Best practices
in cost-benefit analyses
of transport projects co-funded
by the European Union

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Foreword

I have pleasure of presenting you a publication dedicated to best practices in cost-benefit analyses (CBA) of transport projects. It is based upon Centre for EU Transport Project's (CEUTP) experience in reviewing applications for EU co-funded transport projects within the framework of the 2007-2013 Operating Programme 'Infrastructure and Environment'.

Its focus is selected CBA issues that in the past programming period inconvenienced beneficiaries and consultants who carried out the analyses. The detailed CBA methodology – well-described in programme guidelines and **CBA** guides – is rather not problematic to analysts. As a matter of fact, it is the scope of required analyses, their interdependencies, and a proper presentation of conclusions in the submission form, feasibility studies and spreadsheets that turned out to be a challenge. For this reason, we decided to present the general outline of CBA requirements combined with text-book recommendations and detailed methodologies we worked out together with the EU beneficiaries. Furthermore the 'Best practices in cost-benefit analyses' introduces basic changes to be implemented in the CBA methodology in applications submitted in the programming period 2014-2020. The structure and scope as well as many of the recommendations have been formulated by experts who on a daily basis review CBAs submitted in **CEUPT**.

The publication is intended for all current and future EU beneficiaries in the transport sector. It provides numerous tips to project promoters who are going to order CBAs for new projects or are reviewing feasibility studies for internal purposes, to consultants working on CBAs and feasibility studies as well as those who have to modify the CBAs in response to evaluators' comments and suggestions. To facilitate search for the CBA principles currently in force, the **CEUPT** website section on CBA is continuously updated with current methodology interpretations and answers to frequently asked questions posed by beneficiaries and feasibility study authors.

I am convinced that the 'Best practices in cost-benefit analyses' will be of assistance in the process of preparing the transport sector investment projects in the programming period 2014-2020 and consequently facilitate accomplishment of the **CEUPT** mission.

/Paweł Szaciłło/

Abbreviations and acronyms

AADT	annual average daily traffic
BB	Blue Book
BCR	benefit-cost ratio
CBA	cost-benefit analysis
EC	European Commission
ECA	European Court of Auditors
ECB	European Central Bank
ENPV	economic net present value
ERR	economic rate of return
EU	European Union
FNPV	financial net present value
FNPV/c	financial net present value of investment
FNPV/k	financial net present value of capital
FRR	financial rate of return
FRR/c	financial rate of return on investment
FRR/k	financial rate of return on capital
FS	feasibility study
GDP	gross domestic product
GHG	greenhouse gases

IRR	internal rate of return
JASPERS	Joint Assistance to Support Projects in European Regions
kmt	kilometre-tonne
LOS	level of service
NPV	net present value
PSC	public service contract
WTP	willingness to pay
VoT	value of time

Cost-benefit analysis in application documents

Every transport project promoter who applies for EU funding (referred to as the beneficiary of EU funding) is obliged to **submit an application for co-financing that contains a cost-benefit analysis** of the underlying project (CBA). The CBA is part of a feasibility study or another document that presents information from past project studies (the so-called results of the feasibility study).

CBA in the feasibility study

Good practice will be to cover the following issues in the feasibility study:

- the existing transport problem behind the decision to carry out the investment project including presentation of expected project results (the so-called intervention logic),

- socio-economic context of the project[1] ,

- project reference to the European, domestic and local transport strategies,

- complementary investment projects carried out by the project promoter or other entities,

- option analysis, including alternative investment options considered and principles for selection of the investment option (investment scenario) to be carried out,

- identification of the project and the budgeted cost of work scheduled,

- institutional analysis, i.e. information on entities involved in the project, their funding principles and their terms of cooperation,

- cost-benefit analysis (CBA)

The CBA itself should for the most part focus on:

- detailed **demand forecasting** together with capacity analysis[2],

- **financial analysis** and **financial sustainability analysis**,

- **socio-economic analysis**,

- **sensitivity and risk analysis.**

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[1] Beneficiaries readily present the region where the investment project is located including a wide range of information completely unrelated to the project itself or even to transport needs of the project area. The chapter focusing on the socio-economic context becomes then far too long. A good practice is to provide only information necessary in order to understand the rationale for the project.

[2] The capacity analysis shows whether, and if so when, a capacity cap is to be imposed on the demand forecast, as well as determines changes in project assumptions due to decreased level of service (LOS) resulting from capacity shortage (congestion).

The order of chapters does not need to correspond to the order in which they are listed in the guidelines. It would be good practice to sort the issues presented so that they form a logical sequence. If the selection of investment option was based on the value of economic performance indicators (ENPV, ERR, BCR) calculated for the purposes of the underlying study, the socio-economic analysis is to be presented after the option analysis. The financial analysis will be in turn placed further in the study (we conduct it for the selected investment option only, i.e. for the project for which we file the application). This sequence will not however be appropriate if the option analysis was performed by means of a different method (for instance multi-criteria analysis, cost effectiveness analysis or socio-economic analysis conducted earlier in another study). In such a case, the chapter on selection of options will present the reasoning behind the selection of the final investment scenario (option). Consequently, the CBA chapter will contain the socio-economic analysis conducted for application purposes in accordance with the currently recommended methodology.

Figure 1. CBA in feasibility study

INTERVENTION LOGIC
SOCIO-ECONOMIC CONTEXT
STRATEGIC DOCUMENTS
COMPLEMENTARY INVESTMENT PROJECTS
OPTION ANALYSIS
IDENTIFICATION OF THE INVESTMENT PROJECT
INSTITUTIONAL ANALYSIS
COST-BENEFIT ANALYSIS

DETAILED DEMAND FORECAST
FINANCIAL ANALYSIS
SOCIO-ECONOMIC ANALYSIS
SENSITIVITY AND RISK ANALYSIS
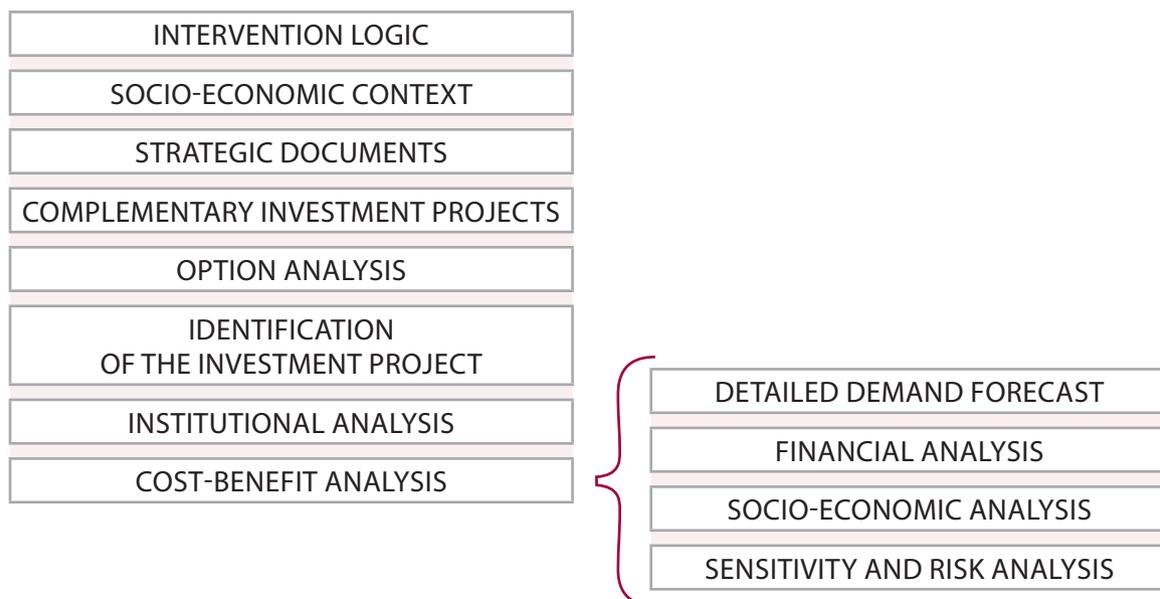
A spreadsheet presenting all analysis-related calculations from assumptions to final results, must be filed along with the study. The spreadsheet is not only presenting the CBA details, but it is also an analytical tool which will be used by the beneficiary for the entire duration of the investment process until it is settled. Sometimes it is also used in the entire period of the project durability required by the EU regulations. It may be necessary for instance to update calculations due to changes in the project scope or cost schedule, significant changes in the tariff policy[3] or when the beneficiary wants to verify the result indicator, etc. Therefore, once the assumptions have been changed, the spreadsheet is supposed to automatically recalculate the analysis. Our past experience led us to introducing a strict requirement for open formulas in the spreadsheet (later included in national guidelines), as well as other detailed requirements (see *Transparency and flexibility of the spreadsheet calculations*). The description of CBA assumptions in the study is to be detailed enough not only to enable the appraisal of the analysis in the application process, but also to allow an analyst who is not familiar with the project to introduce changes into the spreadsheet in the future. It is also in the beneficiary's interest to acquire the copyright to both the study and the financial model in the spreadsheet.

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[3] Depending on rules adopted by Managing Authorities.

Demand forecasting in the CBA

Every beneficiary of the EU assistance is obliged to present a result indicator for the underlying project, which is based on a realistic (feasible) transport forecast. The indicator is usually calculated for the first full calendar year of the operating period (the so-called target year). In some operating programme measures, it is monitored throughout the entire period of the required project durability. If the project fails to achieve the forecasted ex-ante result indicator, ultimately the project promoter might be obliged to return part of the EU funding.

The CBA is in turn based on the transport forecast for the entire reference period. Realistic, i.e. feasible assumptions may be established for the short-term forecasting period (up to 2 years) and to a lesser degree for the medium-term forecasting period (up to 5 years). The long-term transport forecast that corresponds to the CBA reference period may be at best linked to the current macro-economic projections by means of elasticity coefficients. Due to unpredictability of socio-economic trends in the long-term we can however barely assume its complete accuracy.

As for infrastructure investment projects, we may deal with a government forecast, managerial forecast and bank forecast. The government forecast is always to be treated with due caution. The managerial forecast will be more realistic, though it is based on targets which are not one hundred per cent likely to be fulfilled. Bank analysts, on the other hand, assess the real probability of recouping their investment. Their forecasts are usually closest to reality.

A good practice is **to maintain caution when forecasting demand**. During the first years of the reference period, it is important to decide on assumptions with utmost care. The result indicator taken from demand forecast will be then achievable. For the longer forecasting period, we use the basic

economic development scenario, as well as cautiously and conservatively selected factors of transport demand elasticity to the GDP growth rate. If the project is economically justifiable, we try to prove it through a catalogue of socio-economic benefits that match the project objectives. Forcing up the demand forecast in the CBA in order to justify the project may result in false assumptions in the project financial sustainability analysis. Capital expenditure is co-financed by the European Union. On the other hand, maintenance and replacement expenditure in the entire reference period is the project promoter's responsibility. For revenue-generating projects, an overstated transport forecast will result in underestimating the financial needs of the beneficiary and other entities involved. Ultimately, it may turn out that the investment was unaffordable (see *Realistic demand forecasts …*).

Financial analysis in the CBA

The financial analysis in the CBA corresponds only to a certain degree to the standard financial analysis. It includes elements and indicators by no means mentioned during a standard training for financial analysts. This is why before carrying out the financial analysis, it is a good practice to understand its objectives and structure, as well as to get familiar with its general principles.

The aim of the financial analysis is to check:

- **the funding gap**, i.e. estimation which part of capital expenditure is to be funded by the EU taking into account the project profitability. Projects subject to state aid rules are, by definition, exempt from the funding gap calculation[4],

- **project financial profitability** measured by the net present value and the internal rate of return on investment (FNPV/c and FRR/c), which do not take funding sources into account, as well as the return on national capital (FNPV/k and FRR/k), which takes into account the EU grant and external financing costs. Transport projects eligible for EU funding, except for projects subject to state aid rules, are by definition unprofitable from the financial point of view,

- **project financial sustainability** understood as the project promoter's ability to maintain a positive balance of accumulated cash flows at the end of each year of the reference period.

The financial analysis is supposed to reflect the project promoter's actual financial condition. This applies particularly to cost and revenue assumptions (unit rates, indexation, etc.) while simultaneously taking into account all

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[4]   In the programming period 2014-2020 the European Commission allowed a flat rate mechanism that results in a standardized funding gap rate. It does not mean however that beneficiaries will not have to conduct the financial analysis. The financial parameters are to be taken into account in the socio-economic analysis, and the latter is usually obligatory.

potential costs and only assured revenue (conservative approach). It is very important to the analysis that the analyst who prepares the projection starts from a detailed transport forecast. In the transport sector, especially in competitive markets (like long-distance passenger transport services, freight transport), it would be a mistake to perform the financial projections first, and later to prepare demand forecasts based on the former. Realistic assessment of the ability to acquire customers and cargos should be considered priority, particularly as it determines the project result indicator which is binding for the beneficiary. **Financial projections submitted with the application are hence to be derived from the transport forecasts.** Simultaneously, historical data and projections in the financial analysis should correspond to the content of financial documents submitted for appraisal by the project promoter and related entities (see *Internal consistency and transparency...*).

Socio-economic analysis in the CBA

The main purpose of the socio-economic analysis is to show that the project is eligible for EU funding. A positive ENPV is the precondition for the eligibility. (If ENPV>0, ERR>i, whereas i is the economic discount rate, and BCR>1). The analysis itself is however not about the profitability for the project promoter. It is all about profitability for the society.

According to EU guidelines, there are three major requirements for the socio-economic analysis of transport projects:

- the analysis should focus on **social welfare effects,** rather than the project promoter's welfare. Customarily, the project promoter's revenue is excluded from the analysis. (We do include their cost savings by means of importing them into the socio-economic analysis from the financial analysis);

- we include **only direct effects of the project,** that is only its measurable benefits for transport market participants and the environment. We can also include other effects (like employment effects) but only when we are able to attribute them directly to the project. The analysis does not include effects dispersed in the economy, such as multiplier effects, or newly created jobs in the project vicinity. They are generated simultaneously by many different investments and there is no clear methodology for attributing them to particular projects[5];

- the analysis should focus on **generalized transport costs and monetizable externalities.** As for the generalized transport costs i.e. costs determining transport demand, we analyze them for the existing transport flows, for flows diverted from alternative transport routes, and flows of induced transport demand. The monetized externalities are accident costs, pollution

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[5] EU auditors asked us repeatedly about quantification of effects dispersed in the economy, and particularly about jobs created in the project vicinity. In such a case, we usually focus on methodology-related problems. It is a different thing, for instance, to indicate the number of jobs at wharves which will be created thanks to a port channel deepening project (it can be calculated on the basis of ship-to-shore capacities), than to indicate the number of jobs to be created within fifteen km or more from the modernized airport.

and climate change (greenhouse gases, GHG) costs, as well as costs of noise in urban areas.

The starting point for the socio-economic analysis is the demand forecast prepared either separately for the counterfactual scenario and investment scenario, or incrementally, as well as the incremental financial projections.

In order to identify the socio-economic effects, we take a close look at transport chains in both scenarios, and we analyze differences between them in generalized transport costs and monetizable external effects. Quantified and monetized net benefits are added to financial cash flows in the socio-economic analysis.

To do so, we have to properly prepare cash flows from the financial analysis. As mentioned before, first we remove revenue flows. What remains is investment expenditure, operating and replacement expenditure and residual value. For the purposes of the socio-economic analysis, they need to be appropriately converted by eliminating any fiscal transfers. In practice this means elimination of VAT where values were expressed as gross of VAT[6], and after that multiplying all net cash flows by averaged fiscal correction factors (direct taxes and other indirect taxes if applicable). The standard factors may be found for instance in the JASPERS Blue Books. If cost items seem to be distorted by subsidies or transfer prices, we correct for them as well. At this point however, conversion factors must be specified on a case-by-case basis[7].

The sum of converted financial cash flows and net socio-economic flows is the basis for calculating economic performance indicators (ENPV, ERR and BCR). If the analysis shows that costs exceed benefits, the project is pointless from the socio-economic point of view, or... if this seems not to be true – we did not accurately pick our catalogue of socio-economic benefits (see *Selection of socio-economic benefits catalogue...*).

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[6] The financial analysis is based on cash flows gross or net of VAT, which depends on whether VAT is reclaimable or not.

[7] None of the projects we evaluated required any corrections related to subsidies or transfer prices.

Additional difficulties arise when CBA has to address complementary projects. The first option is to analyze complementary projects jointly. (The financial analysis for the purpose of project submission is always done separately for each project in line with the project scope presented in each submission form). Alternatively, we may create a methodology to separate the effects of one project from effects of the other, so that it is possible to conduct both socio-economic analyses separately. The third option is to perform a joint analysis and after that specify a key to allocate the effects to each project. During project audits, EU auditors asked us about the added value of particular projects when the original analysis treated several projects jointly, as well as about an aggregated result when projects were considered separately in the original analysis.

Sensitivity and risk analysis in the CBA

The scope and methodology of the sensitivity and risk analysis in EU projects are defined by the application form structure itself. Therefore, sensitivity analyses in most applications comply with formal requirements. Yet, we frequently have doubts whether sensitivity is properly related to the risk analysis. These two analyses together are a good tool for ex-ante appraisal of project parameters if probable risk factors should materialize (see *Sensitivity and risk analysis...*).

The sensitivity analysis examines the impact of changes of major CBA assumptions on the value of financial and economic performance indicators. Its purpose is **to check whether the project would still be justifiable and eligible for EU funding if the quantifiable project risks were to materialize.** A properly conducted sensitivity analysis allows the EU project evaluators to approve the project even if there are doubts concerning some assumptions. They can see CBA results calculated for other values of these assumptions or by means of the ready-to-use sensitivity formulas they can easily perform simulations they need.

However, it is not obligatory to examine the sensitivity of project financial sustainability when key variables change, which we consider a mistake. After all, such analysis would show potential demand for additional funding if key project assumptions were not to come true.

During the sensitivity analysis, we:

- **check which parameters/variables key** for the calculation of performance indicators are **critical parameters/variables for the analysis,** where a critical variable is a key variable whose change by ± one per cent triggers an NPV change by one per cent or more;

- **perform a simulation of performance indicators for parameter/variable change scenarios** that seem probable for similar projects;

- **calculate the switching values** of key parameters/variables, incl. thore identified as critical ones in particular.

The sensitivity analysis may be supplemented with probability distributions of key variables, though this is not obligatory.

A qualitative method is recommended for the risk analysis. Compared to its previous version, the new CBA Guide provides more precise guidance on the principles of the sensitivity and risk analysis.

The first stage of the risk analysis is the identification of the most important project risk factors. Next, every risk factor is assigned a „probability of risk occurrence" and a „risk severity impact" score on a scale from one to five (where five is the highest probability and the largest impact). The multiplication result of both scores is compared with the risk matrix (see fig. 2) which has been divided into fields of different color in order to simplify the analysis. The red and dark red indicate the most substantial risk factors.

Figure 2. The risk matrix (CBA Guide)

		probability				
		1	2	3	4	5
severity	1	low	low	low	low	medium
	2	low	low	medium	medium	high
	3	low	medium	medium	high	very high
	4	low	medium	high	very high	very high
	5	medium	high	very high	very high	very high

The risk analysis may be presented in form of a table or as a text. We describe every risk factor and specify:

- its possible cause,

- its possible effect,

- project key variables which may change if the risk materializes,

- the risk level in accordance with the risk matrix, and

- ways how a beneficiary can prevent the risk (if they can manage the risk factors) and/or if it materializes – mitigate its consequences.

Risk factors in „red" and „dark red" fields of the risk matrix, which are the most dangerous for the project, require a more elaborate and detailed description of the strategy and instruments to monitor, prevent and mitigate their effects.

CBA best practices

Realistic demand forecasts and projections

General rules

A transport forecast for EU application purposes should contain:

- **a forecast for the counterfactual scenario** (business as usual; scenario 'without the project') and **a forecast for the investment scenario** (investment is carried out in accordance with the selected investment option; scenario 'with the project')[8];

- (if applicable) an allotment of the forecasted incremental volumes[9] into **traffic diverted from other transport routes** (modes and means of transport) and **traffic induced** (generated) due to the underlying investment project. If we do not use advanced forecasting methods, it is advisable to omit the latter.[10] To conduct the socio-economic analysis, **we also need to specify the transport routes used by the diverted traffic before the investment project was carried out.**

To analyze the financial profitability, we use the incremental forecast. To analyze the financial sustainability, we use only the investment scenario forecast. On the other hand, the socio-economic analysis requires information on diverted passenger and/or cargo flows. If we use professional traffic modeling methods (like road network models, public transport models), we may obtain all information necessary for further analyses from the model itself. Contrary, ratio forecasting methods rarely consider diverted traffic in detail. Therefore, for the purpose of the socio-economic analysis we have to supplement our forecast with the modal shift parameters.

In the incremental analysis, forecasts for both scenarios are usually identical for the investment works phase[11] . Differences in traffic volumes emerge first in the operational phase. An exception would be a project aimed at capacity extension

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[8]   If the study submitted jointly with the application contains option selection based on the CBA, and options differ as far as the capacity and transport routes are concerned, we draw separate forecasts for each alternative option.

[9]   Incremental transport forecast is the investment scenario forecast minus counterfactual scenario forecast.

[10]   If we expect the demand outflow in the counterfactual scenario, the incremental forecast must also identify users kept as customers of the underlying services due to the investment project. The example can be an outflow of passengers in the public transport if its quality does not improve or even deteriorates or outflow of seaport cargos if larger ships cannot call at the port.

[11]   With an exception of projects for which works require suspension of service, e.g. railway track shut-off.

which does not cause any additional demand effects. Then, forecasted volumes in both scenarios are identical until the capacity in counterfactual scenario is exhausted. In the year when the capacity is reached, we simply impose a capacity cap on forecasted traffic volumes for the entire remaining reference period. In the investment scenario, we allow further demand increases till the capacity generated by the underlying project is reached. If this happens within the reference period, we impose another capacity cap. If the aim of the project is to increase the competitiveness of a transport service (like public transport) in order to prevent a negative modal shift, without-the-project volumes decrease, whereas with-the-project volumes rise.

The demand forecast methodology may serve as a tool to allocate socio-economic effects between projects which complement one another. Depending on how the projects complement each other, we may apply the principle of the neutrality of the complementary projects towards the underlying project. A given complementary project is carried out in both counterfactual and investment scenarios. Only in justified cases, we may apply the reverse principle, i.e. we include a complementary project in neither scenario. The alternative approach is to apply the principle of subsequent complementary projects. In other words, the investment scenario of one project is the counterfactual scenario of the subsequent one.

Some projects stimulate demand shifts, while others aim only at increased capacities but entail almost no demand shifts. As for the latter, a good practice is to analyze only effects of the capacity change for the identical forecast in both scenarios. This allows us to consider only undeniable effects of the underlying project.

There are numerous practices for splitting forecasted demand shifts between complementary projects. For example:

• Separated forecasts for single wharves in a seaport. Purchasing another gantry crane and/or deepening berths will allow docking of larger ships and shorten the handling time. As a result, the generalized costs of transport borne by carriers will decrease. This in turn will probably boost the cargo turnover. In majority of cases, the investment project will however not influence the demand for services rendered by other port wharves.

- A forecast for the reconstruction of the railway access to a seaport made separately only for the railway link under reconstruction. The project will increase the capacity of the railway link to service port cargo, but will not have any significant impact on the demand forecast for the entire port, unless hinterland access is its bottleneck. If we do not deal with a bottleneck situation, the only effect on the demand forecast will be that the modal split of the hinterland service shifts towards railways. If the hinterland transport is a bottleneck (or would be in the reference period), in the counterfactual scenario we have to impose a capacity cap on the demand forecast for the entire port. As by carrying out the project we remove the bottleneck, we do not need a cap in the investment scenario. The demand forecast for the entire port will be the same in all scenarios, and it should take into account all confirmed investments in the port.

- A forecast where two similar projects would obviously stimulate demand on an overlapping network or transport corridor and are carried out one after another. Counterfactual forecast of the second project must in such a case include completion of the first project. This will be in fact the investment scenario forecast of the first project. To divide the traffic volumes in all scenarios, we need to define impulses (changes in the transport operator's offer), which trigger changes in demand forecast and correspondingly impose elasticity coefficients on the forecasted flows. This case frequently occurs when the same operator buys rolling stock in two separate tranches. Subsequent forecasts take into account subsequent changes in the operator's service offer.

- A forecast when two different projects (for instance an investment into rail infrastructure and a rolling stock purchase) are implemented one after another. The investment scenario forecast of the first project (infrastructure) will be the counterfactual scenario forecast of the other project (rolling stock). To split the forecast, we may assume that the infrastructural project triggers a change in demand as a result of only shorter travel times on a railway line. We do not however assume at this moment any changes in rolling stock parameters. On the other hand, the superimposed forecast for the rolling stock project takes account of demand effects triggered by improved rolling stock parameters and/or level of service like increased frequency of trains. Supposing we deal with two different project promoters, a good practice will be for the infrastructure operator to provide the transport operator with their forecast results.

Forecast assumptions

Forecasting transport demand is a challenge. A large number of variables, a long time horizon, and diverging views of possible development scenarios hinder forecasting but do not make it impossible.

There are different types of transport investment projects applying for EU funding. These are usually investments into infrastructure, handling equipment or means of transport, as well as intelligent transport systems. To begin with forecasting, we always have to define whether the project impact will be of local, regional, domestic or international (trans-European) range and accordingly we have to select the forecasting scope and method. We saw once two traffic forecasts for a road section based on models prepared by two renowned consulting companies on behalf of two different beneficiaries. The annual average daily traffic (AADT) in the last years of the reference period in one of the models varied by a half in comparison to the other one. The reason for these differences was a different number of traffic zones applied. The first forecast was made for local traffic in the city so the model was obviously divided into higher number of traffic zones. The second one was designed for long-distance traffic on the whole national roads network; thus the number of zones for the city was lower. Nobody questioned the investment justification because it concerned one of the most congested city exit roads. The higher forecast was finally corrected, yet this case showed us how important it is **to consider the investment impact area when selecting the forecast methodology.** When talking about the geographical range, we also bear in mind that the expected project impact may be limited by lack of investments in other areas where we do not have any influence[12].

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[12] A railway bottleneck in the territory of one country can block the shift of transport chains (e.g. in intermodal transport) to alternative corridors in other countries even if these other countries implement intensive investment programs.

The transport forecast should rely on suitably identified historical data base and well-selected macroeconomic projections. We suggest use of projections recommended for EU-funded projects in a given country or from other credible sources. These might be research centers, statistical offices or ministries in charge of public finance and/or transport. One should always pay particular attention to the forecast date, and never use outdated forecasts. It is also possible that various available sources project different growth rates for the same period. In this case, it is a good practice to present alternative macro-economic projections in the study, and then to finally show the own projection which was adopted for the purpose of the demand forecast of the project promoter and/or the project. Correcting external projections is by all means justifiable. One should however describe the changes implemented. We saw beneficiaries who cited the same macro-transport forecast for the region in their studies. Yet the sum of forecasted volumes at the operational level made for particular projects (competing with each other) exceeded the most optimistic scenario of the macro-transport forecast. It turned out that the cited forecast, even though relatively current, did not include a crucial event on the regional transport market that triggered a cascade of changes that redefined the entire market. Today we know that our beneficiaries were right in their operational forecasts, and they initially cited the macro-transport forecast in their studies without due consideration.

Elasticity coefficients are of most importance in transport forecasting. These are transport demand elasticities towards GDP growth rates, as well as modal elasticities to changes in generalized transport costs and to improvements in the level of service. Overestimating elasticity ratios will congest on paper every infrastructure and every means of transport. What counts here is knowledge and experience of professional transport forecast specialists. In justified cases when some assumptions are difficult or even impossible to confirm (for instance in reference books, available benchmarks), we may relay on expert opinion. However, we recommend a conservative approach, including usage of elasticity coefficients that change over time.

In accordance with the principle of neutrality, counterfactual and investment scenario forecasts are supposed to equally treat all complementary projects (current and future). Theoretically, we include all significant projects listed in strategic documents. It is however up to the expert who prepares the analyses to verify the list and exclude projects which are less likely to be carried out, as well as shift in time projects about which we already know they are delayed. Here we differentiate between projects and other events which 'steal' the demand from us and those which shift the demand in our favour. The more commercial the project, the more important demand-stealing events become. Improper selection of projects and events at an early stage of the forecast may result in overestimation of the result indicator.

Appraisal of demand forecasts during CBA evaluation

Beneficiaries are obliged to present a realistic forecast based on well-selected historical data and available macro-economic forecasts, using professional experience, as well as financial and technical resources at their disposal.

The CBA reviewer's task is to check whether the forecast assumptions regarding increase/drop of passenger volumes and/or freight volumes, road traffic volumes, modal split, etc. correspond to publicly available socio-economic data or project promoter's internal information. Therefore, it is a good practice to provide references to source documents which confirm the assumptions adopted in the study. The presented forecast input data are supposed to correspond to statistical information published by specialized external sources (like national statistical offices, Eurostat, aviation /road /rail national authorities and/or international organizations), or find confirmation in the project promoter's internal documents and statistics. Sometimes the promoter's historical data differ from the data presented in external statistics. It may happen due to a different method of data aggregation, and if this is the case, we point out the differences in the study and explain them. The evaluator also checks whether the assumed freight and passenger volumes do not exceed the transport capacity/throughput limits of project infrastructure/equipment. We saw for example erroneous projections, in which the anticipated increase in freight volume exceeded the capacity of the intermodal terminal or surrounding roads; the number of passengers who use the airport rose disproportionately fast when compared to competing ports, or did not consider capacity limits in the airside/landside part of the airport; the forecast number of passengers could not have been transported without additional rolling stock.

CBA evaluators' competences (usually transport economics or financial and economic modeling) are not sufficient for a complete professional appraisal

of the methodology and correctness of transport forecasts. In particular this is the case when traffic modeling was applied. However, if forecasts are based on transport elasticity coefficients towards GDP growth rates, and the forecast is presented in the spreadsheet in its entirety, it will be subject to comprehensive inspection in accordance with the standard procedure of verifying calculations in the spreadsheet.

Regardless of whether we deal with a traffic model or ratio forecasting, the descriptions in the study must be detailed enough to enable an overall appraisal of the forecast. The study must include information on GDP growth rates used in the forecast, demographic indicators, elasticity coefficients, assumptions related to infrastructure capacity, means of transport or other equipment technical performance, ratio of peak hours to entire day, technical and commercial speeds, etc. Traffic models enable integrating complementary projects which are currently being carried out and planned in the future – therefore the study must contain the list of projects integrated in each model for both the counterfactual and investment scenario. (As a rule, models are made in five year intervals; projections for remaining years are interpolated). One must also specify all detailed assumptions related to the modeling methodology, such as a type of software used to create the model, number of traffic zones, principles adopted in the process of passenger behavior simulation, etc.

The appraisal of demand forecast credibility and correctness depends on the type of the project and the nature of project promoter's activities, as well as CBA evaluators' competences.

As for road projects where a forecast consists of interpolated traffic model results, we check the coherence of assumptions and forecast results with assumptions and results of forecasts filed for complementary projects. If a ratio method was applied, we check the full calculation sequence and assumptions in the spreadsheet, including the continuity of data sets and possible forecast anomalies. For example, we check for any rapid or unreasonable change of AADT in particular years in some of vehicle categories, for AADT that seems

unreasonable for particular vehicle categories (for instance what result we might obtain when we calculate the bus schedule based on the bus traffic per day), for speeds resulting from LOS and road width deviating from speeds in standard speed tables, for speed limits that are exceeded, etc. We also check what speed is assigned to particular vehicle categories (whether for instance trucks are not faster than cars on the same road section), etc.

In public transport projects (traffic models or ratio forecasting), the principles are similar to those applied for road projects. The forecasts are compared with forecasts of complementary projects. We look also for anomalies. We compare for example the forecasted passenger volumes with vehicle capacity – though we remember that passenger volumes per tram/bus differ during peak hours and off-peak hours. We check the alternative service providers' transport offers. In railway projects for example, we compare the project promoter's offer with bus operators' or airline offer. In railway or rolling stock projects, passenger flows are not as scattered as on roads. We are then able to compare transport statistics (both publicly available ones and project promoter's internal data) with the forecasted volumes. If we notice a clear jump between traffic parameters before and after the investment, the promoter has to deliver an explanation. In extreme cases, we request an independent forecast appraisal.

As for forecasts made by means of a traffic model, we suggest that when contracting out the engineers' services our beneficiaries should reserve the right to receive files containing model data for each year, and for both counterfactual and investment scenario. Each file should contain readable traffic distribution data. If any doubts arise, it will be possible to verify the model assumptions in greater detail, as well as check whether the results were transferred correctly to the CBA spreadsheet. Fortunately, traffic model reader software is not as expensive as the full traffic modeling software suite.

On the other hand, CBA reviewers play a key role in transport forecast appraisal in commercial projects carried out by intermodal operators, seaports and airports. These forecasts are based on turnover growth ratios, so they are subject to a comprehensive verification. The appraisal of the forecast

credibility includes checking whether the projections are in line with national statistics, statistics published by various transport authorities[13], professional reports, press releases, etc. We review annual financial and management reports from the last three years before the application was submitted (it is mandatory for the beneficiaries to provide them with the application). We compare projections to data presented in complementary and competitive project studies at our disposal. We also request beneficiaries to confirm their ability to acquire customers by presenting letters of intent.

Beneficiaries should be aware that their forecasts will be compared with historical data and publicly available forecasts for particular transport modes. We reviewed studies where a promoter did not conduct a sufficient market research. Commitments taken upon overestimated transport forecast assumptions were unattainable due to various market events. In most cases however, during the verification process, we pointed out that to our knowledge projections seemed questionable. The principles of granting EU funds to commercial projects say that if the formal appraisal proves they can apply for the funding, we cannot claim in advance the project will fail. However, we have a good overview of the market where the project promoter operates, as we read many studies, including those of applicant's competitors. Therefore, we advise our beneficiaries that when responding to evaluator questions, instead of rejecting them, they should rather check if their forecasts are indeed not overstated or whether they are to be modified. **A self-correction may protect the beneficiary from the necessity of amending the co-financing agreement, consequences arising from failing to achieve the result indicator or problems related to maintaining project durability.**

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[13] For example, in airport projects of significance is the structure of carriers (traditional carriers, low cost carriers, charter carriers and GA) flying to particular airports as well as projected increases in transport volumes in each carrier category and type of flights (domestic, international and transcontinental) with reference to catchment area.

CBA best practices

II
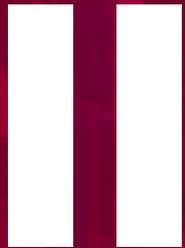
Internal cohesion and transparency of the financial analysis

The scope of the financial analysis and confirming documents

A complete financial analysis consists of financial profitability analysis, project and project promoter's financial sustainability analysis, as well as of a presentation of basic financial parameters in the table E.1.2 of the submission form. Its **scope depends on whether the project generates revenue, and whether the beneficiary operates in the private sector or public finance sector.** The documents that authenticate the analysis assumptions will differ, as well.

Table 1. Parameters of financial analysis in the table E.1.2 of the application form[14]

	Main elements and parameters	Value Not discounted	Value Discounted (Net Present Value)
1.	Reference period (years)		
2.	Financial discount rate (%)		
3.	Total cost excluding contingencies (in EUR, not discounted)		▮
4.	Total cost excluding contingencies (in EUR, discounted)	▮	
5.	Residual value (in EUR, not discounted)		▮
6.	Residual value (in EUR, discounted)	▮	
7.	Revenues (in EUR, discounted)	▮	
8.	Operating and replacement costs (in EUR, discounted)	▮	
	Pro-rata application of discounted net revenue		
9.	Net revenue = revenues – operating costs + residual value (in EUR, discounted) = (7) – (8) + (6)	▮	
10.	Total investment cost – net revenue (in EUR, discounted) = (4) – (9) (art. 55 act 2)	▮	
11.	Pro-rata application of discounted net revenue (%) = (10) / (4)		

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[14] Capital expenditure in the table E.1.2. include information and promotion costs, but do not include any contingencies. Replacements are added to operating costs. If the operating costs item is in fact savings, a "minus" sign must be entered. The residual value is not included into the funding gap calculation if operating costs exceed revenue.

In practice we deal with the following cases:

- **Non-revenue-generating projects carried out by public-sector beneficiaries.** These projects are by definition financially unprofitable. Beneficiaries do not prepare financial reports in accordance with standard accounting principles. The financial analysis is thus limited to calculating the financial parameters specified in table E.1.2. of the application form (the so-called simplified financial analysis). The funding gap is always 100%. Operating costs are based on actual historical costs or on cost tables recommended for a given project type. These costs should never be derived by force from the profit and loss account, balance sheet or cash flow statement (which would be fictitious for these beneficiaries). To confirm financial sustainability, project promoters must submit a declaration in which they oblige themselves to maintain project sustainability. This obligation should correspond to the project promoter's long-term financial plan or another document of a similar nature;

- **revenue-generating projects carried out by public-sector beneficiaries (or similar entities).** If a project generates revenues, we always carry out a full financial analysis. Appraisal of the financial sustainability is done in a similar manner as in the case of non-revenue-generating projects;

- **commercial projects carried out by private-sector entities subject to state aid rules.** When beneficiaries are entities operating on a fully commercial basis and using standard accounting principles, they carry out the full financial analysis (though by definition they are exempt from calculating the funding gap). The parameters of the financial analysis must be connected to and confirmed by profit and loss account, balance sheet and cash flow statement. State aid is used to finance profitable projects. FNPV/C and FNPV/K are allowed to be higher than zero, and FRR/C and FRR/K – higher than i (whereas i stands for the financial discount rate)[15]. Some state aid

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[15]   If FNPV is negative, we advise presenting FRR values in the application form only when the analysis in the spreadsheet shows a positive value (lower than a discount rate). If we have a negative value in the spreadsheet, in the application form we enter "undefined". However, no matter the value the FRR must be subject to sensitivity analysis in the spreadsheet.

frameworks may impose limits on selected indicators[16]. If additional equity or debt is necessary to maintain financial sustainability, it is mandatory for the project promoter to submit an authenticated declaration by shareholders or bank commitment letters (for loans, credit lines). If a project promoter declares ownership of large cash amounts, bank statements must be submitted;

- **projects where operations are based on a public service contract (PSC).** Both public transport providers (PSC contracting parties) and public transport operators (PSC contractors) may become beneficiaries of EU funding. In principle, public transport projects generate additional revenue but remain unprofitable (FNPV/C and FNPV/K < 0). Nonetheless, we carry out a full financial analysis. To confirm the financial sustainability, the analysis should comply with the PSC with regard to compensation rates, compensation indexation mechanisms and transport service volume. Revenue estimated by the operator must correspond to the amount specified in the authority's long-term financial plan in the field "public transport" or its equivalent. It is also obligatory to prove that the operator does not receive an excessive compensation. The financial analysis is carried out at the project level, while the financial sustainability analysis is conducted separately for the operator and the transport provider. Presentation of the full long-term financial plan projection for the authority is not mandatory, but the beneficiary must prove that necessary funds have been secured by presenting the relevant documents (authority budget, long-term financial plan). If submitted documents do not show that sufficient funds were reserved in the reference period, the authority providing public transport must submit a statement of readiness to cover the operator's costs in full during the reference period.

The most important principle in the financial analysis is to maintain the internal coherence of assumptions in all documents submitted by the project promoter and other entities involved in the project.

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[16] For instance, for airport expansion projects in the 2007-2013 programming period the FRR/k (in real prices) could not be higher than 12%. Exceeding this threshold resulted in limiting the EU grant.

Cohesion of financial assumptions

The financial analysis consists of the financial profitability analysis, financial sustainability analysis and funding gap analysis. Once fiscal corrections have been done, financial analysis flows are used in the socio-economic analysis. The transport assumptions key for the financial projections are used to calculate the result indicator. Assumptions common for all CBA partial analyses that are advantageous for the results of one partial analysis are not necessarily advantageous for another one. **Every attempt to sub-optimize assumptions in order to optimize results of one partial analysis will distort the results of other ones. What is more, inconsistencies will appear in comparison to documents that are submitted for verification by the project promoter and related entities.** Therefore, while preparing the study and application documents we must assure that the assumptions reflect the best knowledge of their authors and all available information, from macro-economic forecasts issued by respected institutions to project promoter's internal data, including information presented in the financial reports and trade contracts.

Calculations of the financial analysis, and afterward the socio-economic analysis, are only a mathematical reformulation of individual CBA assumptions into results. The correctness and completeness of assumptions is therefore a pre-condition for the correctness of all CBA partial analyses. Wrong assumptions will hardly deliver correct results, even if the analysis is correct in terms of its methodology and calculations. The cost-benefit analysis of EU projects is carried out for very long reference periods. We should not expect that the assumptions will be one hundred per cent correct in the long-term. It is the purpose of the sensitivity analysis to show the impact of deviations from originally assumed values (the so-called base scenario) on CBA results.

The main assumptions of the financial analysis are:

- macro-economic and fiscal assumptions,
- revenue, incl. tariff levels,

- costs, incl. projections of operation and maintenance costs[17],

- investment expenditure and its schedule,

- sources and costs of financing.

While developing assumptions for the financial analysis, we may come across some practical issues.

- **assumptions are to be appropriately selected and should come from reliable sources.** For instance, when estimating financing costs, we should rely on loan commitments offered to the beneficiary rather than on general market information. Assumptions are to be presented clearly and coherently; the description itself should have a logical sequence. The assumptions are to be placed in a broader context. For example, if assumptions indicate that a new tram rolling stock consumes more power than the old rolling stock we are replacing, then at first sight it does not seem to be logical. But when we learn that the new rolling stock will be fifty per cent heavier, the increased energy consumption turns out to be justifiable. All assumptions which differ significantly from historical data must be explained and described in greater detail;

- **project analysis in separation from the entire enterprise is very difficult.** Theoretically, this analysis should be easier since we limit the assumptions to those directly related to the project. However, this way we can easily overlook certain aspects, such as project impact on company overheads, profitability of other business activities, etc. What is more, while preparing the analysis in the context of the entire enterprise, it is easier to spot potential mistakes because we can rely on historical reports. Verification of the analysis becomes easier;

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[17] Two approaches to cost assumptions are recommended. We may use tables presenting standard unit mainte-nance costs. This approach is recommended for road infrastructure projects where public infrastructure adminis-trators do not keep any complete operating costs accounts. In case of infrastructure in other modes of transport, where even though the operators keep complete cost accounts, it is common knowledge that costs could be understated (infrastructure was not maintained properly), we advise to compare own costs with benchmarks from cost tables. In any other cases, the source of cost data is own historical costs.

- **problems with price adjustments.** Financial parameters in various source documents are frequently expressed in price levels of the period when they were estimated, that is in real prices at a given moment. Certain documents (e.g. budget forecasts, financial report projections) may be prepared in nominal prices. Since financial analysis of EU projects is conducted in real prices, all costs and revenues should be adjusted and expressed in real prices at the moment of the analysis (by means of indexation or discounting) so that data are comparable. If we are preparing an analysis in 2014 and we know the cost data is of 2013, we should index the 2013 costs to obtain values in 2014 prices. In case of EU funded projects, for technical reasons, the adjustment of nominal values does not apply to investment expenditure which in the financial analysis must correspond to the project cost table in the application form (nominal value = real value = value in fixed prices).

Financial analysis when more than one entity is directly or indirectly involved in the project

The basic approach to financial analysis is to analyze the project as a whole. The analysis should take into account all flows between entities carrying out the project and third parties, excluding internal flows.

The project structure must be clearly presented in the study (we recommend a diagram) and then in the spreadsheet, including the allocation of tasks between entities and any cash flows between them. It would be also a good idea to show links and flows between entities involved in the project and the most relevant third parties (including works contractor/supplier, users, EU funds). The task allocation and the cash flows must be shown for the period during the investment phase and the project operational phase. If necessary, we recommend presenting several diagrams.

If there is more than one entity of the same type involved in the project (e.g. several local authorities carrying out a joint project), a separate financial analysis for each entity is not necessary. Nevertheless, we present the flows of every entity in order to prove their financial sustainability, i.e. prove that funds have been reserved for carrying out and maintaining the project in budgets and long-term financial plans.

When more than one type of entities are involved in the project, apart from the financial analysis from the point of view of the project we also present separate analyses for each entity. Every cash flow should be attributed to a specific entity during the analysis. Flows between entities involved in the project should be included in such a way that the outflow of one entity

represents an inflow for another one. The sum of inflows and expenses of separate entities involved in the project should be equal to flows of the entire project. In the same way, the sum of individual FNPVs will be equal to project FNPV. Figure 3 depicts the diagram of flows between two entities – the operator (who purchases the rolling stock and is EU beneficiary) and transport provider, i.e. the competent authority bound by the PSC.

Figure 3. Diagram of flows between the competent authority public transport provider and public transport operator
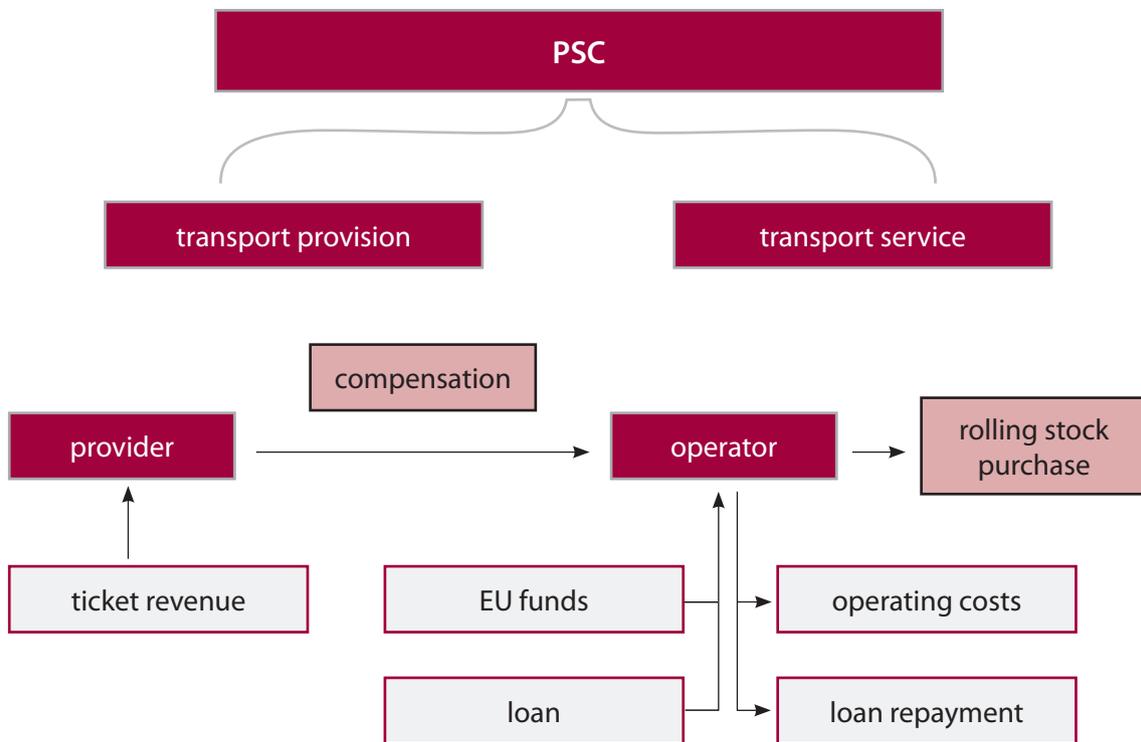
The principles of aggregating flows of these two entities have been presented in table 2.

Table 2. Principles of aggregating flows of two entities, example: public transport provider and operator.

Provider		Operator		Project
+ ticket revenue				+ ticket revenues
– compensation		+ compensation		
	+	– rolling stock expenditures	**=**	– rolling stock expenditures
		– operating costs		– operating costs
		– loan repayment		+ financing repayment
		+ EU funding		+ EU funding
		+ loan		+ loan

From the project perspective, it does not matter which entity bears particular expenditures. If the competent authority pays for the rolling stock, and later lends the rolling stock to the operator, the results at the project level are not affected in any way. Changes in flows occur only in the separate analyses for the authority and operator.

The estimated transport service compensation should correspond to unit rates and transport volumes, as well as the maximum compensation in the PSC (or most recent PSC annex). Unit rates, transport volumes and the compensation are to be included in the assumptions worksheet in the spreadsheet, with their sources given in the adjacent column. This will facilitate verifying the coherence of revenue estimates in the operator's projections. All data presented should be coherent internally and with other documents. This applies in particular to compensation rates and indexation mechanisms, operator's costs and revenues, public transport service demand and supply assumptions, as well as real or nominal prices.

Entities receiving compensation for taking on a public service obligation must include in the spreadsheet a calculation of maximum allowable compensation in accordance with Regulation 1370/2007 and compare it to the compensation calculated on the basis of the current or planned PSC, in order to prove the compensation is not excessive.

For the competent authority (usually the local or regional authority), it is necessary to present the basic parts of a current long-term financial plan in the spreadsheet, including capital expenditure and operating expenditure related to the project.

Another example of two entities involved in the project is when both are directly involved in its investment phase. We had a project with to beneficiaries – one the owner of an intermodal terminal and the other one the operator of intermodal transport services who was supposed to lease this terminal from the owner (see Figure 4).

Figure 4. Diagram of flows between the intermodal terminal operator and the terminal owner.
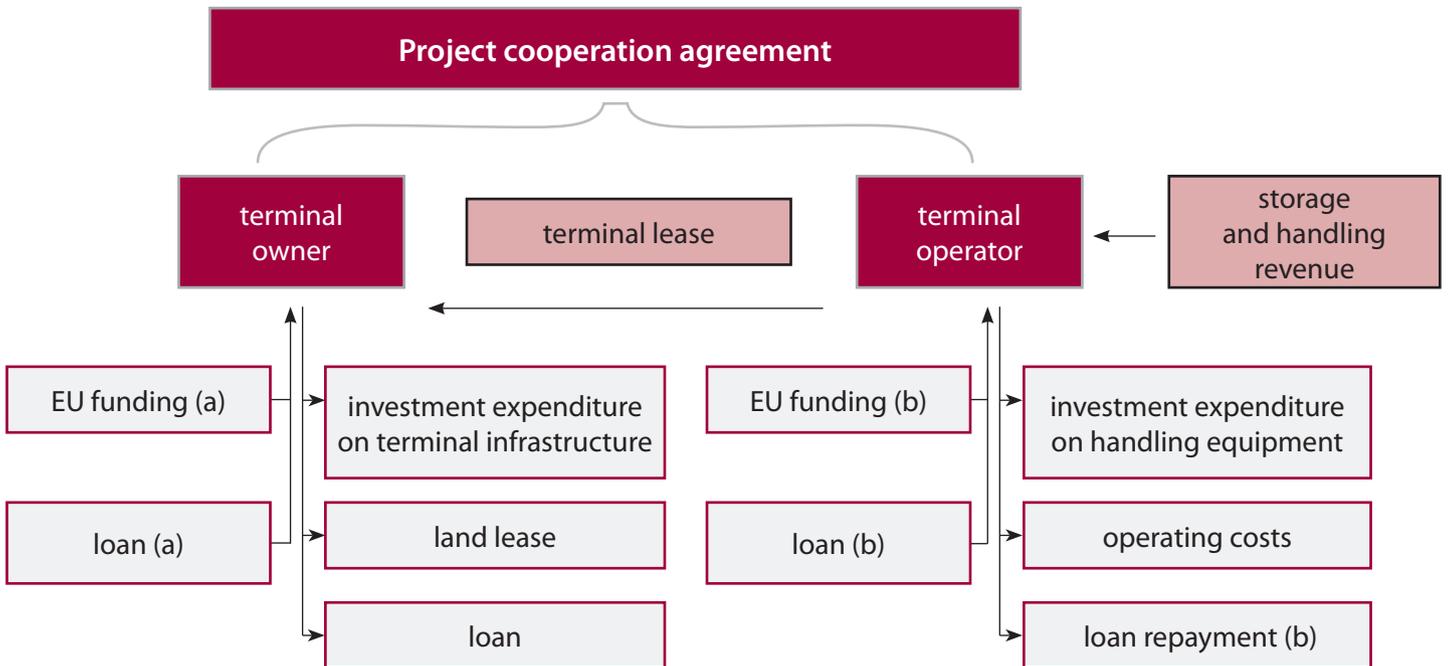
Principles of aggregating flows of these two entities have been presented in the table 3.

Table 3. Principles of aggregating flows of two entities:
the intermodal terminal operator and the terminal owner

Terminal owner		Terminal operator		Project
	+	+ storage and handling revenue	**=**	+ storage and handling revenue
+ terminal lease payments		− terminal lease payments		
− investment expenditure on terminal infrastructure		− investment expenditure on handling equipment		− investment expenditure on terminal and equipment
		− operating costs		− operating costs
− land lease payments				− land lease payments
− loan repayment (a)		− loan repayment (b)		− loan repayment (a)+(b)
+ EU funding (a)		+ EU funding (b)		+ EU funding (a)+(b)
+ loan (a)		+ loan (b)		+ loan (a)+(b)

To prove the project financial sustainability, we must show that both beneficiaries hold enough funds to carry out and maintain operations of the project. If both entities are trading companies, each of them should present separate financial report projections. For non-trading entities, a simplified cash flow statement is acceptable. Such a projection should include at least the projected operating revenue, other revenue, operating and replacement costs, costs related to other business activities, investment expenditure, EU grant, equity increases, loan amount inflows and repayments including interest, and income tax. For each year of the forecast we present the net change in cash, as well as the accumulated end-of-year cash balance.

The financial projections are to be conducted either in nominal or real prices. When the forecast is in nominal values, the assumptions sheet includes the indexation factors used in the analysis.

CBA best practices

III
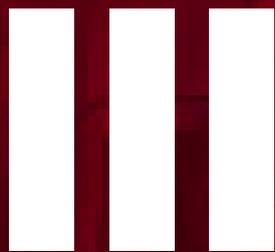
Costs and benefits catalogue, assumptions and methodology of the socio-economic analysis

Links between the catalogue of socio-economic effects and project goals

When designing CBA methodology for a transport project applying for EU funding, we should bear in mind European Commission (EC) recommendations as well as project goals. As far as we know, there is no published methodology guide that would cover socio-economic effects in all modes of transport. **If there is no unified and well-documented analysis standard for a given type of projects, the catalogue of socio-economic effects should be developed each time by the expert conducting the CBA. The expert must take into account generalized transport costs and monetizable external effects.**

We look at project effects from the point of view of both transport users and transport services operators. The main pillars of a customized catalogue of socio-economic effects are presented in Figure 5.

Figure 5. The main pillars of the socio-economic effects catalogue
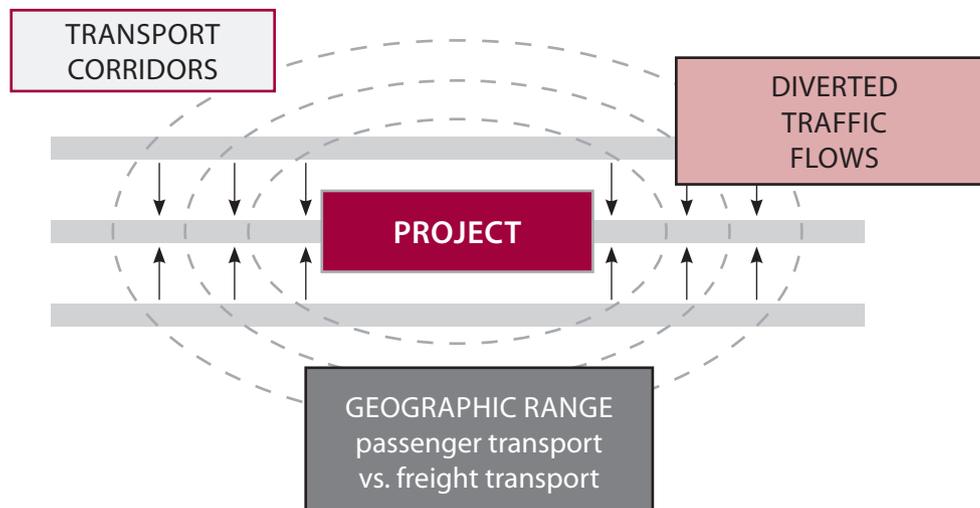
The starting point for the project impact analysis is expected changes of level of service for passengers and cargo (mainly time parameters[18]) **and/or change in transport costs.** These changes are usually related to project goals, which led to taking up the project. They might but did not have to be considered for the purposes of the transport forecast (depending on the selected forecasting and modeling method). Good practice is to compile the list of goals/expected effects once again. If the project by definition does not cause transport flows diversion, the catalogue of socio-economic benefits is developed only for existing users and transport operators.

Most projects however entail **passenger and cargo flow shifts between transport corridors.** Induced traffic may appear as well[19]. If traffic modeling methods are applied, we will know the nature of these diversions. In the case of a ratio forecast for both counterfactual and investment scenario, incremental flows are to be attributed by expert estimation to modes and means of transport.

We will use the traffic model to find the main transport corridors affected by the project – these will be both corridors where the project is located and those from which the project diverts traffic. As far as ratio forecasts are concerned, it is advisable to use representative (averaged) transport corridors[20]. Transport infrastructure is frequently a congestible public good – so we have to consider changes of traffic parameters resulting from transport flow diversions in identified transport corridors[21].

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[18]   That is travel and waiting time, scheduling frequency, punctuality, etc.

[19]   Induced traffic is frequently ignored in CBAs. If included, it appears mostly in passenger transport. The customer surplus due to the change of the generalized transport costs is recommended by the CBA Guide to describe socio-economic effects triggered by the increase in mobility.

[20]   For example, when we talk about intermodal transport, we know the rail routes between intermodal terminals but it is difficult to find the precise number of kilometers of the road hub-to-door (or reverse) transport. Thus we advise to estimate average routes on an expert basis. The same applies to passengers who travel to the railway station or airport.

[21]   The road network clearly demonstrates this dependency. Diversion of traffic from local roads as a result of upgrading high-speed connection leads to increased speeds on local roads. Additional traffic on the upgraded road lowers the travel speed when certain levels of service are exceeded.

The third element of the analysis concerns **the geographic range of impact (door to door). It is not always overlapping for passenger and freight transport.** In practice, in road and rail projects, the geographic range of passenger transport effects is mainly local or regional, while freight transport effects may influence the entire transport chain[22].

To develop a catalogue of socio-economic benefits to be included in the analysis, we start by separating quantifiable changes from those which can only be described in quality terms. Next, we take the quantifiable effects and select those that can be monetized. The latter will be subject of the socio-economic analysis.

One of the basic mistakes we saw in feasibility studies was that in the first part of the study which described the project goals, the goal list was filled with anything that came to mind just to extend it. Then, in the CBA section, project effects were identified, some of them were quantified and monetized, and… the contents of these two lists were not compared. The project goal list did not include certain quantified direct effects presented further in the study, but started with indirect effects dispersed in the socio-economic environment of the project. On the other hand, quantified and monetized effects in the socio-economic analysis did not measure the main expected project impacts described in the first part of the study[23].

Our advice is to assure these two parts of the study refer to the same effects both while working on the study and when filling the application documents. **The list of expected project effects should start from the most important and quantifiable effects and finish with the qualitative ones, or effects dispersed in the socio-economic environment and thus hardly quantifiable.**

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[22]   For projects co-financed by the EU, we calculate benefits only in EU territory (plus Norway and Switzerland). EU borders are the delimiters. For transport routes by sea, we recommend to use the first European base port at which an ocean carrier may call.

[23]   The extreme case we saw was when the consultant did not consider the decrease in generalized transport costs for carriers in a project which aimed to allow larger ships to enter a seaport. It was enough to calculate the expected decrease of fuel consumption per 1.000 tkm between counterfactual and investment scenario, with additional environmental effects resulting from it.

Sources of data and methodology. External inputs adjustments

Valuation of generalized transport costs is based on real costs or prices obtained from transport market analyses. Monetization of other effects which are not subject to valuation via market transactions is however problematic. In the CBA, we assign unit costs from cost tables published by international organizations or research institutes to identified and quantified effects. So far, we have not encountered any expert valuation of external effects but we did come across expert valuations of qualitative aspects of travels via WTP surveys[24].

The basic CBA methodology source for EU projects is the CBA Guide published by the EC. The Guide provides the CBA principles for projects from various industries. In Poland, the JASPERS Initiative Blue Books (BB) develop on the CBA Guide methodology. Most consulting companies advising our beneficiaries deal well with developing methodology to quantify effects which are not described in these sources, either by creating own methodology or using academic publications[25]. The problem is finding up-to-date sources of unit costs for effects which are not included in the BB, especially for freight transport. When monetizing freight transport external effects, we can use the 'External Costs of Transport in Europe' and/or the latest available update of the Marco Polo programme calculator. A good source for value of time in freight transport is publications available on the website of the Dutch Ministry for Infrastructure and Environment (see *Policy papers, regulations and …*). As far as effects of increased quality of public transport services are concerned, the valuation problem is that study samples may not be comparable to the target

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[24] The basic question is: "how many percent more are you willing to pay for your public transport ticket if we improve the service quality?".

[25] The list of publicly available methodology sources which we recommend to our beneficiaries can be found at the end of this publication.

group of the project. For example, if an original study polled students, its results cannot apply to all residents of a city who use public transportation. It is necessary to look for another methodology source or carry out a dedicated WTP survey. We should bear in mind that certain qualitative effects of public transportation can be captured with an appropriate elasticity coefficient in the transport forecast as well.

Before we use data from external sources, it is necessary to adjust them properly. First we check the date applicable to the data. The date of data, that is the year the data were gathered, is not the publication year of the source of the data. We need to identify the year for which the unit costs are dated.

Since we always prepare the analysis in fixed/real prices, source data must be inflation-indexed, but only up to the base year of the reference period. If applicable, we also index data in line with GDP growth forecasts with appropriate elasticity ratios, which will give us annual unit costs in the entire reference period in real terms. In short, from the date of data to the analysis base year we index values with elasticity ratio towards GDP growth and inflation rate, and from the base year to the end of the reference period we use the GDP growth rate multiplied by a relevant elasticity ratio.

The next adjustment pertains to purchasing power per capita differences between the country where we conduct the CBA and the country where the valuation in the original source was performed. (We discourage using unit costs from sources pertaining to other continents). If our analysis includes several countries, we make adjustments for these countries as well. If there are no particular guidelines on a recommended exchange rate, we apply the annual average ECB exchange rate to translate the currency.

To illustrate: unit rates of environmental costs per 1,000 tkm of transport work given in the Marco Polo calculator, and in tables in 'External Costs of Transport in Europe' are expressed in EUR, in prices from 2011 and 2008 respectively (as of 2014) and as average value for EU 27. If we wish to use them in our analysis, we do the following:

- we increase values from the starting year when they were calculated (2008 or 2011) to the analysis base year, taking into account both change of price levels and real GDP growth. We use the nominal GDP for EU27 for this indexation because this value includes both price level and real growth. We use the Eurostat table which gives us GDP in market prices to find values in million EUR for EU27 for the starting year of data and the base year of the analysis, and then we multiply our unit costs by the ratio equal to GDP (base year of analysis)/GDP (starting year of data);

- to convert EU27 values into values for a given country, we use the Eurostat table with GDP in market prices to find GDP per capita in the unit "Purchasing Power Standard per inhabitant" for the base year of the analysis of EU27 and the country in question. We multiply the unit cost from the previous calculation by a ratio equal to GDP per capita (selected country)/ GDP per capita (EU27);

- if the analysis is expressed in the currency of a country outside the euro zone, we multiply the EUR value by the annual average ECB rate of the given currency towards EUR in the analysis base year. (As for both GDP per capita and the annual average exchange rate, if data for the base year are not yet available when the analysis is carried out, we use the data from the year before the base year or most recent available data).

The analysis is carried out in real prices. Therefore in further years of the reference period we index unit costs with the appropriate real GDP growth projections and the proper elasticity ratio towards the GDP growth rate.

Joint analysis of several complementary projects

Large projects are frequently divided into several sub-projects for which separate EU applications are filed. This is usually due to administrative causes:

- different financing sources (e.g. only part of the project meets EU funding criteria for a given measure);

- investment expenditure schedule bridges two or more programming periods (e.g. preparatory works in the first period, rail line construction in the second one, and purchase of rolling stock in the third one);

- the construction works phase was separated from the preparatory phase and equipment delivery phase due to lengthy administrative and environmental procedures; one phase should not affect and delay settlement of the others;

- an infrastructural project was divided into sections according to separate construction contracts; every contract is managed and settled individually;

- the project is carried out jointly by several beneficiaries but separate applications facilitate single project settlement.

If there is a methodology for dividing the project socio-economic analysis, the analysis may be conducted separately. In the section on demand forecasts, we have presented examples of dividing the effects of complementary projects by means of a properly designed transport forecast. However, strong synergies between projects can make it impossible to identify individual benefits of at least one project. The socio-economic analysis must then be conducted jointly for several complementary projects[26] even though applications for funding are submitted separately[27].

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[26] The line between complementary projects may be quite wide – for many projects both a joint analysis and separate analyses are feasible.

[27] The financial analysis is prepared only for the project submitted.

A joint socio-economic analysis is performed when:

- **we have reviewed available methodological instruments and we are unable to indicate separate socio-economic benefits of at least one project (e.g. for the effects of deepening berths to appear, it is necessary to purchase additional handling equipment);**

- **to capture the synergy effects, we should treat several complementary projects jointly.**

In the CBA, the principle is that in the counterfactual scenario we do not carry out any of the projects, while in investment scenario we carry out all of them. We prepare a transport forecast under these assumptions. Impulses that trigger changes between counterfactual and investment scenario forecasts are implemented as individual sub-projects come online. We quantify the effects of transport diversions in the same way as for a single project. The main difficulty is preparing the financial flows which are used in the socio-economic analysis. If all complementary projects (sub-projects) are carried out by one beneficiary, a joint financial projection for all projects is performed, but then it is necessary to develop a key to allocate flows to particular projects. For operating costs, it might be necessary to perform a series of transport forecasts where investment scenario of the first project will account for counterfactual scenario of another project. We use a different approach when projects are carried out simultaneously by several beneficiaries. The standard example is an application for rolling stock purchase, where the complementary project is upgrading the rail infrastructure on which the beneficiary operates, but is not the only railway operator. The financial analysis is conducted for the beneficiary only, whereas financial flows in the socio-economic analysis are augmented by capital expenditures and operating costs of the infrastructure project. The project promoter does not have detailed cost information for the complementary project carried out by another entity. Thus they will not be subject to the same verification standards as the beneficiary's own cost assumptions. Still they should be prepared with utmost care. If new rolling stock represents only twenty per cent of transport work on the upgraded line, we add the appropriate percentage of relevant complementary project cash

flows. In this case, this will be twenty per cent of capital expenditure, operating costs and residual value of the upgraded line. We do not forget to apply fiscal corrections.

In the project appraisal process or during subsequent audits, we may be asked about the added value of the project covered by a single application. The division of benefits can be done according to percentage of capital expenditure, number of users of particular sub-projects, section lengths, etc.

If there is any substantial change of assumptions in any project (e.g. completion delays), it may be necessary to update the entire analysis including the transport forecast. The joint analysis is highly likely to require altering the financial and economic model (see *Transparency and flexibility of model structure…*)

Appraisal of assumptions and methodology

The results of the socio-economic analysis are presented in two main tables in the application form. In table E.2.2. we present the net present values (NPV) of socio-economic benefits of the project and its costs, as well as the impact of particular items on total discounted benefits and costs. In table E.2.3. we present the ENPV, ERR and BCR.

The first review of results should include checking if values in these tables correspond to each other.

Table 4. Table E.2.2 of the application form

Benefits	Unit value (if applicable)	Total value (discounted)	% of total benefits
Costs	**Unit value (if applicable)**	**Total value (discounted)**	**% of total costs**

Depending on the result of the incremental analysis, in table E.2.2. in the benefits section we enter all positive project effects, including operating costs savings if applicable, and in the costs section – all costs and negative project effects. The net present value of the given component of the socio-economic calculations determines its placement in E.2.2. For instance, sometimes upgrading a road will shorten the travel time but generate more exhaust fumes. In this situation, time savings are a benefit, while environmental pollution is a cost item. The residual value is always to be treated as a benefit, whereas investment expenditure – as costs.

Table 5. Table E.2.3 of the application form

Main parameters and indicators	Values
Social discount rate (%)	
ERR, economic rate of return (%)	
ENPV, economic net present value	
BCR, benefit-cost ratio	

If all calculations are correct and the tables were properly filled in, the total of discounted benefits minus the total of discounted costs in table E.2.2. is equal to ENPV in table E.2.3. The absolute value of total benefits divided by total costs will be the BCR. If the BCR is not equal to this division, one of the reasons may be that in the spreadsheet BCR calculations, all annual/undiscounted positive values are included in the numerator, and all negative annual values in the denominator.

Table E.2.2. lets us evaluate the structure of socio-economic benefits. Percentages provided in the last column show which benefits have the most substantial impact on the analysis results, and which have only marginal influence. Once we identify which benefits have the most substantial impact, good practice is to make sure whether assumptions and methodology used to monetize these benefits have not been oversimplified. If so, we should analyze these effects in more detail. Furthermore, the main monetization parameters for these effects are subject to sensitivity analysis. If it turns out that passengers' time savings are the most important factor determining the result of the socio-economic analysis, we should make sure whether distances, travel times and travel motivations have not been oversimplified. We then subject the unit costs we have used to estimate value of time to sensitivity analysis; optionally we may also analyze sensitivity to percentage distributions of travel motivations. **The principle is: the more impact a benefit has on the**

analysis results, the less simplified the assumptions, the better we prepare and describe the monetization methodology and the more detailed we analyze the sensitivity.

Reviewing the analysis results, we should check if the structure of benefits corresponds to the main project goals. If the project is supposed to shorten the transport chains, its main effect should be reduced generalized transport costs (savings in freights, tickets and time costs). If the analysis result is different, we should make sure that the analysis has been prepared properly. (Only in extreme cases the project may turn out not to meet the set goals or it turns out that to meet them, we need to carry out additional unforeseen complementary projects).

CBA best practices

IV

The Sensitivity
and risk analysis as
a tool to monitor
the project impact

Identification of key parameters and variables. Scenario analysis

There are two kinds of assumptions in every CBA: its general parameters as well as project-specific variables. The assumptions being most important for the analysis are referred to as key assumptions. A textbook approach will be to perform the sensitivity analysis only for independent parameters or variables. For example, revenue is determined by tariffs and demand, so if tariff levels change and demand remains constant, the projected revenue will change. Thus the revenue is not an independent variable. These are rather the tariff level and the demand forecast. If the project promoter has other revenue sources than tariff revenue only and these other sources are not demand-dependent, the sensitivity analysis is made both for changes in tariff level and separately for changes in total revenue[28].

The general parameters are assumptions with no direct relation to the project. These include discount rates, fiscal correction factors, unit values of monetized externalities, the share of travel motivations adopted from guidelines, etc. **If we are not certain of general assumptions based on expert estimates or external sources, it is the sensitivity analysis of CBA parameters that secures us against possible imperfections of the CBA model and its methodology.** In our experience, if during project appraisal we are not convinced by assumptions adopted in the financial and economic model, we simply review the sensitivity analysis in the spreadsheet to check how relevant these assumptions are for the entire CBA. Sensitivity analysis does not seem necessary for discount rates and fiscal corrections recommended by the EC or the Jaspers Initiative. According to most experts, the sensitivity analysis is however supposed to take account of unit value of time (VoT) as a key CBA parameter. Time savings are usually the main economic effect of the project

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[28] The public transport operator receives revenue not only from ticket sales, but also from advertisements. If PSC stipulates for compensation to cover the revenue deficit, the sensitivity analysis of financial profitability should concentrate on total revenue rather than just tariff level.

(especially in passenger transport), and there is no commonly accepted level of unit VoT (even if data source is reputable).

Key variables are assumptions specific for the underlying project. They depend on the transport mode and the project character itself. For example, sea freights may be essential for a seaport project but are not relevant for a road infrastructure project. In the majority of cases it is sufficient to analyze sensitivity to changes in standard variables, such as investment expenditure, projected transport volumes, operating costs, revenue rates (tariffs), etc. Nevertheless, it is always useful to review the 'assumptions' sheet in the spreadsheet and look for other potential key variables like those which are susceptible to significant market fluctuations. The list of project risk factors will be helpful as well. If a risk factor can be linked to a variable, then the variable must be added to the list of key variables (unless it has already been included). **Sensitivity analysis of key variables reflects the project financial and economic profitability in a scenario when its business, operating or financial assumptions are not accurate.**

The key variables are subjected to scenario analysis. First we identify deviation range of those variables from base levels typical of similar projects. The second step is a simulation of all CBA performance indicators for the typical deviation scenarios indentified. Every time only one key variable is subject to modifications; other parameters/variables remain unchanged. As for standard key variables, we must remember that:

• only future investment expenditure is subject to the sensitivity analysis of a project being already in the implementation phase. Thus we skip changes in expenditure already paid to contractors. Defining the scenario of capital expenditure changes, we take into account possible cost overruns in works to be completed, as well as contingencies relevant to the works still to be carried out;
• the transport forecast covering 25-30 years, even if conservative, is rarely accurate. Experts working on the CBA Guide recommend usage of a standard scenario with demand 20-25 per cent lower than its levels assumed in the forecast;

- even if we applied a conservative approach in financial projections and took into account all potential costs and only assured revenue, we still analyze sensitivity of the major financial items to ten per cent deviations. If the tariff rates on the project promoter's transport market are subject to higher fluctuations, we rely the change scenario on an expert opinion.

If the analysis of key variables, switching values and the risk matrix points out to a conclusion that a scenario analysis should be carried out for simultaneously two variables, we recommend doing so. For example, road projects have a high probability of cost overruns and unexpected expenditure, and at the same time road transport forecasts are usually excessively optimistic. For this reason the standard two-variable scenario recommended in the Blue Books is a combined 20 per cent capital expenditure increase and 15-20 per cent drop in projected AADT.

When conducting the sensitivity analysis, we change assumptions both in the counterfactual and investment scenario.

Links between the sensitivity analysis and the risk analysis

The sensitivity analysis and the risk analysis complement each other. Sensitivity analysis results can be used in the risk analysis, and vice versa.

Figure 6. Links between the sensitivity analysis and the risk analysis
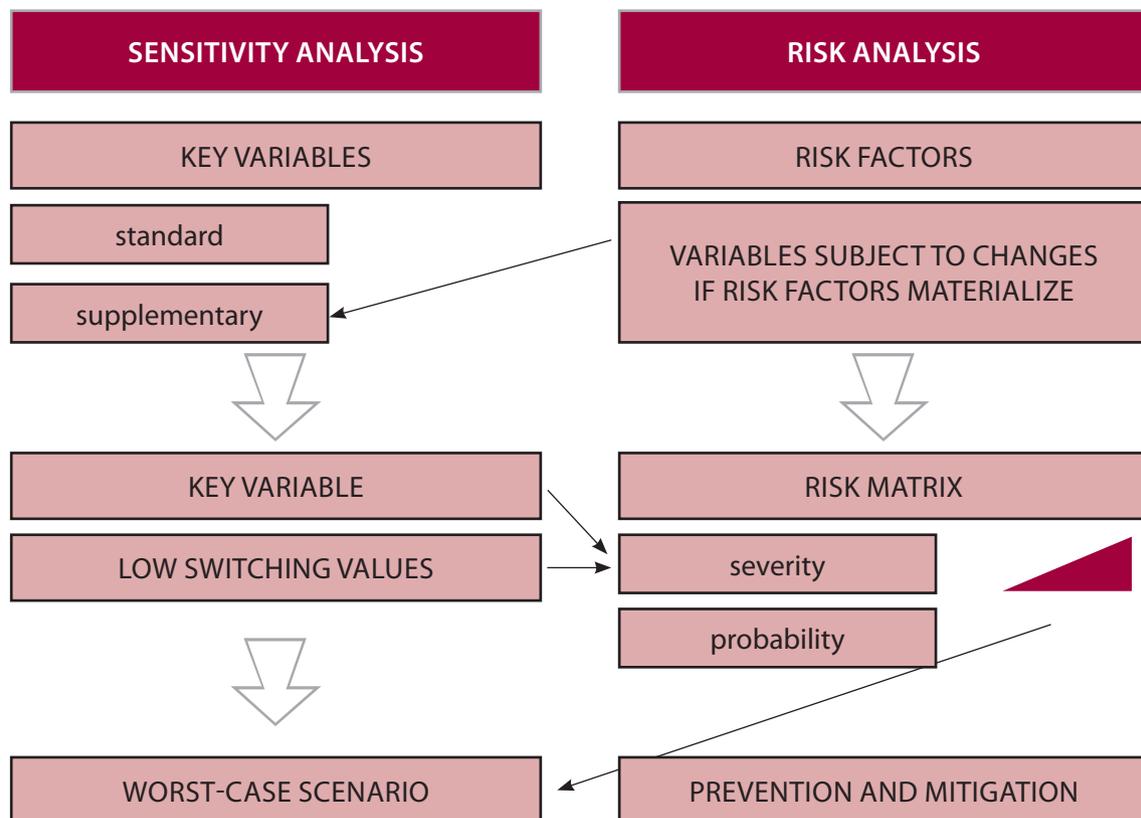
The sensitivity analysis begins with identification of parameters and key variables (described above) which are later subject to scenario analysis. Next, we examine in what proportion the project performance indicators respond to changes of those key assumptions, in other words we identify critical

assumptions of the CBA. According to the current EC interpretation, critical variables are these key variables whose change by ± one per cent leads to a change of the NPV by at least one per cent. The critical variables are thus variables which have an over proportional impact on the NPV. Every risk factor linked to a critical variable has a considerable impact on the project (see Figure 2), unless the switching value of the variable seems unlikely. Critical variables are to be by definition addressed in detail in the risk analysis.

In the application form we find a question 'what are the switching values of critical variables?'. Theoretically then, calculation of switching values is obligatory only for critical variables. Yet, a good practice is to calculate switching values for critical variables and other key variables, as well as the most important parameters, like unit VoT in the socio-economic analysis. If our spreadsheet is constructed properly, this will not require much effort.

Switching values specify the percent change of a variable that makes the project NPV equal zero. In other words, they give us information on what change of a variable would cause the project to become economically ineffective or financially unprofitable. Switching values are also useful when designing the project risk matrix. For example, if the ENPV switching value of capital expenditure is nineteen per cent, then a high probability of cost overruns may lead to losing EU funding eligibility. Variables with low switching values must also be included in the risk matrix and are to be addressed in detail in the risk analysis.

The risk analysis begins with a list of project risk factors. Here we use the standard list recommended by the EC and choose risk factors relevant for our project. After that we extend the list with risk factors specific to the project. When refining the list we take into account the project progress. Good practice is also to compare the list of risk factors with the critical variables and switching values from the sensitivity analysis. If the critical variables or variables with low switching values are linked to a project-related risk factor we have not considered thus far, we add them to the list.

When designing the risk matrix in line with the CBA Guide instructions, we try to relate every risk factor to a project variable which could change if the risk factor materializes. If there are variables which have not been considered key in the sensitivity analysis, we expand the sensitivity analysis. When designing the risk matrix, particularly when assessing "risk severity" for the project, we can also rely on our conclusions as to the critical variables and switching values.

To conclude the sensitivity and risk analysis, we can assess the project financial and economic performance indicators for the so-called pessimistic scenario (worst-case scenario). Customarily, the worst-case scenario is a scenario based on the low scenario of GDP growth rate projections. **The alternative worst-case scenario of the sensitivity analysis is calculating CBA indicators for a combination of all possible negative changes in key assumptions.** For example, in a rail project for calculating ENPV it may be a scenario where transport volumes are lower by twenty five per cent, unit VoT – by fifteen per cent and if cost overruns are highly likely investment expenditures – higher by ten per cent. This way we can assess the underlying project net present value for the worst case scenario of overestimated assumptions.

Sensitivity analysis modeling techniques

Sensitivity analysis calculations in the spreadsheet are to be linked with the CBA calculations by means of active formulas. **Good practice is to create a separate sheet for the sensitivity analysis, including both sensitivity assumptions and a summary of sensitivity results. This way we create a tool to change key variables easily and we show their impact on CBA results.**

Basically we must be able to check the sensitivity of CBA indicators to changes in a given key variable by simply entering the percentage change in one cell, with the spreadsheet recalculating results automatically. Suppose we check the impact of capital expenditure increase by fifteen per cent on CBA results. The model structure is supposed to allow us to enter the value „+15 per cent" in an appropriately described cell, which in turn will trigger an automatic recalculation of results. This way, we would obtain new results of the analysis in the same sheet. The sensitivity indicators are to be always linked from highlighted cells, and the recalculation mechanism is to be active (automatic or based on a mechanism clearly described in the spreadsheet). This is particularly important when the calculations are updated some time after the initial analysis, often by analysts who were not involved in the original project CBA.

Putting the sensitivity analysis in a different file than the base CBA model is unacceptable. We neither advise replicating all calculations in the section on sensitivity analysis. The latter hinders further modifications and model verification (necessity of multiple corrections, higher number of possible errors). We also do not recommend conducting the sensitivity analysis by means of one-time simulations (for instance by typing in capital expenditures higher by fifteen per cent in the assumptions sheet) for the model will not fulfill the flexibility criterion.

There are several techniques for constructing a flexible sensitivity analysis. The choice of the mechanism applied in the spreadsheet depends ultimately on the model structure and analyst's preferences. The analysis should be transparent and easy to verify. We recommend the following techniques:

- All sensitivity calculations are in a dedicated sheet to which we import the financial and economic flows necessary for calculating the CBA indicators. Next, we multiply these flows (e.g. incremental revenue) by sensitivity ratios. The sensitivity ratios are to be placed in separate cells and must be modifiable. The CBA indicators are supposed to recalculate automatically when we change sensitivity parameters.

- The sensitivity analysis calculations are performed in the spreadsheet's relevant calculation sheets. The separate sensitivity analysis sheet is a place where we enter sensitivity ratios and see the results of the sensitivity analysis. We add the sensitivity ratios to the base formulas of the analysis (in calculation sheets, outside the sensitivity analysis sheet). For example, revenue is calculated by multiplying the number of users, service price and (1+sensitivity ratio)[29]. When we change the sensitivity ratio to something different than zero, the entire analysis is automatically recalculated. We remember however not to save the changed sensitivity ratios in the final file. At opening the saved file should always calculate for the basic CBA scenario (all sensitivity ratios set to zero).

The sensitivity analysis in the spreadsheet is more complicated when the CBA is also used to select the investment option from a range of alternative options. Various methods are used to collate results for different parameters and options at the same time. For this, we use the "table" function or paste results to the result table (this can be done manually or with a macro). If we choose to paste **manually, we must be very careful and watch for erroneous entries.**

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[29] Regardless of the approach and provided that the sensitivity ratio has the same influence on all flows analyzed, the results of the sensitivity analysis will be identical, e.g. if an increase concerns all revenue sources rather that just one of them. This is due to the mathematical distributive law, e.g. $users_{counterfactual} * price_{counterfactual} * (1+sensitivity\ ratio) - (users_{investment} * price_{investment} * (1 + sensitivity\ ratio) = (users_{counterfactual} * price_{counterfactual} - users_{investment} * price_{investment}) * (1 + sensitivity\ ratio) = incremental\ revenue * (1 + sensitivity\ ratio)$.
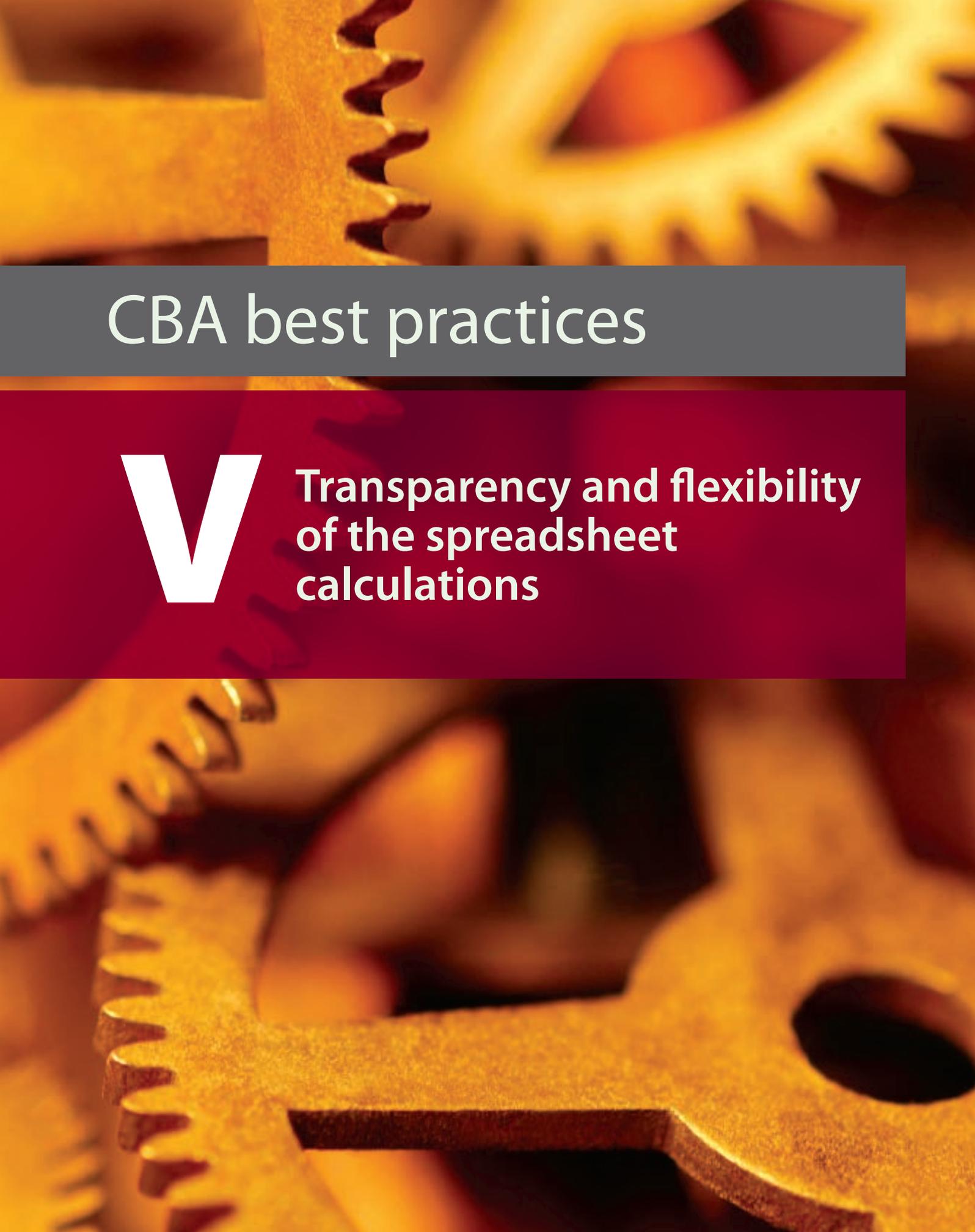
CBA best practices

V

Transparency and flexibility of the spreadsheet calculations

A good financial model is a multifunctional tool

In the beginning of the previous programming period, there was no common standard for spreadsheets filed with an application. Most beneficiaries provided one file with all calculations, but there were also CBAs divided into two or more files. **The analysts who prepared spreadsheets assumed that they were doing it for the purpose of one-time calculation. Few people realized that after signing a co-financing agreement, there could be many reasons to recalculate the CBA.** Watching the whole appraisal process, including more and more cases of CBA recalculations and comparing different approaches to the spreadsheet model structures, with time we identified the most frequent malpractices and errors.

Currently we recommend the following rules as regards the spreadsheets:

- the model is a single spreadsheet without any links to other files;
- calculation formulas are unlocked and allow both full appraisal and modifications;
- calculation formulas do not include numerical values typed into the formulas directly;
- the model recalculates automatically if assumptions are changed (model flexibility)[30];
- there are no hidden sheets and cells;
- the model is composed of worksheets presented in logical order and appropriately named, including at least:
  - assumptions,

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[30] Macros are acceptable, but they must be clearly described so that someone unfamiliar with the model is able to understand when the macro should be activated. Clear indication is necessary when macros must be activated for the model to calculate correctly. Macros also must allow us to edit the model, including editing macros themselves.

- calculations earmarked to each partial analysis in a separate worksheet, including: [1] demand/traffic, [2] capacity/potential, [3] financial analysis, [4] socio-economic analysis, [5] sensitivity analysis,
- tables presenting CBA results standardized to the application form table templates,
- (if the application form is later submitted to the Commission) tables presenting CBA results in euro standardized to table templates of the format for submission of the information on a major project,
- result indicator(s) calculation.

Figure 7. Structure of financial-economic model sections in the spreadsheet.
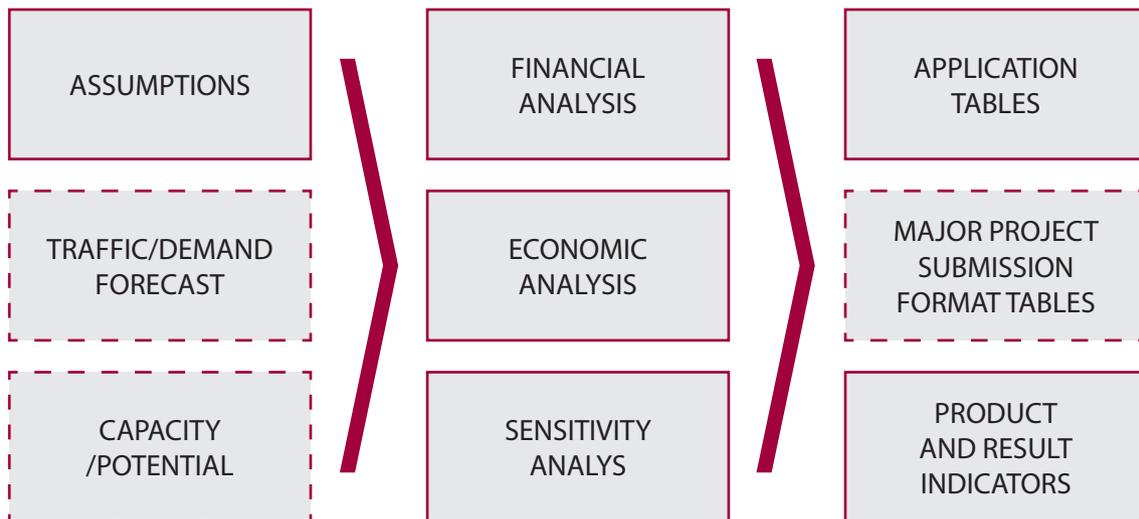
While the feasibility study is verified only before the co-financing agreement is signed with no future updates as a rule, the spreadsheet containing the financial and economic model may be used many times to recalculate parts of or even the entire CBA.

During the appraisal and verification process the spreadsheet may serve:

- CBA recalculation ordered or recommended by the evaluating experts or often self-corrections due to for example project rescheduling or revised project capital expenditure estimation after main contracts had been awarded;

and in the project implementation phase:

- CBA updates due to changes in the project parameters for the same reasons as self corrections during the appraisal process. Another reason may be alterations in the project scope or promoter's business assumptions;

- CBA result indicator updates due to changes in the socio-economic environment or promoter's business assumptions;

- funding gap recalculation if any of standard premises for recalculation occur (depending on rules adopted by Managing Authorities);

and in the project operational phase:

- funding gap recalculation if any of standard premises for recalculation occur (depending on rules adopted by Managing Authorities);

- monitoring of result indicator(s);

- ex post analysis.

It might also be necessary to introduce a revised approach to the CBA methodology. In the previous programming period, if the entire project CBA was recalculated for some reasons, the beneficiaries were also obligated to introduce the revised or refined CBA rules. This was for example removal of revenue from the socio-economic analysis as due to some contradicting interpretations it was not always the case in original CBAs. Another example was removal of incidental revenue from the funding gap analysis if it did not exceed ten per cent of eligible expenditure. In the beginning of the programming period we had no strict interpretation of a 'significant' revenue and the ten per cent threshold was set later.

Alterations in the spreadsheet are unavoidable and can take place many times. To make them easier, the spreadsheet structure is to be transparent and flexible. We bear in mind that the model can be updated by people who did not take part in its creation.

To create a model, start with the design

Every financial-economic model is a simplification of a given reality. **The model design starts with specifying the simplification level which will not significantly distort results and at the same time will not require a too extensive workload. When creating the design, we take into account possible further changes and updates.** For each simplification we consider whether it would not hinder any model modifications in the future. For example: may we assume lump-sum tram track maintenance costs, or is it perhaps better to use unit costs for one meter or kilometer of tracks? Suppose the technical design of the turning loop is modified. It will be somewhat easier to change the length of tracks in the model than to calculate a new lump-sum value (especially if the original lump-sum calculation has not been documented properly).

Each project model is different and it is not possible to assure its complete standardization. Only beneficiaries who carry out similar projects, like consecutive road sections with similar parameters and assumptions, can partially unify the spreadsheets, the result tables in particular. Even in such cases each road project has a different number of road sections, different design of road interchanges and other civil engineering structures as well as different application requirements. The spreadsheets are obviously not identical.

If we adapt an existing spreadsheet for a different project, the probability of errors increases. We may simply overlook something (for instance we leave the name of the previous project, we only partially change the formula in the row, we copy formulas with reference to an empty cell, or forget to modify formulas which contain numeric values), copy mistakes from the previous spreadsheet, as well as commit methodological mistakes (for instance when we use a methodology that was suitable to a project with different socio-economic effects).

If we use a unified spreadsheet, we start with the same basic spreadsheet for each new project (the so called 'master copy'). This way we eliminate the need to delete calculations adapted to another project. The basic spreadsheet must be updated on a regular basis. If we change the spreadsheet of a given project due to our previous experience or as a result of the evaluator's remarks, we consider whether these changes are general and apply to other projects as well. If so, the changes must be transferred to the master copy.

The basic design of the model is a list of worksheets and a data flow chart. We know that spreadsheets with the three-worksheet structure 'assumptions-calculations-results'[31] are opaque and inflexible. In extreme cases, we cannot identify where alterations should be made and where actual analysis results can be found. On the other hand, if there are too many worksheets, we can have difficulties in understanding the calculations. For this reason we create separate worksheets or grouped rows (grouping is the only recommended form of hiding rows in the model) when the outcome of complicated calculations is only one analytical item. Depending on the nature of the project, these may be for instance total revenue (many groups of users and a complicated tariff), a particular category of economic benefits, or complement projects etc.

Not every CBA model is supposed to contain financial report projections. They are presented only if we need to justify the sustainability of projects carried out by entities who are obliged to prepare such reports. In other cases (like a project carried out by a public sector entity) financial report projections are fictional, distort the transparency of the model structure and… leave room for more mistakes. When designing a CBA model, we bear in mind that projections for several entities might be necessary (see *The scope of the financial analysis and …*).

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[31] This is particularly striking when the 'results' worksheet contains not only result tables that are copied into the application form but also all possible project data, including assumptions, all investment options and sensitivity scenarios. This is why we ask for a separate worksheet with all result tables corresponding to table templates from the application form (format for submission of the information on a major project), so that CBA results can be located immediately.

The spreadsheet should present annual data consistently. Each column in each worksheet must be assigned to a specific year (for instance data in column F always refer to the year 2014, while column G presents 2015 data). This way we reduce the risk of linking data to a cell dedicated to a different year. We remember that CBA has an annual basis. The only exception is the section presenting the detailed quarterly schedule of capital expenditure for purposes unrelated to CBA, if included in the CBA spreadsheet (which is not obligatory; may be presented in a separate spreadsheet).

We advise using colors to mark the cells where assumptions were entered, as well as formatting data in the entire spreadsheet in a consistent way. Every value (both assumptions and formula results) is to be assigned a unit and the source in the adjacent columns (with sources of assumptions in one column and units in another). We provide sources for all assumptions.

Avoiding errors in spreadsheets

The more complicated the financial-economic model, the higher the likelihood we make a mistake. Good practice is to simplify the model structure and formulas, as well as to introduce validation formulas[32]. Also, it is good practice to ensure that a second analyst who had not been directly involved in the project checks the spreadsheet[33]. **When verifying EU applications, the most significant problem we have encountered was errors in the spreadsheet. These were for example errors related to assumptions and inconsistencies between the spreadsheet and the study content. The necessity to correct a spreadsheet many times significantly prolonged final acceptance of financial-economic models and feasibility studies. It was evident that many consulting companies did not subject the spreadsheet and the study to any in-house quality verification. What is more, many beneficiaries trusting the consultant's competence forwarded these materials to us without reading them.**

Mistakes are also made whilst introducing alterations to the spreadsheet. After alterations have been implemented, a repeated quality verification is necessary. Among the most difficult alterations there are shifts in the reference period as we need to remember to assign particular values to other years according to the new schedule. These are usually the residual value (always in the last year of the reference period) and the beginning of the operational phase (with impact on revenue, operating costs, economic benefits, replacement cycle, etc.). For this reason, we advise using coherent formulas in the entire row, so that relevant items are activated automatically[34].

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[32]   For example, in the application table E.2.2. the total benefits minus the total costs should be equal to project ENPV or in a financial analysis consolidated for several entities – the total FNPV/C of all entities should be equal to the FNPV/C of the entire project.

[33]   The same principle of double checking by two evaluators is recommended when verifying the entire CBA and other project documents.

[34]   For example, the moment we start charging fees may depend on a separate assumption "beginning of operation period" or be based on the principle "we start charging fees the next year after the last capital expenditures were borne".

Simplification does not mean minimizing the number of rows and size of the model. The opposite is usually true. We advise as simple formulas as possible. Complicated calculations should be performed in several rows, rather than in one. This approach provides for transparency in the analysis. For example, when we sum up operating costs, we aggregate them with respect to particular tasks or institutions, and after that we add up the total amount in another row. A perfect formula has no more than two types of functions (for instance multiplication and addition) and no numbers entered directly into the formula, only references to cells[35].

In order to avoid mistakes when adding and subtracting, it is good practice to mark revenue and benefits in the entire model as positive values, whereas costs and expenditures as negative ones. After having applied this rule, we can use only addition (when calculating the sum of particular costs), and the interpretation of results will be easier especially regarding the difference of costs between investment and counterfactual scenario.

Table 6. Mechanisms increasing the likelihood of mistakes and errors in spreadsheets

Mechanism	Problem	Recommendation
Links to other spreadsheets	When implementing alterations, we cannot locate other spreadsheets and we cannot be sure what data were originally entered there.	All assumptions, calculations and results of the CBA model must be entered in one file.
Assumptions or calculations for the same items in several places	In the most extreme case we saw, a change of capital expenditure after all work contracts had been awarded required four alterations in various worksheets; what is more these were alterations in different formulas. At the end we saw three different expenditure values in various parts of the spreadsheet.	Each item is entered or calculated once, and later linked up to further calculations.

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[35] This applies even to averaging values. If we use a formula to calculate the average for two road sections, we cannot rule out that in the future the project will be extended by a third section. Therefore, it is a good idea to use a suitable spreadsheet function (in this case – AVERAGE), rather than dividing the sum by 2.
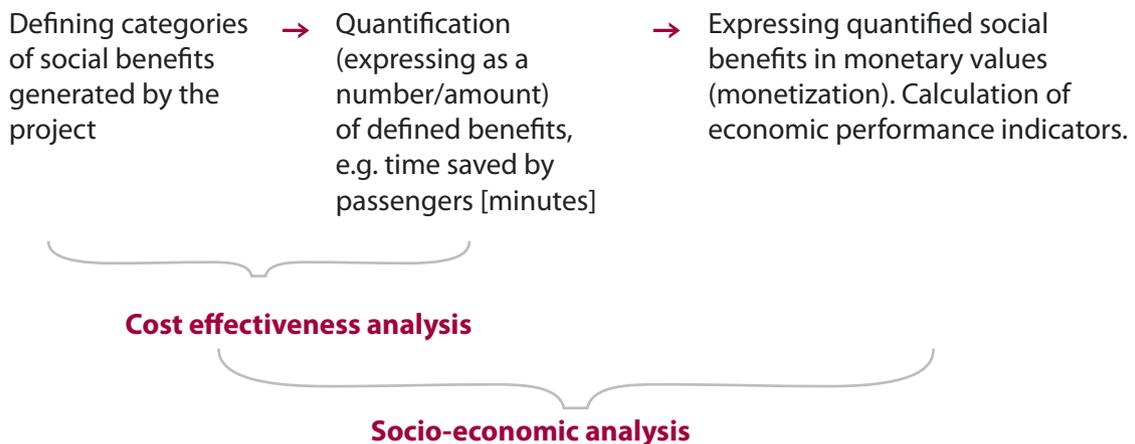
Mechanism	Problem	Recommendation
Circular references	Circular references provide false results for certain functions or are not activated when the model is opened. The model gives incorrect results.	We do not advise usage of circular references.
NPV formula	The formula calculates the present value for the year before the first year in the scope of the formula. This does not correspond to the CBA rules where the base year is not discounted.	The formula is to be applied to data from the second to the last year of the analysis, and after the formula we add the first year value. We can also calculate the discount factors, multiply them by annual data and add up the results.
IRR formula	The formula generates an error instead of calculating values for projects with a negative rate of return (the error may not appear every time the model is opened. Excel attempts to guess IRR twenty times, starting from the default value ten per cent, unless a different default value has been entered in the function. If actual IRR is negative, twenty iterations are not always enough to reach negative values).	We enter a negative default value, e.g. IRR (C20:AA20;-0,1) in the formula as the last argument.
NPV and IRR formulas	The formulas calculate the value for the year before the first year for which data have been entered. They do not take into account empty cells.	We use cohesive formulas from the first to the last year of the analysis (even if they result in zero in the first years).
Hidden worksheets, rows and columns	When making changes, an analyst unfamiliar with the model skips calculations they cannot see, while changes in the hidden sections may be necessary to obtain a correct new CBA result.	Worksheets, rows and columns must be unhidden. For presentation purposes, only grouping is acceptable.
Rounding	Rounding all items in the analysis can significantly distort CBA results, and overstate co-financing or understate project effectiveness.	Rounding is acceptable in application tables only. Note: the grant amount is always supposed to be rounded down.

Glossary of terms

Budgeted cost of work scheduled – in the financial-economic analysis: the schedule of main investment expenditure divided into years and presented in net and gross prices. For the purpose of advance payments, refunding and settling the project, the project promoter should also possess its more detailed version.

Cost effectiveness analysis – a particular type of the cost-benefit analysis. Unlike the socio-economic analysis, the project effects are not supposed to be expressed as monetary values (monetized). We use it when it is not feasible to measure the benefit in cash or when the margin of error is too great (for instance if we attempt to adapt an existing valuation methodology to the project specifics). Using this approach we calculate costs of one unit of benefits generated by the project (an example of the cost effectiveness analysis is the dynamic generation cost method, DGC).

Defining categories of social benefits generated by the project → Quantification (expressing as a number/amount) of defined benefits, e.g. time saved by passengers [minutes] → Expressing quantified social benefits in monetary values (monetization). Calculation of economic performance indicators.

Cost effectiveness analysis

Socio-economic analysis

Economic performance indicators define the economic profitability of the project on the basis of financial flows less revenue corrected for fiscal transfers together with monetized socio-economic benefits. The latter are for example savings in generalized transport costs and lower environmental costs, and if applicable other kinds of socio-economic benefits. The **ENPV** (economic net present value) is the net balance of all discounted projects benefits and costs. The project is economically profitable if its ENPV>0. The **ERR** (economic rate of return) specifies the economic return on the project. The project is economically profitable if ERR>i (where i is the economic discount rate). Considering the nature of IRR calculation formula, if we deal with a non standard cash flow balance that changes sign more than once

over the reference period, more than one IRR result is possible. In this situation as well as when for other reasons the same cash flows deliver contradictory ENPV and ERR results raising questions as to the economic performance of the project, the ENPV result should be given priority over ERR. The **B/C** (benefit-cost ratio) is total discounted benefits of the project divided by total discounted costs generated by the project in the entire reference period. The project is economically profitable if B/C>1.

Financial profitability indicators – FNPV/c i FRR/c (measure financial profitability of the underlying project) and FNPV/k i FRR/k (measure profitability of the national capital whereas calculations exclude the part of capital expenditure funded by the EU and instead include all project related debt service costs). To calculate **FNPV/c** and **FRR/c** we take account of the total capital expenditure less contingencies, replacement and operating expenses (less depreciation and amortization), project revenue from direct users, as well as the residual value in the last year of the reference period. The project is financially unprofitable if FNPV/c<0 and FRR/c< i (where i is the financial discount rate). To calculate FNPV/k and FRR/k we take account of total capital expenditure less contingencies and less expenditure funded by the EU grant, replacement and operating expenses (less depreciation and amortization), project revenue from direct users, debt interest if applicable as well as the residual value in the last year of the reference period. The project is financially unprofitable if FNPV/k<0 and FRR/k< i (where i is the financial discount rate). As external financing might be very costly, particularly for medium and high credit risk projects, FNPV/k may be lower than FNPV/c. In the previous programming period the indicators /k posed a problem when the domestic/national capital was not equal to the project promoter's capital. According to the new CBA Guide, if necessary we may use additional financial profitability indicators. These are, for example, the FNPV/k and FRR/k of the beneficiary, which take into account only beneficiary's own contribution, including non-repayable operational subsidies.

Funding gap – a method used to calculate the maximum percentage value of costs eligible for co-financing (other methods are flat rate approach and maximum percentage value of eligible costs set at the national level and based on, for example, acceptable state aid limits). The funding gap is calculated when discounted revenue (not including residual value) is higher than discounted

operating costs. It is calculated as [discounted total capital expenditure (excluding contingencies) minus discounted income (including the residual value)] divided by discounted total capital expenditure (excluding contingencies).

Generalized costs of transport – any costs arising in the transport users' perception that are subject to their transport decision. The first group of these costs is any charges borne to use a transport service. In passenger transport these are all costs related to using cars, including fuel costs, tolls, parking fees or ticket prices if we use public transport (buses, trains, airplanes) expressed as per one person or transport volume (in passenger kilometers). As for cargo transport, these are freights as well as any handling and storage costs. The second group of costs is transport costs for which no market prices are quoted but they are still subject to a transport decision. This is mainly costs of time perceived by passengers, which are borne when riding in the means of transport, as well as when waiting at and walking from or to public transport stops. Measuring time in transport chains is relatively easy. Contrary, the valuation (monetization) of unit value of time (VoT) is based on many general assumptions and a specific methodology.

Incremental method of analysis – projections and calculations are prepared separately for a counterfactual (without the project) scenario and an investment (with the project) scenario. The results for the counterfactual scenario are subtracted from the results for the investment scenario – the difference (the so called incremental result) defines the project. A simple method (non-incremental) is applied only if projects are carried out from scratch (results of the counterfactual scenario equal zero) and/or when the beneficiaries are able to separate the project flows from flows of their other activities in a clear and transparent way.

Monetization of external effects – expressing quantifiable external effects as monetary values. We can also monetize some of the generalized transport costs, including value of time (VoT).

Project financial sustainability – non-negative annual balance of not discounted accumulated cash flows in the investment scenario (note: we do not use incremental analysis when presenting financial sustainability). The financial sustainability analysis is used to prove that after the project completion the financial inflows (own contribution, other funding sources as well as revenue pursuant to art. 61 of

the Directive 1303/2014 and other inflows) are sufficient to cover all expenditures, including debt service (installments plus interest), if applicable. The financial sustainability is indicated for each entity co-funding the project (except the EU funding).

Reference period – depending on the transport mode – 25-30 years. The standard reference periods may be found in the EC recommendations. If the economic life of entire project scope (or its vast majority) is substantially shorter than the standard reference period, we conduct the CBA for a shorter reference period. The reference period covers the investment phase as well as the operational phase. The first year of the analysis is referred to as the base year. Customarily it is the year in which the application for co-financing is filed. If the project started before the base year, we add the capital expenditure in earlier years to the base year expenditure. The values in the base year are not subject to discounting.

Residual value – value of the project at the end of the reference period put into the calculations (financial and socio-economic analysis) in the last year of the reference period. In the programming period 2007-2013 it could have been the net value of assets computed on the depreciation basis or by means of simplified indicators (see Blue Books). For the purpose of the financial analysis the alternative approach to residual value calculation was the income method, i.e. the net present value of future cash flows assumed to be indefinite in time. The new CBA Guide recommends calculation of the residual value (for the last year of the reference period) as cash flows (financial analysis) or economic flows (socio-economic analysis) computed from the last year of the reference period to the end of the project life cycle, based on values for the last year of the reference period[36] . The methods based on the depreciation are acceptable in the financial analysis for projects which do not generate revenue or for long-life projects whose residual value calculated as the NPV of cash flows is very high. In the new programming period, if in the financial analysis we consider the net present value of cash flows, then in the socio-economic analysis correspondingly we consider the net present value of economic flows after

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[36] For instance, for the project with fifty years of life cycle and thirty years of reference period we assume that after the reference period for the next twenty years the project generates cash flows at a level equal to flows in the last year of the reference period. The NPV of cash flows generated in the twenty year period after the reference period is put into the financial analysis in the last year of the reference period.

fiscal corrections in the financial items. If in the financial analysis the residual value is computed on the depreciation basis, in the socio-economic analysis we use the same value however corrected for fiscal transfers at the same rate as the capital expenditure.

Switching values – percent changes of key parameters/variables, which cause NPV to equal 0. If capital expenditure of a project would have to rise by 330 per cent so that ENPV is equal 0, then 330 per cent is a switching value of the capital expenditure in the socio-economic analysis. For majority of variables, the decrease below -100 per cent is physically impossible – if we obtain such a result, the switching value is non-existent.

User revenue – in the programming period 2014-2020 pursuant to the article 61 of the Directive 1303/2013, "net revenue" means "cash in-flows directly paid by users for the goods or services provided by the operation, such as charges borne directly by users for the use of infrastructure, sale or rent of land or buildings, or payments for services less any operating costs and replacement costs of short-life equipment incurred during the corresponding period. Operating cost-savings generated by the operation shall be treated as net revenue unless they are offset by an equal reduction in operating subsidies". Thus fees paid by passengers for using public transportation are user revenue, but government subsidies are not. (In the programming period 2007-2013 the definition of revenue was specified by the article 55 of the Directive 1083/2006).
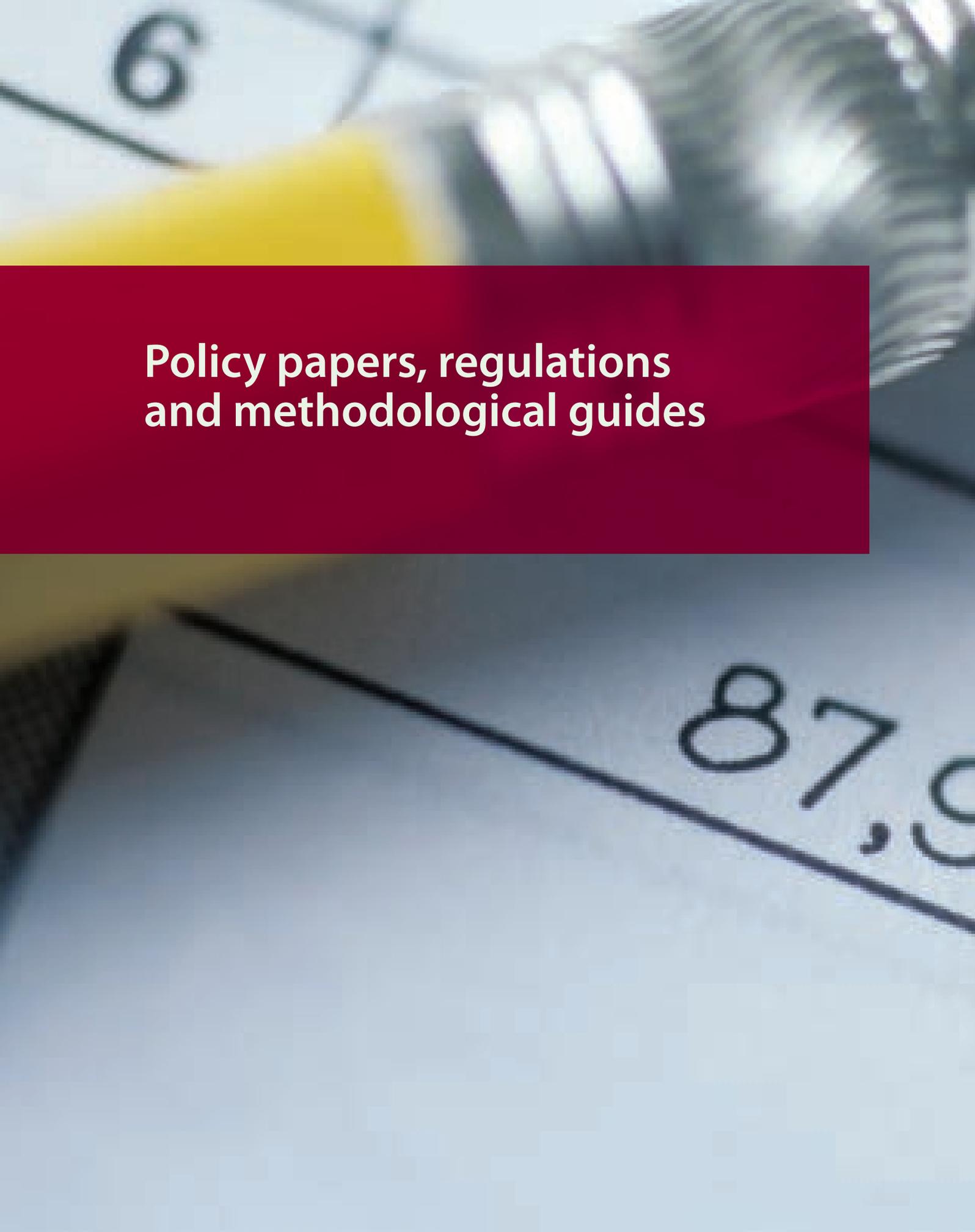
Policy papers, regulations and methodological guides

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