The Global Project Assessment Method: a new tool to bridge the gap between cost-benefit analysis and budgetary decisions *

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Abstract

Despite a broad consensus that infrastructure is essential for economic development, investment in infrastructure is far below what is needed, even in developed countries. One of the main reasons is that it is difficult to assess with certainty the medium- and long-term budgetary impacts (expenditure and revenue) generated by a project, as this assessment calls for a micro-economic analysis of the project (cost-benefit analysis) to be linked with budgetary macroeconomic impacts, through country-specific financial mechanisms. In general, the cost benefit analysis stops just before the budget impact assessment. As a result, evaluations predict an almost systematic deterioration in the debt-to-GDP ratio and thus slow down the investment decision. However, some projects generate future direct and indirect revenue streams for the State, the discounted value of which is higher than the initial investment. In this paper, we propose a new evaluation method, the Global Project Assessment Method (GLOPRAM), which takes into account the complexe nature of investment assessment for public decision and better reflects the economic and budgetary reality. More specifically, the GLOPRAM makes it possible, for a given project, to reconcile the socio-economic assessment, the environmental impact study and the budgetary impact.

JEL classification: H54; H61; H68; 018

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1 Introduction

Because of their intrinsic characteristics[1], the budgetary evaluation of infrastructure investment projects is problematic, as is the inclusion of their specificities in the public accounts. Indeed, these projects imply a temporary deterioration in the debt-to-GDP ratio, even though some projects generate future direct and indirect revenue flows that exceed the initial investment. As a result, there is a global infrastructure gap that could reach USD 820 billion by 2040 according to the Global Infrastructure Outlook (2017).

However, an abundant empirical literature[2] (see in particular the surveys of Straub (2008); Pereira & Andraz (2013)) which has developed since the 1980s, shows the importance of the capital stock in the growth process.[3] These results have relevant policy implications and show that investment in infrastructure can generate significant economic benefits by increasing the productivity of firms. However, Cost-Benefit Analysis (CBA)[4], which is the privileged analytical tool for the evaluation of these projects, does not fully take into account this positive impact of infrastructure on economic activity and its budgetary consequences . As underlined by Atkins *et al.* (2017), while some infrastructure can have dynamic effects, i.e. change the structure of the economy, CBA considers only static effects.

In this paper, we develop a new method that aims at providing a global evaluation of infrastructure projects, the Global Assessment Project Method (GLOPRAM). The GLOPRAM differs from conventional methods by the global nature of the analysis performed. It allows to link microeconomic data (at the scale of a project or a company) with macroeconomic variables such as the State budget, the GDP or the public debt. It thus enables a project to be evaluated objectively by estimating its market and non-market impacts for all economic agents (users, the population, the construction company, the State and the private partner, if applicable), taking into account environmental costs/benefits (climate change, local air pollution and variation in ecosystem services) but also other factors often neglected in traditional CBAs (variation in surplus induced by the return to employment, tax expenditure and revenue, avoided costs, etc.). Social and societal

[1]Infrastructure investment projects are characterized by unconventional financial flows (significant short-term investment and long-term return). They also generate significant externalities, which are often difficult to evaluate in monetary terms.

[2]This litterature is essentially built on the theoretical contribution of Barro (1990).

[3]Although there is no consensus on the magnitude of this impact and the results differ widely from one paper to another, the overall effect appears to be positive.

[4]For further details on the theoretical foundations of CBA see Drèze & Stern (1987).

aspects are also taken into account in the analysis, and translated into budgetary terms where possible.
The major advantage of this approach is that it reflects, through simple modeling, the inherent complexity of measuring the consequences of a project as well as its real impact on public accounts in the short and long term.

In order to empirically test the GLOPRAM, we have developed the GLOPRAM-2020 model. We have applied this model to a highway infrastructure construction project largely inspired by the A89-A6 link in France. Without anticipating on our findings, this empirical analysis shows that conducting a proper budgetary evaluation to complement the socio-economic and environmental evaluations of projects is highly informative for decision-makers. In addition, this budgetary evaluation should: i) take into account all relevant fiscal revenues; ii) be conducted over different time horizons ; and iii) take into account various contractual arrangements.

This paper contributes to the existing literature on project appraisal as it presents a new analytical tool that allows to perform global project evaluations and bridge the gap between cost-benefit analysis and budgetary decisions.
In addition, the GLOPRAM may be of particular interest to the public decision. In the current context of high government indebtedness and slower growth, recourse to public financing is problematic, despite low interest rates, since it implies an increase in the stock of debt.
In addition, the COVID-19 crisis has further increased the global debt burden and there is great uncertainty about the prospects for economic recovery. In this context, a new project assessment tool that allows the allocation of public expenditure to growth-generating projects and the selection of the most favorable contractual arrangement is of interest to decision-makers.
Finally, the challenges posed by global warming cannot be met without a considerable budgetary effort. The European Union is planning to mobilize EUR 1,000 billion between now and 2030 in order to achieve climate neutrality by 2050 (European Commission (2020)). It is then necessary to provide decision-makers a project selection tool that allows them to identify projects that reconcile ecological sustainability, productivity and fiscal sustainability.

This paper is organized as follows. The next section presents the theoretical framework, Section

3 describes the GLOPRAM. Section 4 presents our empirical analysis and Section 5 concludes.

2 Theoretical framework

In the current context of economic slowdown and rising public debt, particularly in developed countries, the prospects for large-scale investments are reduced. Yet countries face a growing infrastructure gap that has been widely documented in the academic and practitioner literature (see among others Andrés *et al.* (2014); McKinsey Global Institute (2017); Rozenberg & Fay (2019)). If countries want to maintain/increase their growth potential in the medium and long term, an investment effort must therefore be made in this sector. As documented by the literature, infrastructure is indeed a necessary condition for economic development. Since the late 1980s, an abundant literature studying the link between infrastructure and growth has emerged. The models of Barro (1990) and Barro & Sala-i-Martin (1992) place public infrastructure at the forefront of the long-term growth process. In these models, infrastructure participates directly in the production process through the intermediate goods and services it provides. In line with this theoretical background, and stimulated by the seminal paper of Aschauer (1989), an aboundant empirical literature has emerged. Despite a persistent debate on the magnitude of the effect of infrastructure on economic activity, most of empirical analyses estimate positive elasticities (see in particular the meta-analysis performed by Melo *et al.* (2013) and Holmgren & Merkel (2017)).

From a theoretical point of view, the contributions of the New Economic Geography (Krugman (1991a,b)) are substantial. One key characteristic of infrastructures is that they generate spatial externalities. In addition, infrastructure influences the location choices of economic agents, which impacts the price of goods and services. A new infrastructure in a given geographical area can induce a dynamic of concentration of firms and thus increase: i) the demand for labor, which leads to a change in the equilibrium on the labor market; ii) competition between firms, which reduces the price of goods and services for households; and iii) the price of fixed factors of production such as land.

While there is a broad consensus that infrastructure stimulates economic activity, project evaluation is hampered by methodological shortcomings which prevent the production of reliable and comprehensive evaluations. The most popular tool for project evaluation is cost-benefit analysis (CBA). Guillaume (1972) describes the theoretical foundations of CBA, which he defines as a partial equilibrium analysis, classifying public projects according to the economic surplus they provide to society. From a more operational perspective, CBA determines the feasibility of a project by weighing the monetary value of all the costs and benefits generated by the project. It is *"a tool to determine the project's value for money"* (Volden (2019)). However, as underlined by Gibson & Wallace (2016), although CBA is widely used, there is no international standard that would allow uniform analyses to be produced. While some parameters are included in most CBAs, there is no unified analytical framework to implement such an analysis. The guide to CBA produced by the European Commission (2014), which aims to provide practical advice on the evaluation of major projects, identifies numerous sources of error at each stage of a CBA.[5] There is therefore a great deal of heterogeneity in the application of CBA. Moreover, this method, as it is generally applied, omits many impacts that nevertheless largely influence the results. In addition, CBA focuses on microeconomic variables (at the project level), which cannot be linked to macroeconomic aggregates (debt, GDP, government budget, etc.).

3 The GLOPRAM

The general structure of the GLOPRAM is presented in Figure 1. As in any project evaluation method, the starting point is the assessment of socio-economic impacts. In addition, in accordance with the rules applicable in the European Union[6], the socio-economic evaluation is complemented by an assessment of the environmental costs and benefits of the projects. These two first parts of the evaluation cannot be done without input data on forecast demand and a set of hypothesis which should be as realistic as possible.

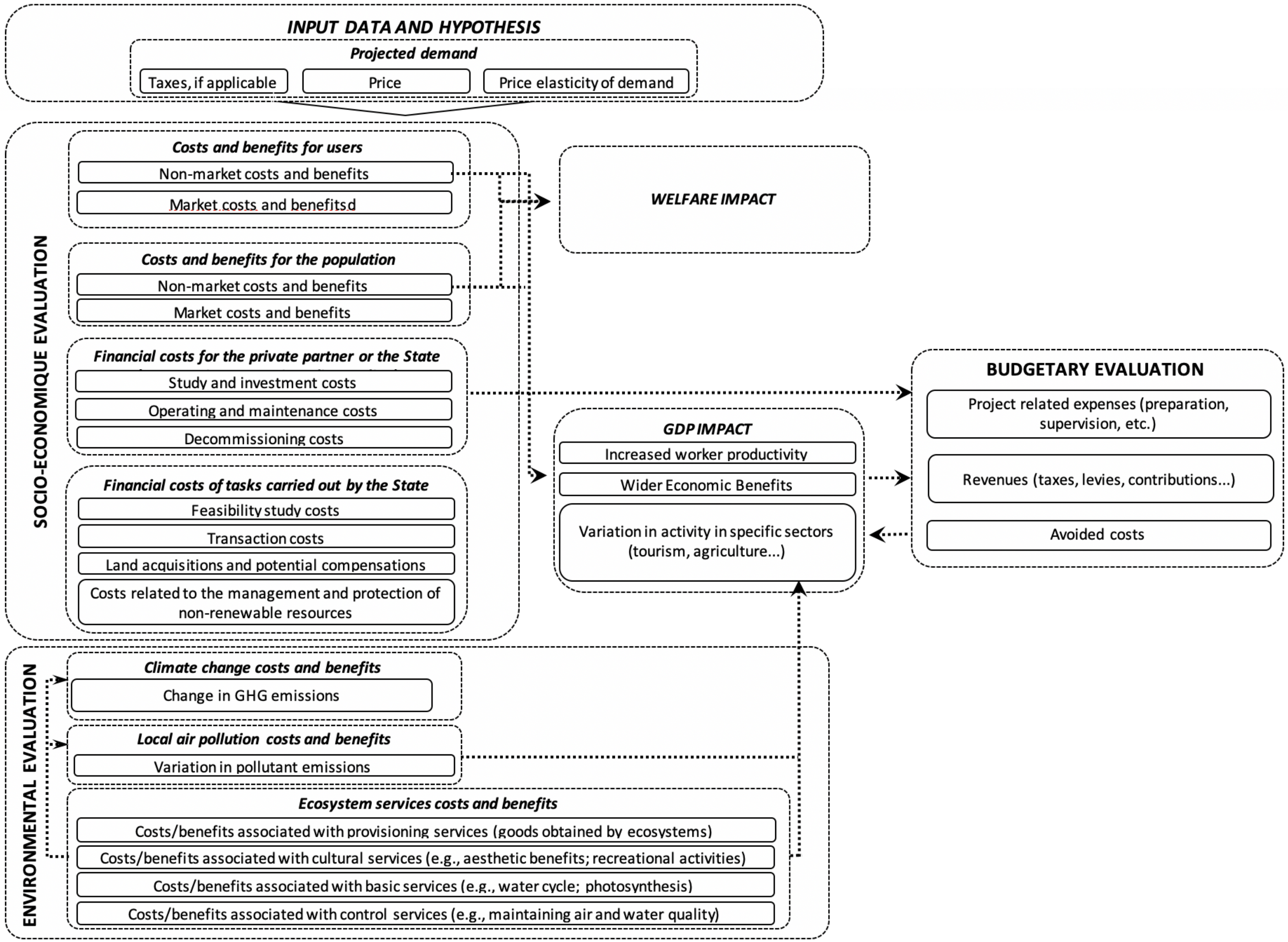
These social, economic and environmental impacts may have repercussions on both the welfare of the population and the economic activity of the geographical area considered. A new infrastructure may, indeed, increase workers productivity, stimulate specific sectors or generate wider economic benefits.[7]

[5] Such as the absence of a quantified analysis of an alternative scenario, the failure to take into account replacement costs in the calculation of residual values, or the use of nominal interest rates for the calculation of interest payments even though the analysis is carried out at constant prices.

[6] Directives 2011/92/EU and 2014/52/EU establish the EU regulatory framework for environmental impact assessments.

[7] For more details on the wider economic benefits, see Byett *et al.* (2015); Douglas & O'Keeffe (2016); Legaspi *et al.* (2015); Venables (2016); Veryard (2016).

Figure 1: General structure of the GLOPRAM



We then complement the socio-economic and environmental evaluations with a budgetary evaluation that makes it possible to anticipate the effects of a project on the government budget and, more generally, on the debt-to-GDP ratio. With this method, it is then possible to evaluate : i) the Net Present Value (NPV) and Internal Rate of Return (IRR) of the project, but also the NPV and IRR for the private company and the government; ii) the cumulative costs and revenues for the government; and iii) the change in the debt-to-GDP ratio induced by the project.

3.1 Socio-economic evaluation

In order to evaluate projects on their socio-economic aspect, we propose to carry out a cost-benefit analysis. Market and non-market costs/benefits are assessed for the following population groups: i) users; ii) the population; iii) the private partner or the State depending on the contractual arrangement; iv) the State, which necessarily bears certain preparation and supervision costs.

For users and the population, costs/benefits are grouped according to their market and non-market character.[8] However, some nonmarket costs/benefits may have an impact on GDP, such as the gain in work time, in the case of transport infrastructure, which positively influences the productivity of workers.

The financial costs for the private partner or the State are broken down as follows: i) study and investment costs; ii) operating and maintenance costs; and iii) decommissioning costs.
The costs of preparing, carrying out and operating the project have been divided into two categories: i) costs that are always borne by the State ; and ii) costs that, depending on the type of contract, may be borne by the State or a specific project company. In the first category, there are the initial studies, land acquisition and release of rights of way, transaction costs, part of the pre-project studies, the control and monitoring of the contract, and part of the costs related to the protection of natural resources. In the second category, we include the cost of detailed studies, construction, cost overruns, transaction costs and, if there is a project company, its operating and maintenance costs.
It should be noted that the costs and benefits for users are specific to each type of infrastructure, while the costs for the State and/or the private partner are fairly similar for all projects.

[8] Market goods and services have a market value, directly usable, whereas non-market goods and services do not strictly speaking have a "price", and are therefore more difficult to monetize.

3.2 Environmental evaluation

In accordance with the rules applicable in the European Union[9], the socio-economic evaluation is complemented by an assessment of the environmental costs and benefits of the projects. However, as highlighted by the European Commission (2014), there is generally a lack of consistency between the options analyzed in the CBA and the options analyzed in the Environmental Impact Assessment (EIA). In order to avoid this pitfall, we have included an environmental evaluation in the GLOPRAM, that systematically completes the CBA of a given project.

One of the major difficulties related to the environmental evaluation lies in the identification of the costs and benefits to be taken into account. To do this, we relied on the recommendations of the European Commission (2014, 2019), the SuRe® (Standard for Sustainable and Resilient Infrastructure) methodology, and the academic literature on the subject (see in particular Wale & Yalew (2010); Mueller *et al.* (2016); Farley (2012)). The environmental costs and benefits associated with infrastructure are diverse and differ widely from one infrastructure to another. However, it is possible to group these effects (potentially positive and negative) into three categories: i) climate change costs and benefits; ii) local air pollution costs and benefits; and iii) ecosystem services costs and benefits.

Details of the calculation of the environmental costs and benefits are presented in Appendix 1.

3.3 Budgetary evaluation

The main originality of the GLOPRAM lies in the budgetary evaluation which allows to assess the budgetary (or fiscal) revenues related to the socio-economic and environmental benefits generated by the project.

In this part of the evaluation, we propose to list all the revenues and expenses to be borne by the State. The expenses are taken from the socio-economic evaluation (preparation, construction, opex and control & monitoring). Revenues are mainly additional tax revenues and avoided costs for the State, generated by the surplus of economic activity induced by the project.

The estimate of these additional revenues necessarily depends on each country's fiscal framework and is based on a number of assumptions that must be as realistic as possible.

[9]Directives 2011/92/EU and 2014/52/EU establish the EU regulatory framework for environmental impact assessments.

3.4 Sensitivity analysis

In order to take into account the uncertainties related to the evaluation of projects, we propose to carry out an evaluation using GLOPRAM on all the contingencies considered by associating a probability to them. A statistical analysis can then be performed for each of the key results produced by the model in order to provide decision-makers with the most accurate information possible.

These may be exogenous risks caused, for example, by extreme weather events whose frequency and intensity are expected to increase with climate change. This analysis is of particular importance in the current context of high uncertainty associated with the effects of climate change. In its final report, the TCFD (2017) indeed states that *"while it is widely recognized that continued emission of greenhouse gases will cause further warming of the planet and this warming could lead to damaging economic and social consequences, the exact timing and severity of physical effects are difficult to estimate"*.

This analysis may also apply to the input assumptions of the model, such as traffic forecasts in the case of transport infrastructure. It may also concern the discount rate to be used or the price per ton of CO_2, which are the subject of much debate. Finally, this model may be useful to simulate the impact of policy decisions such as the implementation of a carbon tax.

Thus, the GLOPRAM would make it possible to anticipate the effects of a project on the economic activity, the welfare and the national budget while taking into account the impact of exogenous factors.

4 Empirical Analysis : evaluation of a project in the transportation sector

4.1 The project

In order to carry out an empirical application of this method, we developed the GLOPRAM-2020 model which allows to evaluate a given project by applying the GLOPRAM. We then applied this model to a project for the construction of a 5.5 km highway infrastructure largely inspired by the A89-A6 link in France. The construction cost is estimated to be EUR 146 million, excluding VAT. The observation period of the project is 23 years, broken down as follows: i) 3 years of work; and ii) 20 years of operation.

As noted above, the costs/benefits to users and the population are specific to each type of infrastructure. In the case of a highway project, the identified costs/benefits are presented in Table 1. Other costs/benefits are common to all types of infrastructure.

Table 1: Transportation infrastructure costs/benefits to users and the population
This table presents the costs and benefits to users and the population in the context of a GLOPRAM evaluation of transportation infrastructure.

	Market	Non-market
For users	Change in vehicle operating costs Toll, if applicable Taxes, if applicable	Time saving Comfort improvement Reliability Improvement
For the population		Decongestion of alternative roads Improved security Change in noise pollution Vibration variation Job creation

4.2 Data and hypothesis

In this analysis we use input data inferred from the public inquiry file and a set of hypotheses. Traffic forecasts, costs/benefits to users, safety benefits, construction and operating costs as well as volumes of GHG and pollutant emissions were deduced from the public inquiry file.

In addition, some costs/benefits were added to the socio-economic assessment. Regarding benefits for the population, a project induces job creation and thus the return to employment of a certain number of unemployed or inactive people, which directly impacts their welfare. This change in welfare can be measured by the worker's surplus, which is the difference between the reservation wage and the wage received. The reservation wage was estimated as a proportion of the median wage based on the individual's initial status (without earnings, receiving minimum income, or receiving unemployment benefits). The wage received is set at the level of the median salary, provided by the French Institute of Statistics (INSEE).

We also assumed that the project would generate wider economic benefits (WEBs). To estimate these WEBs, we assumed that they imply an increase in conventional benefits (i.e. benefits for users and the population) of 7 percent. This hypothesis was deduced from Douglas & O'Keeffe (2016) which indicates that the WEBs of the WestConnex in Sidney represent 9% of conventional benefits. As a conservative measure we applied a discount of 2 percentage points.[10]

[10] A sensitivity analysis of this rate has been carried out but is beyond the scope of this paper. The results are available on request.

Regarding the environmental evaluation, we valued the volumes of GHG and pollutant emissions deduced from the public inquiry file in accordance with the recommendations of the European Commission (2019). The variation in ecosystem services was inferred from Tardieu (2016)' results who estimates the monetary value of the loss of ecosystem services caused by the construction of a highway in France.

For the budgetary evaluation, expenses and revenues were derived from the socio-economic and environmental assessments by applying the French tax system.

Regarding the calibration of one key parameters of the model, the economic discount rate, we set its value at 5%. As underlined by Gollier & Hammit (2014), recommendations on the discount rate differ widely depending on the sources (academics, governments, international institutions). Discount rates recommended by governments or governmental organizations range from 1 to 15 percent, with the highest rates used in developing countries (Harrison (2010)). In the United States, the Office of Management and Budget recommends using a rate ranging between 3 percent and 7 percent depending on the project, which can be reduced when the project has an impact on future generations. In the United Kingdom, the recommended discount rate ranges from 1% to 3.5% depending on the time horizon. In France, Quinet *et al.* (2013) recommends a rate ranging between 1.5% and 2.5% depending on the time horizon used. A risk premium specific to each project is added to this discount rate. There is therefore a lack of consensus both on the methodology for estimating the discount rate and on its calibration.[11]

Regarding the calibration of another key parameters of the model, the budgetary discount rate, the issue is tricky. Indeed, budgetary analysis usually do not discount, as Kohyama (1991a) points out. However, in the case of an evaluation using the GLOPRAM, it would not be appropriate not to discount the budgetary component since we adopt an intertemporal approach. Since this issue is the subject of as yet unresolved academic debate, we arbitrarily set its value at 2%.[12]

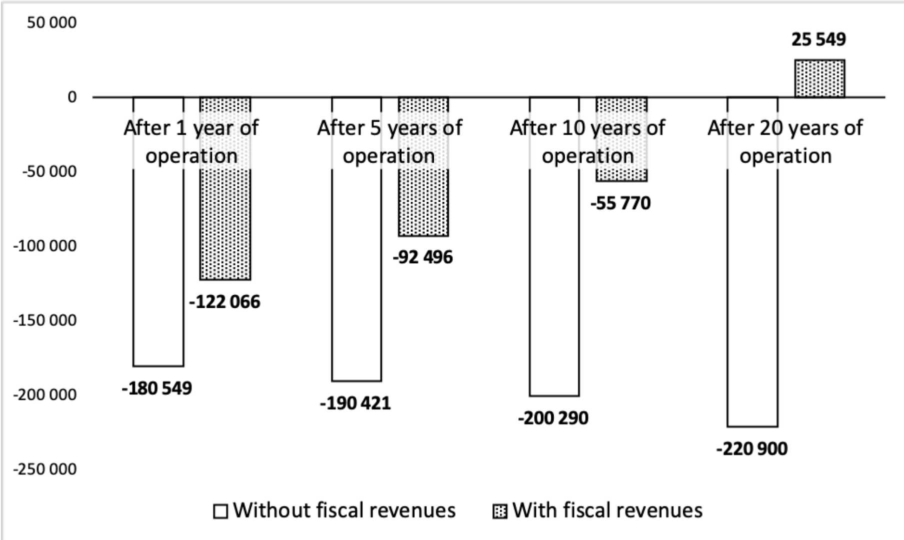
4.3 Results

We present here the results of the GLOPRAM-2020 in the case of a free highway financed by the public (hereafter referred to as traditional financing). Figure 2 shows the project's NPV for the State budget over different horizons with and without fiscal revenues.

[11] A sensitivity analysis of this rate has been carried out but is is beyond the scope of this paper. Results are available upon request.

[12] A sensitivity analysis of this rate has been carried out but is is beyond the scope of this paper. Results are available upon request.

Figure 2: Comparison of NPV for the State budget with and without considering fiscal revenues - traditional financing, free highway
This figure presents the Net Present Value (NPV) for the State budget for a 5.5km free highway project, financed by the State. The project is largely inspired by the A89-A6 link in France. These estimates were obtained using the GLOPRAM-2020 model. The NPV is calculated with and without considering fiscal revenues, and is expressed in thousands of euros.



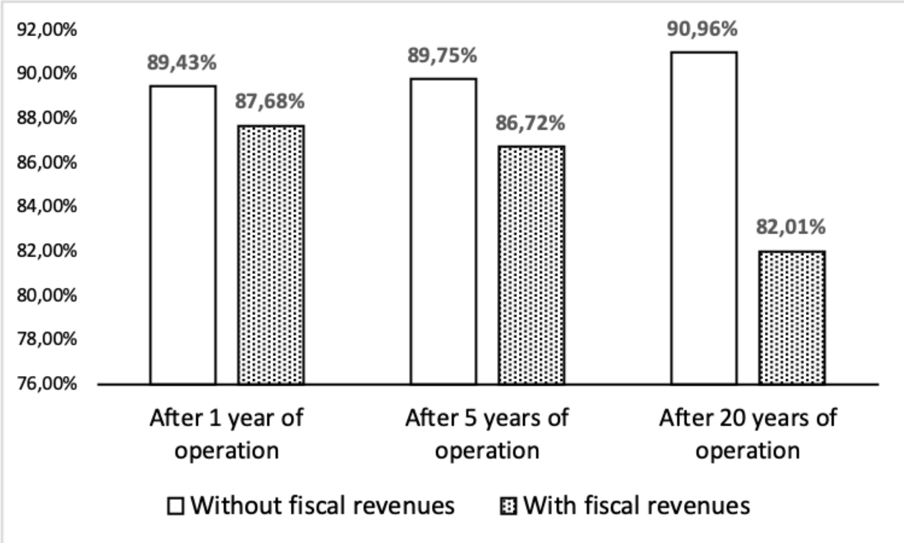
Several insights arise from these results. We find that taking into account fiscal revenues in the budgetary evaluation is crucial. Whatever the time horizon, the NPV with fiscal revenues is significantly higher than the NPV without fiscal revenues. More importantly, we find that the NPV without fiscal revenue declines over time while the NPV with fiscal revenue increases and becomes positive after 20 years of operation. This also reveals that the time horizon of project evaluation strongly influence results. In this example of a “good” GDP-generating project, the costs are fully offset by tax revenues. For a set of projects, this fact has already been recognized by the IMF in its macro-economic studies (see for example IMF (2014))

Figure 3 shows the forecasts of the debt-to-GDP ratio after 1 year, 5 years and 20 years of operation, assuming an initial ratio equal to 100% and an investment representing 5% of the GDP.

Here again, the inclusion of fiscal revenues in the budgetary evaluation is decisive since the debt-to-GDP ratio is much lower when fiscal revenues are taken into account. In addition, these results confirm the importance of the time horizon considered. In the short term, there is an improvement in the debt-to-GDP ratio, attributable to a Keynesian stimulus effect. In the long term (20 years), the new infrastructure, because of its dynamic effects, stimulates economic activity and considerably reduces the government’s level of debt in comparison with its GDP.

Overall, these results show, first, that carrying out a budgetary evaluation that takes into

Figure 3: Forecasted debt-to-GDP ratio - traditional financing, free highway
This figure presents the forecasted debt-to-GDP ratio after 1 year, 5 years and 20 years of operation of a 5.5km free highway project, financed by the State. The project is largely inspired by the A89-A6 link in France. These estimates were obtained using the GLOPRAM-2020 model. For these forecasts we assume an initial ratio equal to 100% and an investment representing 5% of the GDP.



account the fiscal revenues generated by a project constitutes an important incentive for the funding of infrastructure projects by the State. Second, the myopia of investors is a hindrance to the funding of this type of project, whereas a long-term analysis shows that a "good" project generates higher discounted revenue flows than the initial investment.

4.4 Robustness analysis

4.4.1 The case of a toll highway

We perform here a robustness analysis by considering the same project but by setting up for the 5.5 km a weighted average toll which amounts to 0.66 euros, incl. VAT. This level corresponds to the present tariff grid and a percentage of Heavy Goods Vehicles equal to 6.3%, according to the motorway ACB. This new hypothesis has a direct impact on the results produced by the GLOPRAM-2020 model, since socio-economic and environmental assessments depend largely on traffic. We assumed here a price elasticity of demand of -0.3, taking into account the free alternative routes available to users.

Figure 4 shows the project's NPV for the State budget over different horizons with and without fiscal revenues. These results confirm the previous findings. First, the NPV with fiscal revenues is much higher than the NPV without fiscal revenues, regardless the time horizon. And second, the NPV without fiscal revenues increases but remains negative over time whereas the NPV with fiscal revenues becomes potitive after 10 years of operation.[13] These results confirms that short-term perspectives as well as incomplete evaluation of projects are obstacles to the financing of this type of project.

Figure 4: Comparison of NPV for the State budget with and without considering fiscal revenues - traditional financing, toll highway
This figure presents the Net Present Value (NPV) for the State budget for a 5.5km toll highway project, financed by the State. The project is largely inspired by the A89-A6 link in France. The toll is set at 0.66 euros, incl. VAT. We assume a price elasticity of demand of -0.3. These estimates were obtained using the GLOPRAM-2020 model. The NPV is calculated with and without considering fiscal revenues, and is expressed in thousands of euros.

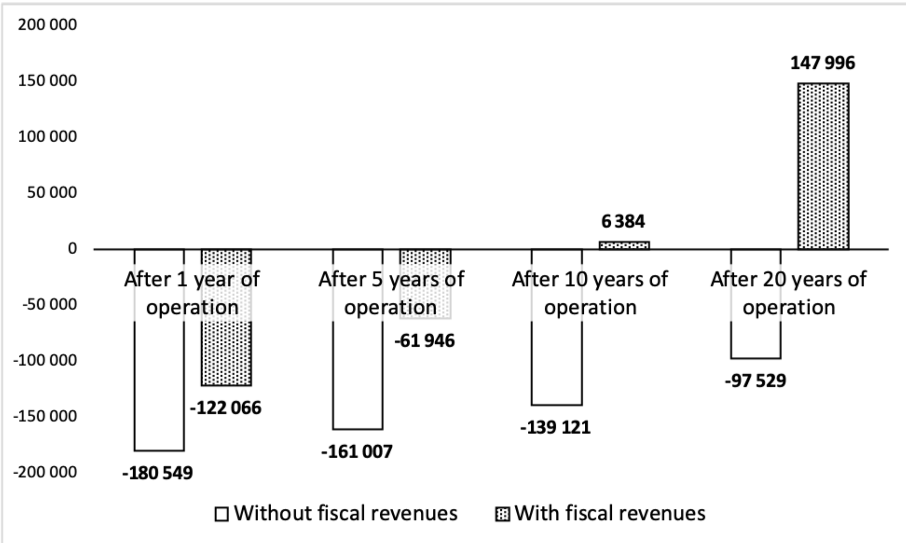
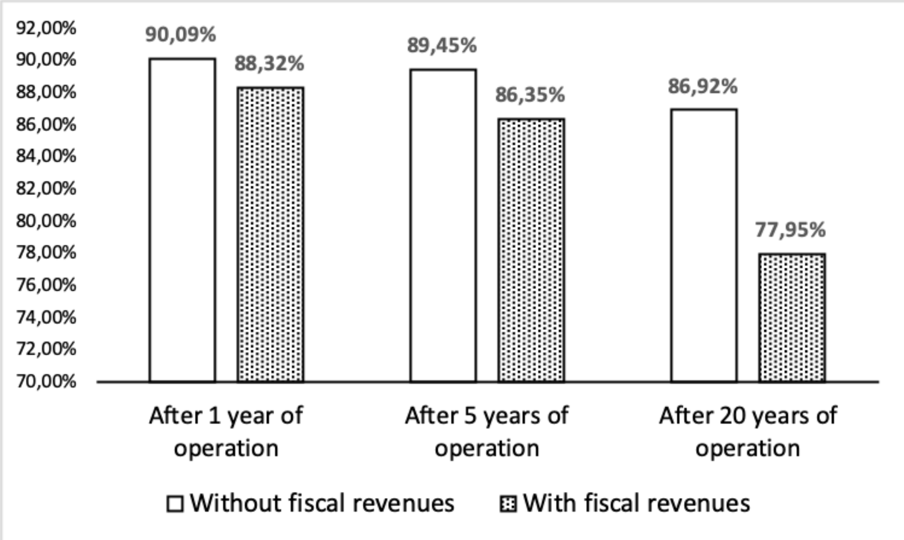


Figure 5 shows the forecasted debt-to-GDP ratio after 1 year, 5 years and 20 years of operations. These results confirms that including tax revenues in the budgetary evaluation as well as performing long term-analysis are crucial to perform analysis that allow to properly anticipate the outcomes of projects.

[13]Without questioning our previous conclusions, the results differ from the previous case on NPV after 20 years of operation, which is negative. This is explained by the decrease in traffic induced by the implementation of a toll.

Figure 5: Forecasted debt-to-GDP ratio - traditional financing, toll highway
This figure presents the forecasted debt-to-GDP ratio after 1 year, 5 years and 20 years of operation of a 5.5km toll highway project, financed by the State. The project is largely inspired by the A89-A6 link in France. The toll is set at 0.66 euros, incl. VAT. We assume a price elasticity of demand of -0.3. These estimates were obtained using the GLOPRAM-2020 model. For these forecasts we assume an initial ratio equal to 100% and an investment representing 5% of the GDP.



4.5 Implications of the financing structure

While many infrastructure projects are publicly funded, other contractual arrangements are available to ensure their financing. We have therefore replicated our analysis taking into account the specificities of the main existing contractual arrangements. More specifically, we consider the following contracts: i) Design, Build, Operate and Maintain (DBOM)[14]; DBOM & Finance[15] ; iii) Concession SOE[16]; and iv) Private concession[17]. We consider here a toll highway.

The NPV for the the State budget for each contract is presented in Figure 6. While the results confirm that it is essential to take fiscal revenues into account in project evaluation and to have a long-term perspective, what emerges from these estimates are the differences in the NPVs for each type of contract. In order to have comparable results, we have assumed that all projects are tolled. For concessions it is obvious, but for traditional financing, DBOM and DBOM finance it is

[14]Defined by the U.S Department of Transportation as follows : *"with DBOM contracts, a private entity is responsible for design and construction as well as long-term operation and/or maintenance services. The public sector secures the project's financing independently and retains the operating revenue risk."*

[15]In this case, the responsibilities for designing, building, financing and operating are bundled together and transferred to private sector partners.

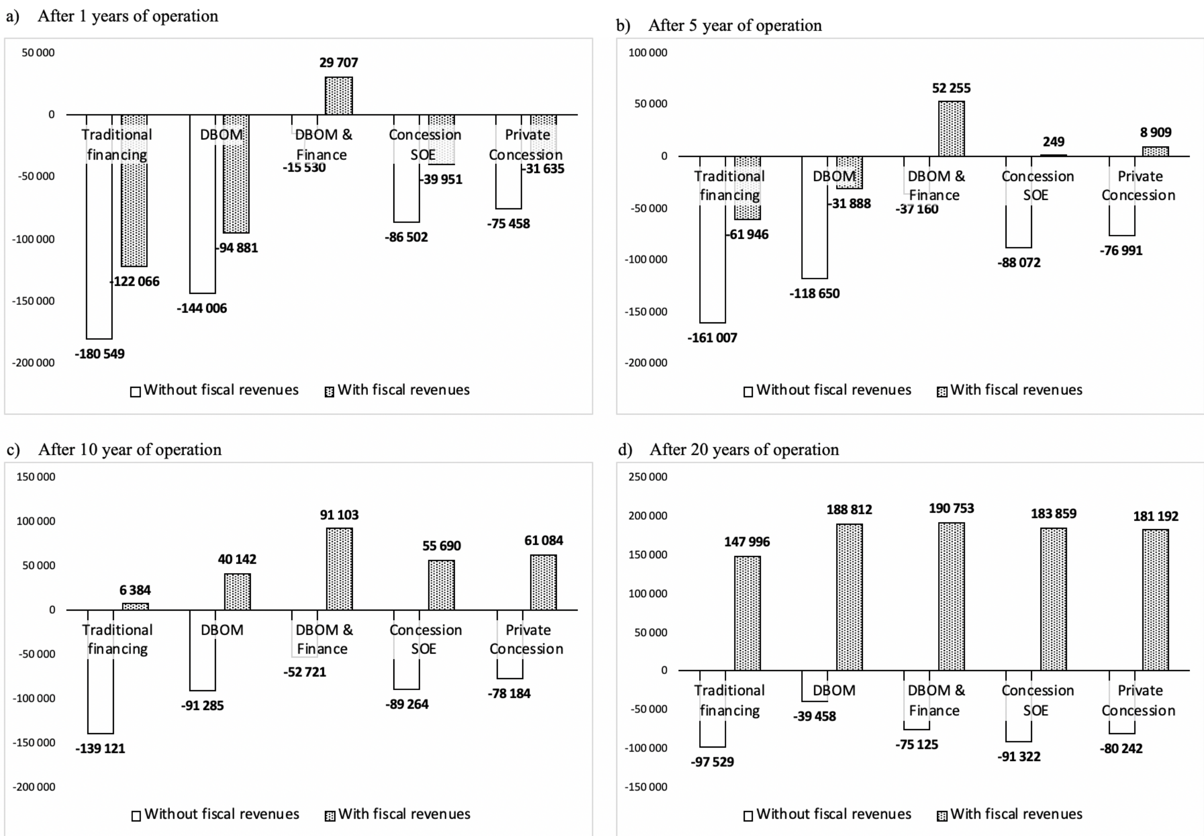
[16]According to the European Commission, Internal Market, Public procurement, Concession contracts, Concessions involve a contractual arrangement between a public authority and a public economic operator (the concession holder is a State Owned Entreprise). The latter provides services or carries out works and is remunerated by being permitted to exploit the work or service.

[17]Concessions involve a contractual arrangement between a public authority and a private economic operator (the concession holder). The latter provides services or carries out works and is remunerated by being permitted to exploit the work or service.

not automatic. We can even say that there are very few (if any) DBOM financed contract subject to tolling. And this is a pity because it is a very efficient solution for the State budget. DBOM finance contrats are often selected to postpone short term payments by the State, and the long term is not even considered. Under these hypotheses, in the short term (after 1 year and 5 years of operation), we observe that most of financing methods produce a negative NPV for the State. In medium term (10 years), DBOM & Finance, Concession SOE and Private Concession produce higher NPVs. In the long run, the gap becomes negligible with the exception of the traditional one which generates a much lower NPV.

Figure 6: NPV for the state with and without considering fiscal revenues - comparison of contractual arrangements - toll highway

This figure presents the Net Present Value (NPV) for the State budget for a 5.5km toll highway project, after 1, 5, 10 and 20 years of operation, and considering the following contractual arrangements : i) traditional financing; ii) Design, Build, Operate Maintain (DBOM); iii) DBOM Finance; iv) Concession SOE; and v) Private Concession. The project is largely inspired by the A89-A6 link in France. The toll is set at 0.66 euros, incl. VAT. We assume a price elasticity of demand of -0.3. These estimates were obtained using the GLOPRAM-2020 model. The NPV is calculated with and without considering fiscal revenues, and is expressed in thousands of euros.



Figures 7 and 8 show respectively the forecasted debt-to-GDP ratio after 5 years and 20 years of operations. In the short term and on condition that the motorway is tolled, the DBOM & Finance contract improves the State's indebtedness significantly more than other methods of financing. In the long run, the forecasted debt-to-GDP ratio become similar, no matter the contractual arrangement. If there is no toll, the worst budgetary result is given by the DBOM finance contract. So the truly important issue is the tolling or not of a scheme, and not the contract type.

Figure 7: Forecasted debt-to-GDP ratio after 5 years of operation- comparison of contractual arrangements - toll highway
This figure presents the forecasted debt-to-GDP ratio after 5 years of operation of a 5.5km toll highway project, considering the following contractual arrangements : i) traditional financing; ii) Design, Build, Operate Maintain (DBOM); iii) DBOM Finance; iv) Concession SOE; and v) Private Concession. The project is largely inspired by the A89-A6 link in France. The toll is set at 0.66 euros, incl. VAT. We assume a price elasticity of demand of -0.3. These estimates were obtained using the GLOPRAM-2020 model. For these forecasts we assume an initial ratio equal to 100% and an investment representing 5% of the GDP.

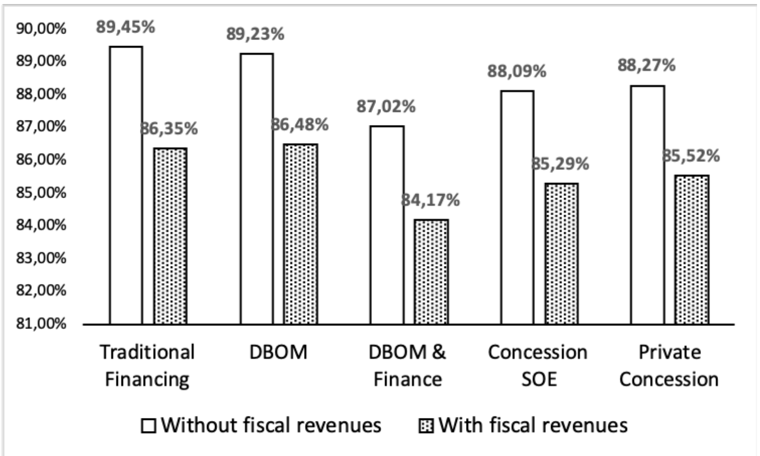
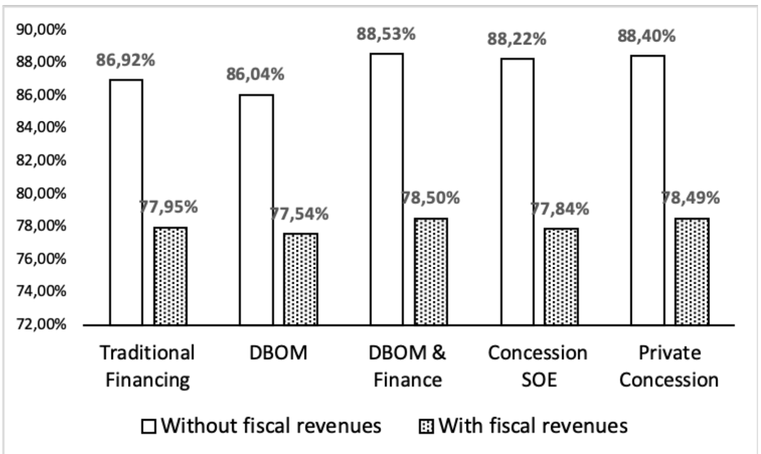


Figure 8: Forecasted debt-to-GDP ratio after 20 years of operation- comparison of contractual arrangements - toll highway
This figure presents the forecasted debt-to-GDP ratio after 20 years of operation of a 5.5km toll highway project, considering the following contractual arrangements : i) traditional financing; ii) Design, Build, Operate Maintain (DBOM); iii) DBOM Finance; iv) Concession SOE; and v) Private Concession. The project is largely inspired by the A89-A6 link in France. The toll is set at 0.66 euros, incl. VAT. We assume a price elasticity of demand of -0.3. These estimates were obtained using the GLOPRAM-2020 model. For these forecasts we assume an initial ratio equal to 100% and an investment representing 5% of the GDP.



Overall, this complementary analysis confirms the robustness of our initial results. On the operational side, it shows that it is essential to consider different forms of contractual arrangements when conducting a project evaluation.

5 Conclusion

In this paper, we propose a new project assessment method, the Global Project Assessment Method (GLOPRAM), which allows to bridge the gap between microeconomic analysis and macroeconomic aggregates. More specifically, the GLOPRAM consists of a comprehensive socio-economic evaluation, an environmental evaluation and a budgetary evaluation. These three evaluations taken as a whole enable to apprehend the full impact of a project on users and population, on the environment but also on the State budget and in particular the debt-to-GDP ratio.

In order to illustrate this global project appraisal method, we have developed the GLOPRAM-2020 model which we applied to a highway project, largely inspired by the A89-A6 link in France. Several insights emerge from this analysis. First, our results show that a ”good” project will pay for itself in the long term, even if non tolled. This is mainly due to the dynamic effects of the project also called Wider Economic Benefits. Taking these impacts into account radically changes the results of the evaluations. Second, our results show that taking into account direct and indirect fiscal revenues induced by the project significantly alters the results of the budget assessment. When fiscal revenues are not taken into account, the project appears to degrade public finances over time, whereas when fiscal revenues are taken into account, in the long run the project is refinanced. Third, the temporal aspect is of crucial importance. In the very short term, the NPV for the State is largely negative, whereas the opposite is true in the longer term. Finally, the choice of financing method (contract type) is decisive for the budget evaluation. Overall, these results reveal the need for a project evaluation tool that can produce comprehensive appraisals.

Given, on the one hand, the current economic context of slower growth and high state indebtness, and on the other hand, the challenges to be met (ecological transition, rebound after the COVID 19 health crisis), a project evaluation method such as the GLOPRAM could be of interest for decision-makers trying to allocate funds efficiently. It is indeed necessary to provide decision-makers a project selection tool that allows them to identify projects that reconcile ecological sustainability, productivity and fiscal sustainability.

This paper also opens up the way to further research: how to properly take into account the dynamic effects of projects without falling into excessive complexity? Which discount rate should be used for the budget evaluation? How to correctly value the environmental costs/benefits? How to evaluate the fiscal impact of a project generating additional GDP? Under which conditions the salary as indicator of marginal productivity increase is relevant?

What is certain, is that a furter step is to be taken in evaluating the full impact of project implementation, mainly on the State budget.

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Appendix 1: calculation of the environemental costs and benefits

5.1 Climate change costs and benefits

One of the most obvious consequences of the construction and use of infrastructure is the impact on climate change, induced by greenhouse gas (GHG) emissions: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). Climate change costs are defined as the costs associated with all the effects of global warming, such as sea level rise, loss of biodiversity, water management issues, increasing frequency of extreme weather events and crop failure (European Commission (2019)). One of the essential characteristics of GHG emissions is their global nature: the impact is the same regardless of the geographical area in which the GHGs are emitted.

The European Commission (2014) proposes a methodology for estimating the costs of climate change derived from GHG emissions, a methodology that we adopt in the GLOPRAM approach:

1. Quantification of the additional volume of emissions (or emissions savings) into the atmosphere
2. Calculation of total emissions in CO_2 equivalent (CO_2e) using the *Global Warming Potentials (GWP)*: GHG emissions other than CO_2 are converted to CO_2e using standardized conversion factors, the GWP .
3. Monetary valuation using a unit cost of CO_2e: CO_2e emissions are multiplied by a unit cost expressed in EUR/tonne.

The two first steps can be carried out following the methodology proposed by the EIB (2018). For the third step the following formula is then applied:

$$Cost\ of\ GHG\ emissions = V_{GHG} \times C_{GHG} \tag{1}$$

with V_{GHG} the additional volume of GHG emissions produced by the project, expressed as CO_2 equivalent and C_{GHG} the unit price of CO_2, discounted and expressed at the prices of the year in which the analysis is performed. Note that there is no consensus on the unit price of CO_2 to date.

5.2 Local air pollution costs and benefits

To assess the impact of a project on local air pollution, it is necessary to have data on the variation in the concentration of each type of pollutant in the air induced by the project and the monetary value applicable to each type of pollutant. In its *Environmental Prices Handbook*, CE Delft (2018) proposes a monetary valuation of each type of pollutant applicable in the European Union[18]. This calculation method has been used by the European Commission (2019) to estimate the costs associated with air pollution for transport infrastructure.

5.3 Ecosystem services costs and benefits

As highlighted in the academic literature (Wale & Yalew (2010); Mueller *et al.* (2016)), the impact of projects on biodiversity and ecosystems is not always taken into account in EIAs. This can be explained by the difficulties in defining and measuring biodiversity. Yet, as Farley (2012) points out, the economic impact of ecosystem degradation can be major. Marine resources contribute, for example, to global GDP through fishing or tourism. In order to understand the economic impact of projects on biodiversity and ecosystems, it has been common practice to use the concept of ecosystem services (see in particular Mueller *et al.* (2016)) which can be defined as the benefits provided by the functioning of ecosystems that contribute to the well-being of society and all economic activities. One method to assess the costs and benefits associated with biodiversity and ecosystems is to list and quantify ecosystem services (e.g. the amount of food consumed, days fished by anglers or days used for recreation) and then convert them into monetary values. Millenium Ecosystem Assessment (2005) suggests grouping these services into four categories:

- Provisioning services are the material goods obtained by ecosystems, such as food or fuel ;
- Regulating services such as climate regulation, pest control, maintenance of air and water quality;
- Cultural services that are non-material benefits such as aesthetic benefits or the opportunity to enjoy nature for recreational purposes;
- Basic services are the ecological processes on which all other services depend, such as the water cycle or photosynthesis.

[18] This handbook gives an estimate of the cost of damage for more than 2,500 pollutants. It is based on a combination of two models: (i) economic damage cost estimation; and (ii) life cycle assessment.