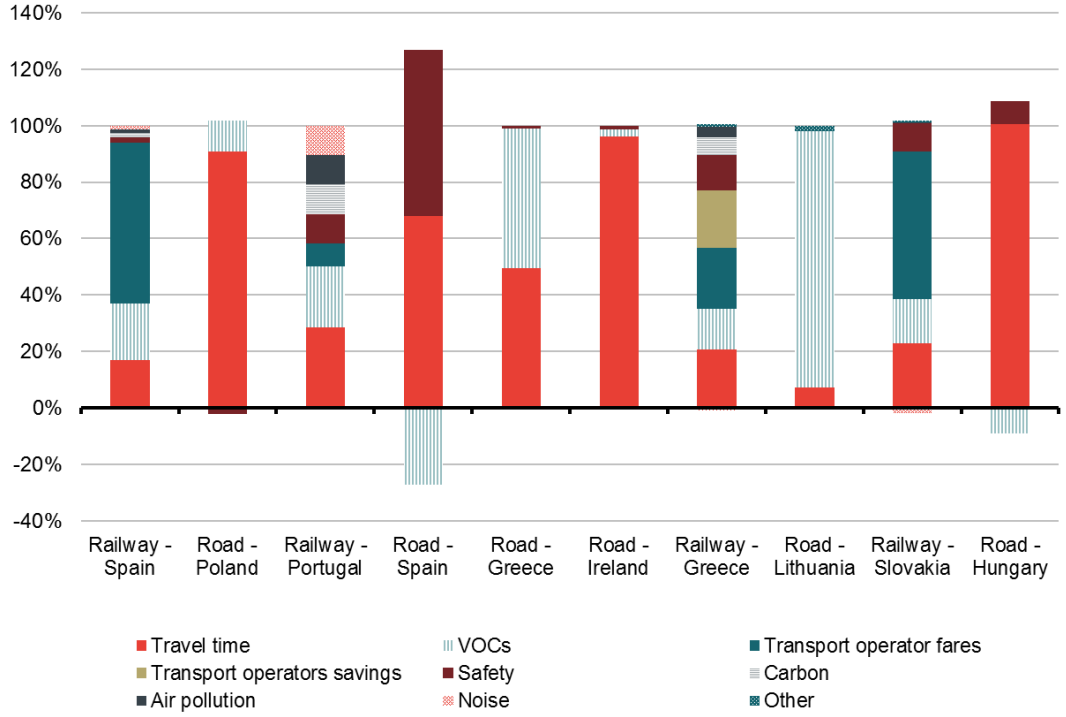
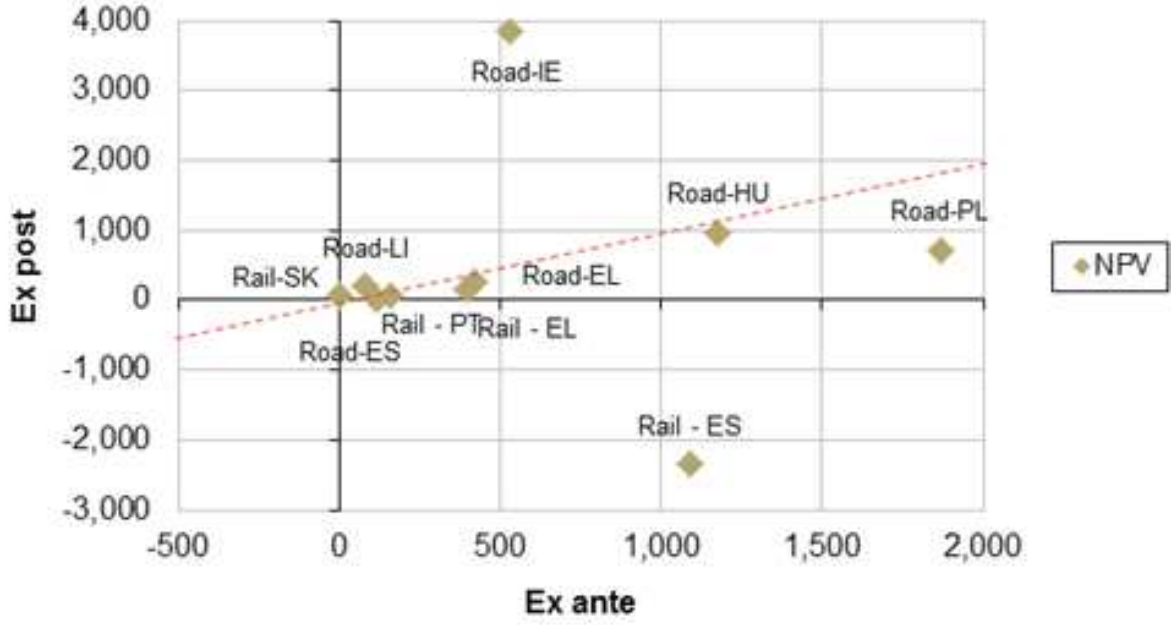
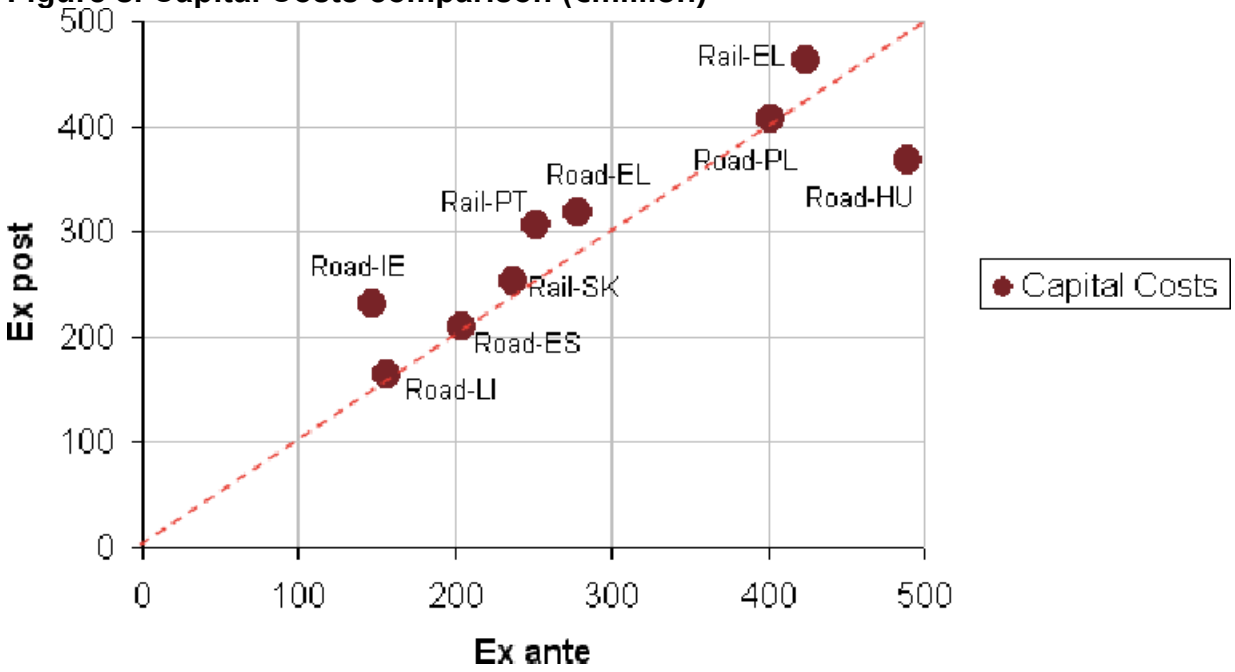


Figure 2. Comparison of ex ante and ex post NPV (€million)



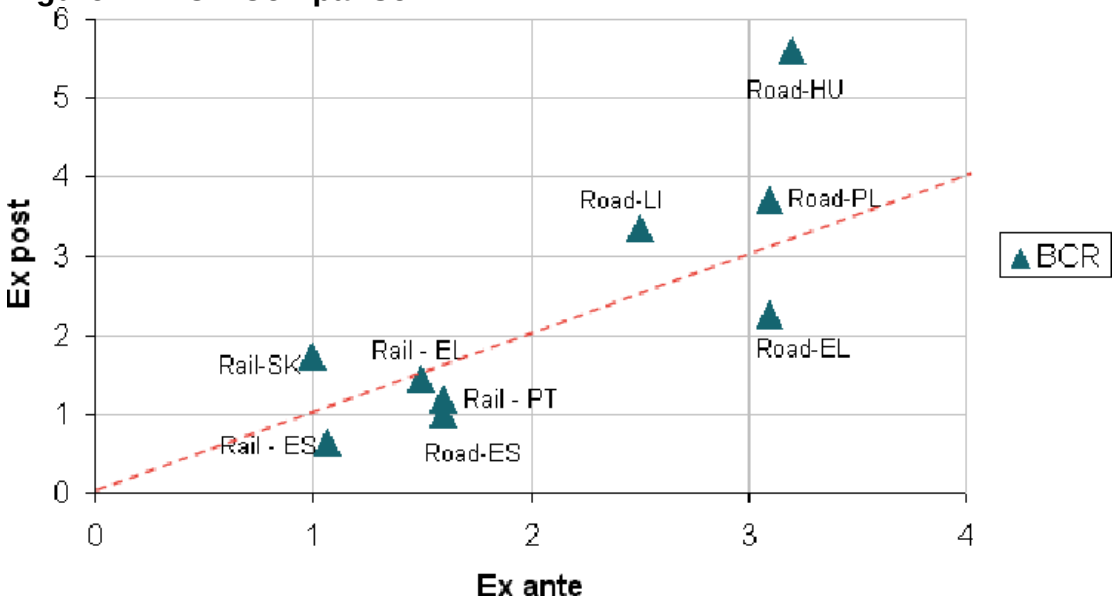
Note: Ex post figures correspond to the average for the high and low case scenarios

Figure 3. Capital Costs comparison (€million)



Note: AVE Madrid Barcelona has been excluded from the graph as it is an outlier

Figure 4 . BCR Comparison



Note: (i) Excludes Road – Ireland; (ii) Ex post figures correspond to the average for the high and low case scenarios.