PROJECT APPRAISAL AND LONG TERM

STRATEGIC VISION

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INTRODUCTION

France is among the countries with a long tradition of infrastructure project appraisal. Under the aegis of the Prime Minister's offices in charge of mid- and long-term strategies, commissions have been successively set up for the definition and improvement of appraisal procedures; their conclusions have been transformed into official guidelines by the administrations directly concerned.

If we focus only on the last twenty years, the 1994 commission presided by M. Boiteux defined the fundamental principles anchoring project appraisal in the more general frame of economic calculus. These principles have been successively applied to the appraisal of environmental effects [1], to the determination of the discount rate [3], to the collective value of carbon [3], to biodiversity [4] and to taking account of the risks in project appraisal [5].

Thus, the report [6] on which the present paper is built pertains to a long series of reflections which, grounded on the practice of economic calculus, have progressively adapted and enriched this practice. It stems from the thematic analyses developed by the national commission which was set up for making this new report, and from numerous feedbacks and recent studies from France as from other countries. Its conclusions cover updating of unit values such as the value(s) of time or the value of statistical life, together with the integration of recent research developments into appraisal analyses, for instance developments on spatial analysis. They also deal with measures needed for adapting socio-economic analysis to the present and future conditions of our societies, which are indeed subject to numerous transitions, such as ecological and energy transitions, together with increased uncertainty.

The first section gives an overview of the report, the second develops the elements regarding necessary adaptations to a changing world, then simulations of the effects of long term issues on project appraisal's results are given, and the last section concludes.

GENERAL VIEW OF THE NEW NATIONAL REPORT'S RECOMMENDATIONS

A first set of recommendations aims at improving integration of appraisal with decision making on infrastructure projects. The feedback on this topic is harsh: “Investment choices are presently insufficiently grounded. Procedures for appraisal and for decision making do not always allow a correct ranking of projects nor highlighting those most useful from a collective point of view”.

The report proposes a series of measures intended to reduce these defaults. Since they are tightly liked to specific decision processes and judicial rules valid in France, we will not go through them. We will only indicate that they focus on improved readability and increased transparency of the informations delivered to the decision makers, and that they insist on organisation of independent expertise. Independent expertise should deliver advices on the traffic models used (in France we do not have a single reference model used for all studies, but as many models as operators of infrastructure managers) and on the quality of appraisal studies of each infrastructure project, at least for the most important projects. The latest item has been officially implemented by a recent French law.

A second set of recommendations is related to unit values. We will not dwell on this subject, but just underline the key points: first, the values of time have been fixed in consideration of a survey of traffic models and stated preference studies, mainly from France; they are on the whole a bit lower than the “Boiteux II” -updated 2010- values, about10% lower. What is the reason for this change? Probably a mix of a better knowledge of the value of time, and a result of the fact that travellers are now able to better manage their travel time, especially using modern telecommunications. Second, the value of statistical life and value of life year have been sharply increased, from around 1,9 to 3,0 Million Euro (2010 values); this increase is due to the results of new surveys (especially the OECD 2012 survey). Consequently, the values of environmental effects such as local air pollution and noise have increased by about 30%, this percentage being the combined result of increasing the value of life and decreasing emissions per vehicle. In accordance with these unit values are presented advices on how to reckon the user’s surplus, which raises difficult theoretical questions in case of induced traffic or traffic transferred from another mode, especially when the traffic model is not drawn from canonical utility functions.

A third set of recommendations is related to extending the scope of appraisal. There are several effects which are of great concern to decision-makers, and which the classical CBA does not address. Many attempts are made in various countries to take them into account, see for instance the wider economic effects in the UK. The commission selected four topics: effects on macroeconomics (growth, employment), effects on market power and competition, spatial consequences, and redistribution and equity consequences. For each of them, the report gives indications on how to take them into account; for some of them, such as employment, it is mainly caveats on the magnitude of the effects, plus some recommendation on how to use macroeconomic models and to take into account their limits.

For market power, the recommendations are that it is necessary to take them into account and to assess the changes that the project may induce in this field; for redistribution, an indicative index is proposed in order to take into account distributive effects on user's surplus. The most elaborated recommendations are those which deal with spatial effects; they first suggest, for the major projects, to use land-use and transport interaction (LUTI) models in order to at least visualize the spatial consequences of the projects. They also give qualitative indications on the effects of both urban and interurban investments on the spatial repartition of populations and employment. They recommend to estimate the agglomeration externalities and to add them to the welfare calculation; for this purpose they give precise rules (the elasticity of productivity vis-à-vis the density of employment is 2,4%, as estimated from thorough econometric studies).

A fourth set of recommendations aims at adapting the appraisal to the situation of modern economies and societies. It deals mainly with risks analysis and long-term considerations.

Risk is an increasingly important issue for our societies, and the recognition of this importance has been accelerated by the succession of systemic crises we have seen in the last decades. The report insists on this point; it reminds of the importance of biases (usually: under-estimation of costs and over-estimation of traffics) and recommends several counter-measures, which rely on expertise and organised feedbacks. We must also reach a better understanding of current risks, those resulting from the imperfection of forecasting methods or from not taking into account evolution trends or uncertainties affecting exogenous variables (such as economic growth forecasts or evolution of key prices such as petrol price); scenario methods, widely used by private operators for their financial studies, should be transposed to socio-economic appraisal. Finally: we have to take into account carefully the systemic risk, the risk resulting from the more or less strong links between the benefits of an investment and the economic growth. This systemic risk may be estimated using two kinds of methods. One consists in valuing this risk by correcting the value of each monetised component (e.g. time gains, safety, pollution, etc) and having their net present value (NPV) discounted with a single "no risk" discount rate. The other method consists in keeping the mean value of each of the components as in usual CBA, but having it discounted with a rate adjusted accordingly to the risk characteristics. Each method has its advantages and drawbacks, we will detail a little the second one.

To put it simply, using an approach which presents formal analogies with financial asset valuation, the discount rate that gives the present value of a future item exposed to risk (this risk corresponding for instance to the effect of an investment), is the sum of the risk-free rate (set at 2,5% in the report) and a risk premium. This risk premium is the product of a specific coefficient (the "beta" value chosen consistently with the correlation between the investment's effect and the economic growth) and the general risk premium of the economy, set at 2% in the report: $r = \rho + \beta\,\phi$.

For investment programming, the rule of decision is now similar to deciding when to exercise an option, corresponding in financial technique to calculating a stopping time. Such a calculus has complex formulations and very often has to go through mathematical simulations [7] . Besides risk, another important issue of the present situation is how to deal with long term.

LONG TERM ISSUES

Infrastructure projects are long term investments; they are quite costly and their effects largely irreversible. They modify existing infrastructure networks and contribute to structuring during several decades, possibly several centuries, the territories, the economic competitiveness and the quality of environment. Therefore it is not possible to let aside their incidences on a far horizon, that should be at least 50 years and, rather, in the order of one century, possibly more.

This necessity was perhaps not obvious during the last decades, where extrapolation of past trends could be taken as long term strategy. After the “glorious thirty” (the 30 years post-war boom), the growth path became more irregular and less steep than before. This observation led simply to diminish the expected rate of economic growth, and to correct accordingly the growth trend of traffic, and possibly to introduce in project appraisal an additional term in the discount rate, common to all projects.

These adjustments now appear quite insufficient. First, it is not possible any more to consider that long term effects are “crushed” by the mechanism of discounting. Discount rates are now much lower than in the past, which is justified if we want present decisions to consider inter-generational equity. In France for instance, the official rate set by the Lebegue report in 2005 is 4% , compared to 8% before, and it regularly decreases after 30 years, to reach 3% after 2040; this risk-free rate will probably be revised downwards with a risk-free rate of 2,5% progressively getting down to 1,5%. The result is that the future has a much higher weight than before: simple calculus show that for a typical investment made in 2010, the discounted advantages cumulated after the first 50 years of operation represent more than half the advantages over the first 50 years. Thus, it is not possible to disregard, in project appraisal, what happens between, say, 50 to 100 years of infrastructure operation, which, considering the long lives of infrastructures, corresponds to a mid-term of their operation period.

Now all studies indicate that, in order to meet both natural resources limits, especially energy resources, and environmental requirements such as factor 4 objective (consisting in dividing by 4 GHG emissions by 2050) or the stopping of land artificialisation, major strategic changes will be required in a closer future, about 2 or 3 decades from now. These new strategies imply changes in modal split, more or less rapid development of new services (car sharing, car pooling,...), technological mutations (electrical vehicle for instance, changes in urban development logics. We must therefore place project appraisal within a frame of scenarios which need prospective analysis and political choices.

We had done without during the “glorious thirty” and even at the end of the 20th century despite the slowing of economic growth and successive crises, considering growth was merely less strong and more uncertain. But now major uncertainties are so visible that we cannot ignore the question. The actions that will be required for implementing these strategic changes are largely in the hands of public authorities: regulation of vehicle emissions, control of urban patterns, pricing and taxing of transport, technical progress also, since the State may generate and favour it although it largely depends also on private initiative, and infrastructure planning. They result in increasing or decreasing evolutions of travel needs and traffic, depending on geographical zones and modes, or differing sensitivities of these demands to travel time or to prices, all of them factors which have major consequences on infrastructure needs and depend of course on the choice of the strategy to be implemented.

Research on mobility generally observes that infrastructures are only one of the vectors of a more general strategy. Thus, it is not through a policy purely focussed on rail infrastructure development that modal split will be strongly modified; it is not simply by building new metro lines that car use in urban areas will be deterred (Didier and Prud’homme, 2007) or by multiplying high speed rail lines that the emissions of green house gases by the transport sector will be deeply cut down (CGDD 2011). It is mainly through other types of actions – regulation, pricing, incentives – that technical progress will be able to spread largely and rapidly, that behaviours will change and that new mobility patterns will get structured; and it is mainly by these new structures that traffic evolutions and infrastructure needs will be driven.

To give an example, France, as all Member States of the European Union, has engaged into a proactive policy of green house gas (GHG) reduction, with the “factor 4” objective. Such an objective may be reached by diverse combinations of measures and actions. But the nature of these combinations may have a strong influence on the results of project appraisals. Indeed, if this objective is met essentially by reducing the unit emissions of vehicles, it is the value of the “CO2 externality” of the projects that will get reduced, which for a good part of the projects will not fundamentally modify the socio-economic interest of the projects, other things being equal. But if, on the opposite, reaching factor 4 goes through a strong reduction of car travel, it is clear that the core of the advantages of road projects will be impacted through the main components of their net present value (NPV). Similarly, the vectors of public intervention may have a direct effect on the relative competitiveness of transport solutions, particularly through their effects on relative prices.

Finally, in the context of deep transition our societies are encountering, strategic analysis is vital. Without it, correct CBA simply cannot be implemented; this does not mean, however, that CBA cannot give useful indications for strategic exercises.

Coming now more precisely to the recommendations given in the commission's report, three issues are taking an increasing importance in the definition of a strategy for transport infrastructures.

The first one deals with pricing the use of existing infrastructures. Congestion pricing and pollution pricing are still imperfectly implemented, which means that all kinds of mobility tend to get public subsidies. Transport under-pricing, below marginal social cost, leads to an excessive use of transport. Similarly, struggling against global warming implies valuing carbon emissions at a level consistent with the targeted emission reductions, and implies also to use this value for pricing and for investment selection.

The second issue, linked to the first one, is the interaction between transport infrastructure, economic growth, and land use. It opens a large field for numerous debates, hopes and also preconceived ideas. Presently, it seems that the main effects of transport infrastructures are to be found at the conurbation level, through their effects on location choice and on polarisation of space. At a more local level, it is also clear that the orientations given to urban policy have major impacts on urban transport. Housing and job densifications tend to favour public transport; conversely, development of electric vehicle allows to reduce the constraints that car traffic levels will be subject to.

The third issue, so much alive in the minds that we do not need to insist on it, is the link between transport strategy and energy strategy. The latest impacts transport through many different channels. On the side of energy supply, petrol prices has obvious consequences on traffics; besides, the shares of nuclear power and of renewable energies in the energy mix determine the development opportunities for electrical vehicles. From the demand side, opportunities for energy savings in other sectors directly influence opportunities for energy consumption in transport.

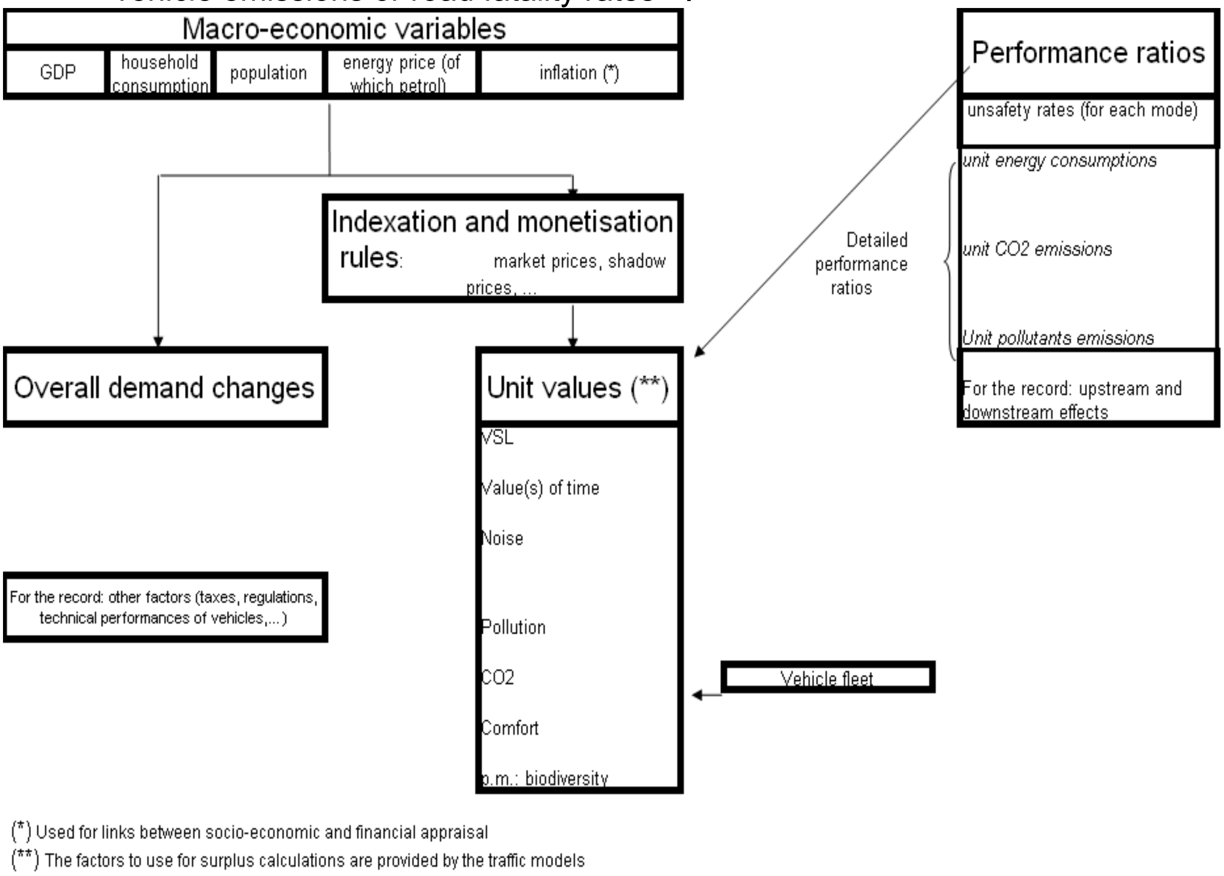
Therefore we really need a complete strategy on the whole three domains: transport, energy and land use policy, in order to improve in the same time efficiency and consistency of public policies, and the relevance of project appraisals' results. This strategy must, first, cover the evolution paths of national parameters common to all sectors, over the project's appraisal period: demographic and macro-economic indicators (GDP, population,..), prices of goods and services that are most directly concerned (price of the diverse sources of energy, wages, possibly interest rates, …). This supposes having taken sides on major political options as regards macro-economy, environment and energy, and to have defined the main data specific to the sector studied. Last, supply evolution has to be considered; when analysing localised investments such as those concerning a conurbation, the reference scenario should cover the conurbation's development policy, for instance on a spatial level, as regards housing and activities.

As we have seen, these diverse trajectories have to be examined in relation to the major mid- and long-term objectives of public policies. Achieving these objectives may be in some cases technically translated by one or two key parameters. For other objectives, it may be more complex, particularly for the “factor 4” objective because reducing CO2 emissions will be translated diversely in parameters and project appraisal's results, depending on the nature of the measures taken and on assumptions taken on trends.

Due to the mid- and long-term uncertainties present in numerous fields, several alternative strategies should be considered. For example, we could imagine two contrasted scenarios presenting reference trajectories consistent with mid- and long-term policy objectives, but diverging on the ways taken to reach these objectives (for factor 4, according to the more or less important development of technical progress and on actions on mobility, for instance) and an “informed trends” scenario extrapolating present trends while taking account of public policy measures that are already decided. These scenarios should also reflect societal perspectives and possible evolutions as regards living environment and demography.

This work should start from a general macro-economic framework covering several key parameters and using when possible the works on mid- and long-term scenarios made by international institutions (IMF, World bank, IEA,...), to be confirmed or changed whenever more precise studies become available. Technically, monetising the effects of a project over its appraisal period supposes to make assumptions on the long-term evolution of diverse kinds of key parameters, which are interdependent (see the figure below), such as:

- general socio-economic indicators (GDP, population, petrol price,...) ;
- average growth of demand ;
- relative prices of unit components of NPV ;
- “performance ratios” that are used for estimating impacts, such as unit vehicle emissions or road fatality rates [8] .



Graph1 Reference trajectories for project appraisal (horizon e.g. 2013/2080)

These scenarios should also give indications on more qualitative and prospective elements concerning lifestyles, technological evolutions and land use organisation, policies regarding regulation and pricing, or demography. Besides, it is necessary to make assumptions on network evolution. This should lead to the definition of an explicit scenario at the national level (e.g. a list of projects and main regulatory measures), common for all projects subject to individual appraisal.

Finally, unit values used in project appraisal should be consistent with shadow prices resulting from reference scenarios. Accordingly, for carbon price, the value used in appraisals should coincide with the shadow price of carbon corresponding to the policy defined in the long term strategy. We should pay attention, though, to the “anti-self-fulfilling” risk, that is: if we suppose that a problem, say global warming for instance, is solved on the mid- and long-term, then short-term actions needed for coping with the problem could well be rejected under individual appraisal, their own effect being negligible if the bunch of all the other actions almost solves the problem [9] . This gives another argument in favour of a complete macro-economic consistency check of the reference scenario, together with using a sound process for splitting or regrouping the measures or projects to be appraised.

EFFECTS OF LONG TERM ISSUES ON PROJECT APPRAISAL RESULTS

We shall begin this section by giving an illustration of the effects of simple scenarios, with limited consistency on a single project, and then present a more complex example comparing the outcomes for two different projects.
First, we will use contrasted “factor 4” scenarios, one in which factor 4 is obtained by a very sharp cut in unit vehicle emissions, and another one where a less sharp reduction in unit emissions is combined with a lower traffic growth.
Unit vehicle emissions are reduced by 75% in the first scenario and only by 50% in the second one. The first scenario considers the following traffic growths: 2% until 2025, then 1,5% until 2050 then stability; the second scenario begins as the first one but growth is then smaller between 2025 and 2030 (1%) and traffic decreases (-2%) until 2050. Even though it may not be obvious at first sight, these different assumptions end up in traffic being for 2050 in scenario 2 about half the traffic in scenario 1, counterbalancing the increased unit emissions.

Please note that, since factor 4 is a global objective, and that in other sectors and in urban traffic, more ambitious progresses are expected in emission reductions, we assumed that interurban traffic emissions need not be strictly reduced by 4. Anyway this assumption does not change the kind of results obtained by the simulation: the fictitious but realistic motorway project considered ends up having its gross present value (that is, without subtracting the project's cost) of 53 for scenario 1 and 35 in scenario 2. This means that considering the 2 scenarios does not change the decision if project's costs are lower than 35 (the project is a good one for both scenarios, even though it performs better in scenario 1) or higher than 53 (the project is a bad one for both scenarios). It is more clearly in the intermediate range of cost that strategic considerations may change the appraisal's outcome.

These figures are shown here just to give an indicative illustration, but they show that, when cost-benefit ratios are low or intermediate, long term issues may change the judgement made on projects: the socio-economic profitability threshold for project cost becomes 50% higher in our example's scenario1.

Still, the rough simulation presented here is not fully consistent, among other things because the carbon price is supposed to be the same in both scenarios, whereas shadow prices are likely to differ if the path to factor 4 bears on technical reduction of unit vehicle emissions, or conurbation densification plus constraints on traffics, or from a scenario where economic growth would be lower. Also, we have not considered the question of optimal building year nor compared two different projects in this first simulation exercise.

Therefore we will now take a view of the effects of long term issues and macro-economic feedbacks through simulations drawn from Quinet (2010), using another modelling framework. Here we deal with a very simple model with one representative agent, whose utility function is nested-CES type [10], and depends on three goods, a common consumption good and two specific substitute goods, which are in the nest, and on which the attention is focussed; one of them is carbon intensive (dirty) and the other one does not use much carbon (clean).

These three final goods are made out of two intermediate goods, through constant returns technologies: a common production good and carbon. The two transport goods differ by the percentage of carbon they use: the “dirty” transport uses a larger percentage than the “clean” one. The production process is a perfectly competitive one. Box 1 shows the parameters and their values.

Box 1 Notations and values of the parameters used in simulations

Let us use the following notations:
t is the year (t=0 in 2010)
X(t) is the quantity of common consumption good at year t, whose price is Px(t)
Td(t) and Tc(t) are the quantity of dirty and clean transport goods at year t, whose prices are Pd(t) and Pc(t)
Y(t) is the quantity of common production good, whose price is 1
C(t) is the quantity of carbon good, whose price is 1 at t=0 and pc(t) at year t
g is the growth rate of the quantity of available common good. This quantity of common good is used for production of transport goods, and for the import of carbon good,
j is the discount rate
sx is the share of common production good in the cost of the common consumption good
sd is the share of common production good in the cost of the dirty transport
sc is the share of common production good in the cost of the clean transport
shx is the share of common consumption good in income of year 0
shd and shc=1-shd are the share of transport d and c in transport expenses
σ is the elasticity of substitution of the upper layer of the utility function
σ' is the elasticity of substitution of the lower layer of the utility function

It is assumed that the production processes of the common consumption good and of the two transport goods are Leontieff and such that:
Px(t)=sx+(1-sx)*pc(t)
Pd(t)=sd+(1-sd)*pc(t)
Pc(t)=sc+(1-sc)*pd(t)

The exogenous variables are listed below:
The shares of consumption goods in household expenses for year 0:
- shx is fixed at 0,85 following the share of non- transport expense in total household expenses;
- shd is fixed at 0,6 and shc at 0,4
The shares of common production good in consumption goods for year 0:
- sx=0,95 following the share of energy in GDP, rounded to 5%;
- sd=0,75 under the consideration that roughly half the car use expenses are made of petrol and that, in Europe, half the price of petrol is made of industrial cost (the remaining being taxes), similarly, this is the share of non-kerosen expenses in air transport
- sc=0,90 according to the share of non energy expenses in environment-friendly transport modes such as rail or inland waterways.
The elasticities of substitution:
- σ , elasticity of substitution between the common consumption good and transport, is fixed at 0,3. This figure has been used in other studies such as : Raux 2007 , Kanemoto 2003[11] .
- σ ' is set at 2,0, implying a high substitutability between modes
The default rates of growth: g is set at 2%; the discount rate j is set at 4%
– π, the growth rate of carbon price, is a key parameter. We assume that the price of carbon is composed of the industrial price plus either the economically optimal tax or the price of a permit resulting from an optimal permit market, both being decided at the global level. Many studies consider that, starting from an appropriate value, a growth equal to the discount rate (Hotelling rule) is convenient (Quinet A 2008). Assuming that the present value is appropriate and allowing for a productivity rate of 1% per year leads to a value of 3% for π.

In this framework, it is possible, for any project which induces a decrease in the cost of transport, to reckon its yearly surplus[12] , and its Net Present Value (NPV) for all possible future years of implementation, and to deduce from these calculations whether the investment is worth being done and when it must be implemented –the year for which its NPV is maximal provided that it is positive-, as well as the traffic evolutions.

Given these bases, we consider two alternative projects, C and D, whose investment costs are the same and which provide the same amount of surplus for the present year. Project C improves the clean mode and D improves the dirty mode. The difference between them comes from the future surpluses which are different if the price of carbon evolution differs from the evolution of the price of the common production good. We assume systemic risk is similar for the 2 projects, and thus use the same discount rates for both. A set of simulation is shown in table 1.

Table 1 Simulation results

Surplus of first year (2015)	a2015 =	1,1			
Investment cost	I =	26,8	28,8	30,8	32,8
Carbon price growing at 3% a year					
Dirty project D	NPV	0,9	-0,5	-0,6	-0,6
	Year of impl	2015	never	never	never
Clean project C	NPV	10,1	8,1	6,5	5,0
	Year of impl	2015	2017	2023	2026
Carbon price growing at 3% a year for only 50 year then stable					
Dirty Project D	NPV	7,8	5,9	5,1	4,8
	Year of impl	2015	2020	2066	2066
Carbon price stable					
Dirty project D	NPV	21,2	19,3	17,6	16,0
	Year of impl	2015	2017	2021	2024
Clean project C	NPV	21,2	19,3	17,6	16,0
	Year of impl	2015	2017	2021	2024

This table deserves some explanations :

- the first row gives the 2015 year surplus provided by the projects. This surplus is the same for all projects
- the second row gives the values of the investment costs for further alternatives. It is clear that the lower the investment cost, the earlier the implementation year and the higher the NPV are. These intuitions are verified in the simulations
- In the following rows are shown, first , the results of optimisation in terms of year of implementation and NPV for the different investment costs, both for the type D and the type C projects, all in the case where the price of carbon is steadily growing at 3% a year. It appears that the dirty project is profitable only for the lowest value of the investment cost: if the investment cost is higher than 0,268, then the D project should never be implemented. The picture is different for the C project: if the investment cost is larger than 0,268, the project is just postponed for a few years.
- The result for the dirty project D is partly due to the extent of the assessment: if the horizon is limited to 50 years instead of 100 years, the range of values of investment is much extended: the year of implementation is farther, but the project remains profitable for some far year.
- It is also due to the evolution of the relative prices of the common production good and of the carbon good; as shown in the last rows, if both prices have the same evolution, the two types of projects, C and D, do not show any difference.

As a whole, taking into account a sufficiently large horizon and including relative prices changes in a –simplified- macro-economic framework involves huge differences in the results of project appraisal, and large mistakes if the appraisal uses a too short horizon and no –or an insufficient- relative prices differentiation.

CONCLUSION

If we want project appraisal to give an appropriate estimate of the future value of projects in a world subject to deep transitions, we have to adapt appraisal methodologies, to take risks into account, and to use long-term strategic scenarios that make possible a more correct quantification and monetisation of the project's effects.

Building strategic scenarios is a complex and difficult task, which cannot be undertaken on a scope limited to the transport sector.

Nevertheless we think this work on scenarios is necessary, and hope that the key points and hints for developments that are given in this paper may facilitate this work.

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[1] Rapport **Boiteux I** (1994) Transports : pour un meilleur choix des investissements ; rapport **Boiteux II (2001)** Transports : choix des investissements et coûts des nuisances.

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[6] L'évaluation socio-économique des investissements publics, rapport de la commission animée par E Quinet

[7] When outcomes are not uncertain, the decision rule is simple: under quite general assumptions (mainly: advantages independent from the date the infrastructure is put into operation, advantages growing with time), the infrastructure is to be built when the first year's advantage divided by the cost equals the discount rate -as long as NPV in this situation is positive -.

[8] For instance, do we suppose, on the mid- and long-term, a stability of the number of fatalities on the roads, or a stability of the fatality rate per million vehicle kilometers, or something else? On this regard, see for instance

Weijermars and Wesemann (2013).

[9] It is for such a reason that appraisals of European Union measures for GHG policy are made on the basis of an “informed trends” scenario and not under the assumption that the reduction objectives are fully met. This simple procedure is not exempt from theoretical critics, however.

[10] the utility is, with the notations of box 1:

$U_t = (a1 * X_t^{(\sigma-1)/\sigma} + a2 * T_t^{(\sigma-1/\sigma})^{\sigma/(\sigma-1)}$ with

$T_t = (b * Td_t^{(\sigma'-1)/\sigma'} + (1-b) * Tc_t^{(\sigma'-1)/\sigma'})^{\sigma'/(\sigma'-1)}$

[11] This value is also in the middle in the range of estimates which can be derived from the relation linking elasticity to price and elasticity of substitution (see for instance Keller 1976 or Kanemoto 2003): $(\partial T/\partial PT)/(T/PT)$ equals $-\sigma-(1-shx)*(1-\sigma)$ where T is the total transport, PT is the average price of transport. Current estimates of these variables are -0,3 to -1,0 for the price elasticity $(\partial T/\partial PT)/(T/PT)$, and 0,85 for shx.

[12] It is the difference between the values of the indirect utility function with and without the price decrease