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Infrastructure Funding and Public-Private Partnerships

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INTRODUCTION

Towards the end of the twentieth century, the trend that seemed to be emerging in many countries was towards a certain distribution of roles whereby transport operations were assigned to the private sphere and infrastructure to the public sphere. Over the past ten years, however, growth in the use of PPPs has signalled a significant change which completely redefines the issue of infrastructure funding.

1. A MAJOR YET PARADOXICAL TREND

The period 1990-2000 was marked by the growing involvement of the private sector in the financing of public infrastructure investment. This trend has been systematically tracked in developing countries and transition economies by the World Bank¹. The Bank reported 2 500 projects involving private operators during the period, of which 675 were in the transport sector. Even though transport projects remain a minority in these statistics, investment in transport infrastructure nonetheless amounted to 135 billion dollars.

This trend is also apparent in the developed economies, although initiatives in this area remain limited to a small number of toll highway concessions and to an even smaller number of rail projects that, like Eurotunnel or the Orlyval to Paris link, have not been clear-cut financial successes.

These trends obviously reflect economic rationales which, although they may sometimes prove controversial, can draw on an extensive literature.

The first rationale is that such investment offers private operators the possibility to manage the construction and operation of a given project more efficiently. This argument is based on the premise that the internal rate of return (IRR) for the project will vary according to whether the project is managed by a government administration/enterprise or by a firm that in theory accustomed to constant optimization of its operations. There are many reasons put forward to explain this difference: lower salaries in the private sector for certain types of personnel, greater flexibility, shorter lead times that will speed up the return on the investment, or even a greater capacity to withstand political demands that would entail additional costs (Dewenter and Malesta, 2001).

The second rationale is particularly important in countries with relatively little experience of toll infrastructure. J.A. Gomez-Ibanez and J.R. Meyer (1993) note that tolls are resented on infrastructure owned by the State, but are perceived as normal if the works are financed by a private enterprise. The use of private operators is therefore often the only way in which to make application of the user-pays-principle more acceptable.

The third rationale for the use of private funding is an excessive level of public debt, on the part of either the public operator likely to take charge of the project or the State itself. Even though it is underwritten by the future revenue stream, the additional debt may prove disadvantageous in terms of the adverse impact on the credit rating of a public operator or, as is more generally the case, the government's ability to control public debt².

Nevertheless, this development faces an obstacle, particularly in Western Europe. PPPs have started to become attractive at a time when the financial rate of return on projects is at a historic low. In the case of motorways, for example, in countries where the development of motorway networks has primarily been financed through the use of tolls, as in the case of France, Italy and Spain which between them have 28 000 km of motorway, all the major corridors have been in place for a long period of time and the networks therefore already have a high grid density. The links that still remain to be built, either to increase grid density or to open up isolated areas, will therefore carry lower volumes of traffic. While new projects may be justified in terms of their socio-economic return or their contribution to territorial development, their financial rate of return is usually far too low to ensure that they will be self-financing.

The same is true of rail networks. In the conventional rail network, the contributory capacity of carriers, and hence revenue from charges, is at best sufficient to cover the costs of network management and maintenance. In the high-speed network, the commercial success of the South-East TGV during the 1980s was such that construction of a new Paris-Lyon line and the purchase of dedicated rolling stock could be comfortably self-financed. The following projects, however, have proved to be less and less financially profitable³, to the point that there are now no longer any projects which do not require most of the investment to be covered by public funding.

Paradoxically, this situation has seen an increase in the use of PPPs for new projects. In France, for example, the most recent concessions for toll road construction have been awarded to private operators and the future international high-speed train lines (Perpignan-Figueras and Lyon-Turin) are set to follow suit.

Going beyond the case of France, the historical paradox may be stated as follows: PPP mechanisms emerge (or re-emerge) at a time when the number of financially profitable infrastructure projects seems limited or even, in certain countries, non-existent.

We shall demonstrate in the following paragraphs that this paradox may be explained by the mathematical function determining the rate of subsidy required for a PPP project with an inadequate financial rate of return.

2. DETERMINATION OF THE SUBSIDY REQUIREMENT

The aim, in short, is to determine the extent to which the use of a private partnership can reduce the burden on public finances compared with the use of a public enterprises whose debts are guaranteed by the State. To make it easier to state the question formally, we have assumed that a choice must be made between two options stylised as follows:

- *In the "public" option*, the operator in charge of the project is assumed not to make a profit but is deemed to be able to cover his investment and operating costs, including borrowing charges, with the commercial revenue arising from either tolls paid by users or shadow tolls⁴ paid by government. In the case of a loss-making project, it is assumed that government will make good the loss; in addition, the level of subsidy, determined on the basis of an ex ante cost-benefit analysis, must provide a sufficient top-up to the predicted income to allow the operator to cover all his costs.
- *In the "private" option*, the mechanism is exactly the same except that the private operator's charges include the remuneration of his own capital and therefore allow him to make a profit.

We start out by assuming that the IRR for the project will be the same for both a public and a private operator. While we are aware that this assumption is not necessarily relevant, it will not be removed until paragraph 4.

Accordingly, it is assumed that the public operator will implement the project if the forecast IRR is capable of covering the market interest rate plus a risk premium which takes account of the uncertainties associated with any financial assessment of the project, i.e. uncertainties over costs and over traffic and revenue forecasts. To give a practical example, if the long-term rates on the financial market are 4 per cent and if the risk premium is estimated at a similar 4 per cent, then the public operator cannot commit itself unless the IRR is equal to at least 8 per cent. Any rate below that would have to be compensated by a subsidy to bring it back up to that level.

For the same project, the private operator has to cover the same assumed market rate and risk premium, to which he has to add a profit margin of, say, a further 4 per cent. This means that any IRR of less than 12 per cent will require a subsidy to ensure that the project is financially profitable.

It should be noted that the use of taxpayers' money can in theory be justified, with regard to both a public and a private operator, in terms of benefits that are unrelated to the project's balance sheet and that can be identified through calculation of the economic rate of return (ERR). The project can therefore be assessed not simply from the standpoint of the carrier and his balance sheet, but also from the standpoint of society as a whole. This assessment will address the benefits and costs to all economic agents, for example net loss of income for competing modes or variations in surpluses for users, or even the impact of the project on safety and the environment. Considerations relating to territorial development, which cannot readily be taken into account in a cost-benefit analysis, can also justify a decision to invest.

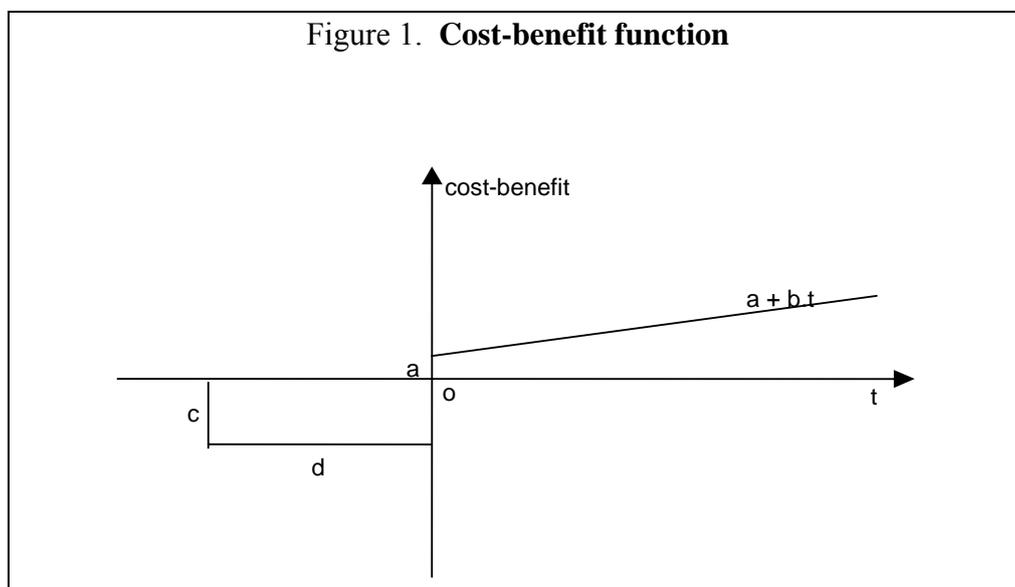
On the basis of the orders of magnitude mentioned above, we can distinguish three types of project:

- 1) For projects with a high rate of return (over 12 per cent according to the suggested orders of magnitude), no public funding is required, irrespective of whether the operator is public or private;
- 2) For projects with a medium rate of return (between 8 per cent and 12 per cent), the public operator can invest without a subsidy, whereas the private operator needs to demand a subsidy level that will increase the project's rate of return to 12 per cent;
- 3) For project with a low rate of return (less than 8 per cent), a subsidy is required in both instances, but will be higher in the case of a private operator because, in this instance, the financial rate of return on the project needs to be raised to a higher level.

On the basis of our chosen assumptions, and particularly that of equally efficient public and private sectors, this presentation would suggest that the "private" option can be more expensive for public finances than the "public" option. It nonetheless remains a rough approximation in that *it does not detail the relationship between the subsidy requirements and the IRR in question*. We therefore need to determine this relationship in order to gain a clear idea of the challenges for public finances and so that the assumption of equal efficiency can be subsequently set aside.

Accordingly, let us consider a typical project assumed to be completed within a period d representing a number of years during which the annual investment costs c are assumed to be constant. Once the infrastructure enters into service, the net profit earned by the operator is expressed as a and is assumed to grow at an annual rate of b .

This is a stylised, although ultimately classical⁵, account of costs and benefits that is represented in Figure 1. If the infrastructure is assumed to enter into service on the date $t = 0$, the annual expenditure between the dates $-d$ and 0 will be c . From the entry into service onwards, the profit earned is assumed to take the form $(a+b.t)$.



The internal rate of return of the project (IRR), that is to say, the discount rate that cancels its net present value (NPV), will therefore be a function of the four parameters c , d , a and b . This rate is to be compared with the rate of return that a (public or private) operator would be entitled to expect.

We shall use the following notation:

- α discount rate used to calculate the net present value (NPV);
- α_0 discount rate that cancels out the project's NPV, i.e. its IRR;
- δ IRR top-up that the subsidy gives to the operator;
- τ rate of subsidy of the investment, i.e. the part of c financed by a subsidy.

For a discount rate, α , and a discounted balance calculated from the dates $-d$ to T , the net present value of the project may be expressed as follows:

$$\text{NVP} = \int_{-d}^0 -c.e^{-\alpha t} .dt + \int_0^T (a + b.t).e^{-\alpha t} .dt \quad (1)$$

To simplify the calculations, we shall assume that the discounting extends to infinity, which does not affect the results we are interested in due to the low impact of the distant future and, above all, the convergence of the integral functions of equation (1). This equation therefore becomes⁶:

$$\text{NVP} = \frac{1}{\alpha} \left[c(1 - e^{\alpha d}) + a + \frac{b}{\alpha} \right] \quad (2)$$

The IRR of the project, α_0 , is then expressed by:

$$c(1 - e^{-\alpha_0 d}) + a + \frac{b}{\alpha_0} = 0 \quad (3)$$

A subsidy rate, τ , lowers the annual construction cost, c , to $c(1 - \tau)$ and increases the IRR α_0 to $(\alpha_0 + \delta)$ so that (3) becomes:

$$(1 - \tau)c(1 - e^{-(\alpha_0 + \delta)d}) + a + \frac{b}{\alpha_0 + \delta} = 0 \quad (4)$$

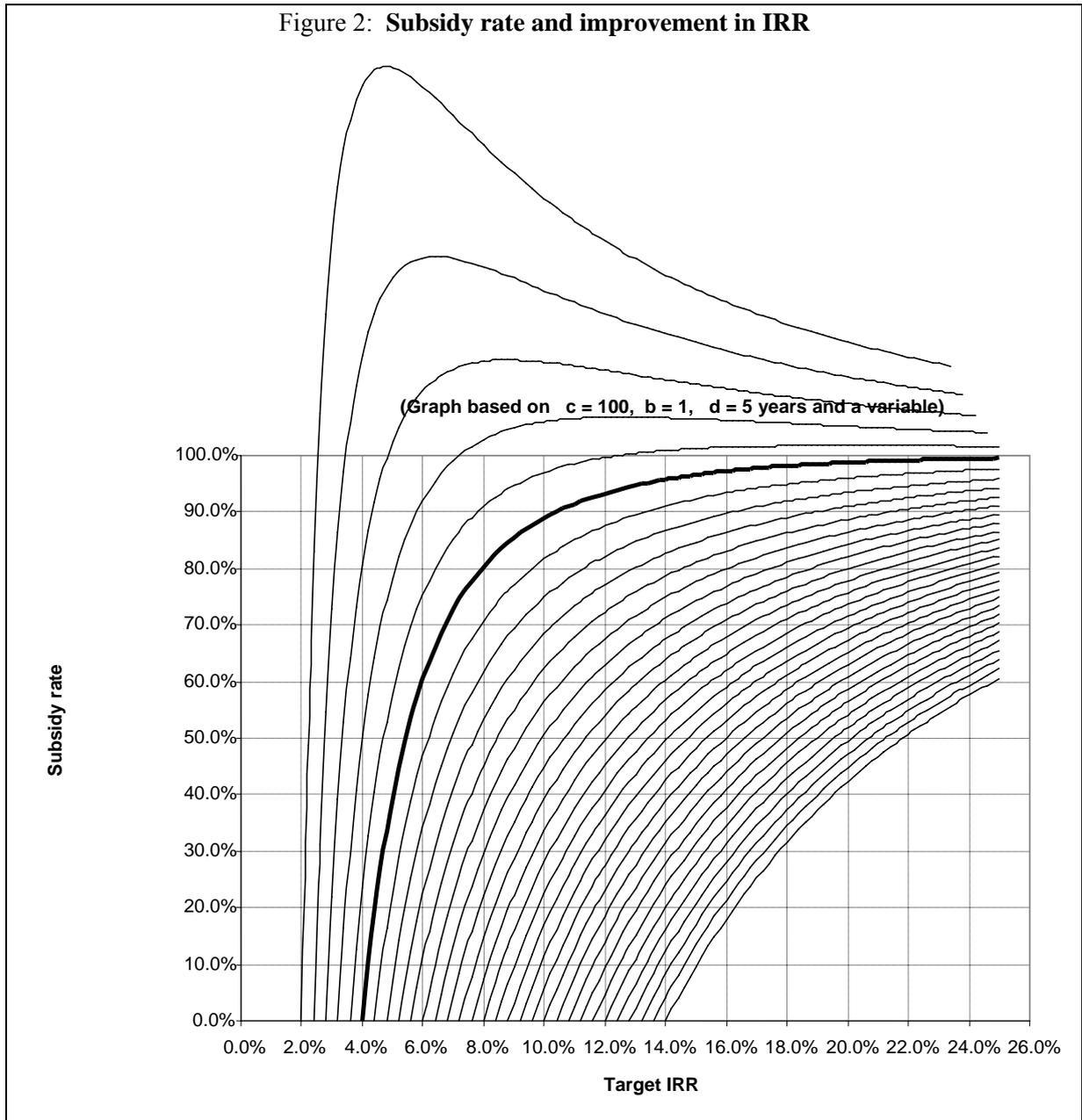
From which we can deduce the following expression of the subsidy rate:

$$\tau = 1 - \frac{a(\alpha_0 + \delta) + b}{c(\alpha_0 + \delta)(e^{(\alpha_0 + \delta)d} - 1)} \quad (5)$$

The important aspect of this function with regard to the economic issues we are examining is the relationship between τ , the subsidy rate and δ , the increase in the IRR of the project to be accorded to the operator. This relationship obviously depends on the parameters c , d , a , b and, of course, α_0 , characterising the economics of the project. Furthermore, these parameters are interlinked by equation (4) defining α_0 , the IRR of the project. This means that if we wish to represent equation (5), some of these parameters must be fixed parameters, so that the only ones which will vary are those whose role we wish to display. To do this, we shall use a conventional graph-plotting technique.

We shall only present one of these graphs (Figure 2), as this will be sufficient for the purposes of our discussion. The annual construction cost, c , was set at a standard value of 100, and the length of the construction period was set at five years. The annual increase in net cost advantages, b , is taken as equal to 1. This is the same as varying the initial IRR of the project, α_0 (or even a , since α_0 depends solely on a , the net profit from the project at the time of entry into service). The graph below therefore represents function (5) for a series of values of α_0 between 2 per cent and 14 per cent plotted at 0.4 per cent intervals. For each of these values of α_0 , read on the x-axis, each curve expresses the subsidy rate required to raise the IRR to the values indicated.

Figure 2: Subsidy rate and improvement in IRR



Although based on the characteristics of the cost-benefit time series of the project in question and on the specific values used for certain parameters, the shapes of these curves are of a general nature. In particular, their concavity is attributable to the properties, which can easily be demonstrated, of the second derivative of function (5). This concavity has major consequences with regard to the choice between public operator or private partnership, which we shall discuss in greater detail below. The first of these consequences, however, concerns the increasingly important role played by the rate of return as it decreases.

3. THE TYRANNY OF THE FINANCIAL RATE OF RETURN

While it was to be expected that the subsidy requirement would increase in accordance with the internal rate of return to be offered to the operator, in addition the slope of the curve in Figure 2 is sharply decreasing. This concavity is a rather more unexpected outcome and means, in this instance, that the initial discrepancies between the initial IRR for the operation and the target IRR are extremely expensive, whereas intuitively an injection of subsidy into a project might be expected to secure a rapid increase in the rate of return for the operator. This graph therefore provides us with some highly intriguing orders of magnitude: at an initial IRR of 8 per cent, the project can be implemented by a public operator without subsidy; if the initial IRR is merely 6 per cent, a increase of 2 per cent to bring it up to the target IRR of 8 per cent would require public financing of 37 per cent of the cost of the project. This funding requirement is obviously even higher for projects whose intrinsic rate of return is even lower. If the rate of return is 4 per cent, for example, then making up the four missing percentage points would require a subsidy rate of 80 per cent!

This means that the leverage effect of public financing on the rate of investment is far greater than generally suspected due to the fact that priority may or may not be given to projects offering the best financial rate of return.

It is well known that the public financing requirement is inversely proportional to the initial rate of return. However, in addition, this public financing requirement increases very rapidly as soon as any attempt is made to increase the initial rate of return by a few percentage points. If public financing capacity is assumed to be low, financing resources may be depleted even faster if priority is given to projects with a low rate of return on the grounds that they offer a good economic rate of return.

Consequently, whereas the ERR is supposed to indicate projects with the highest social return, there is no guarantee that investing by (decreasing) order of the economic rate of return will provide a better overall social return than giving priority to projects with a high financial rate of return. In such a case, scarce public resources can be used to implement a greater number of projects and could in turn yield, on aggregate, a higher social and economic surplus than the order of magnitude suggested by the ERRs.

A number of simulations were made of investment programmes to lend some consistency to this thesis⁷. The exercise consisted in examining 17 toll motorway projects for which all the data required for the simulations were known and had been evaluated by means of standard methodology⁸. Subsidy rates were calculated by equations (4) and (5). It was initially assumed that the projects were subject to a budget constraint under which annual public financing was restricted to 150 million euros during the first year of the programme, after which the financing was assumed to increase by 2.5 per cent a year.

Four simulations are proposed which assume, respectively, that projects are implemented in order of decreasing IRR, in order of ERR, and then in two random orders (corresponding to alphabetical order and reverse alphabetical order). Each of these programmes, which were assumed to run for 15 years, clearly exhibited a social return which we chose to represent by the ratio between the socio-economic NVP (or collective surplus) generated by the programme per euro of subsidy. The results are given in the table below.

Table 1. **Social return of a programme of 17 toll motorway projects in the order in which projects were implemented**

Order in which projects are completed	Decreasing order of IRR	Decreasing order of ERR	Alphabetical order	Reverse alphabetical order
Collective surplus per euro invested	4.27	3.26	2.19	0.77
Length of network constructed	525	485	335	330

Source: Julien Brunel, LET research seminar.

It should first be noted that this table emphasizes the potentially adverse impacts, in terms of economic efficiency, of implementing programme projects in random order, in this case alphabetical and reverse alphabetical order, which is the type of order which could well result from the wielding of political influence by local dignitaries.

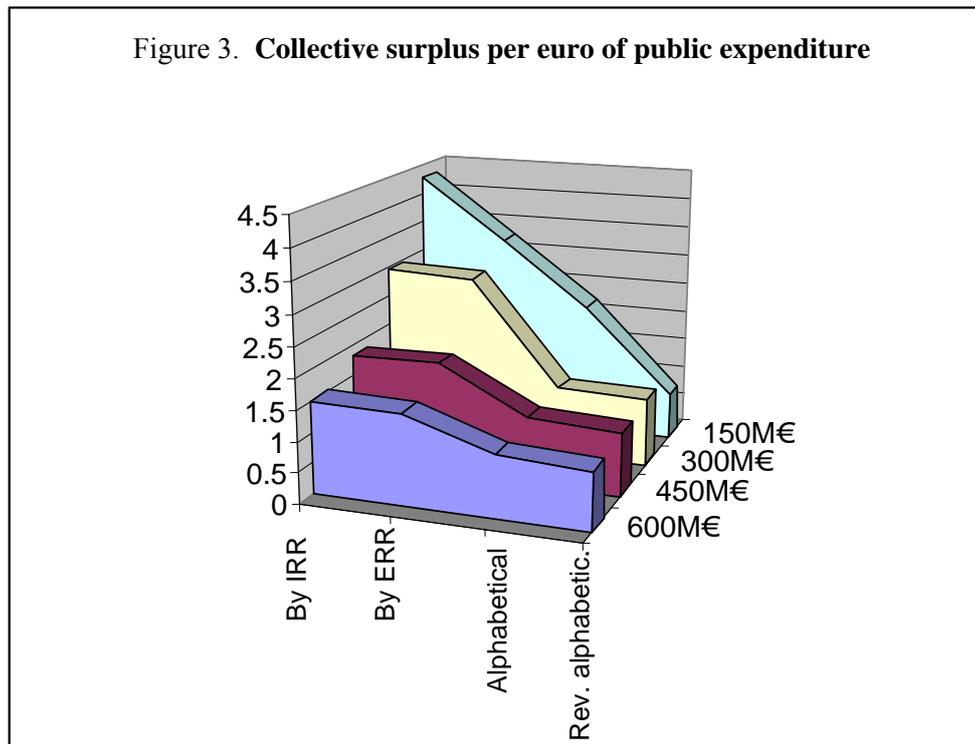
These results also hold an even more important and above all less well-known lesson, namely, that they challenge the widely accepted principle in public economics that the ERR of projects indicate those which should be undertaken first in order to generate the best social return. In this example, however, the collective surplus generated by the programme is greatest when projects are implemented in order of their IRR rather than their ERR. This is obviously attributable to a financial constraint, namely, that when public financing capacity is very low, an investment programme which takes little account of the financial profitability of the project will very quickly consume the public funds available, resulting in a slower rate of entry into service. The last line in Table 1 clearly demonstrates this "budget effect" and explains the paradox in terms of the length of network brought into service according to the order of programme implementation.

It would be fair to assume that the weaker the public financing capacity, the greater the likelihood of such a scenario arising. Taken to the extreme, it would suggest that an unlimited public funding capacity would permit all projects to be completed as soon as possible. To illustrate this trend in the budget effect, the programme simulations were diversified by relaxing the budgetary constraint (from 150 to 600 million euros). The results are given in Figure 3 below.

The data clearly show that the budget effect diminishes in direct proportion to the degree to which the public financing constraint is relaxed. Once the figure of 600 million euros has been reached, all the projects considered (i.e. 1 105 km of new motorways) can be completed within the lifetime of the programme. In this instance, the explanation of the paradox in terms of length of time before entry into service throughout the programme lifetime no longer holds, although the random orders in which projects are implemented will nonetheless generate less overall surplus, because projects with high rates of return and generating the greatest surpluses⁹ were not the first to be implemented.

It is worth noting, in passing, that the light thus shed on the variable role played by the budget constraint suggests to us that, on the whole, it is perfectly logical that, historically, territorial development considerations only started to be taken into account once public finances had become sufficiently healthy. Not only is this a sign that the most urgently needed investments had been made, but in addition it is a situation in which our results show that the social loss is minimal if priority is given to investments with low rates of return.

Figure 3. Collective surplus per euro of public expenditure



It should be noted at this point that these simulations, suggesting that the rate of return criterion is imperative when public resources are limited, obviously depend upon the configuration of projects in alternative programmes. Each of these programmes may have intrinsic "network effects", whereby the order in which projects are implemented, for example, has an effect on the rate of return of individual projects. What we are advancing here is no more than a working hypothesis to the effect that: *an investment programme in which projects are implemented by decreasing order of their economic rate of return can have a lower overall social return than a programme which gives priority to high financial rates of return. The greater the constraint on public financing capacity, the greater the probability that such a relationship exists.*

4. THE PARADOX OF FINANCIAL PROFITABILITY AND USE OF PPPS

The concavity of the curves in Figure 2 determining the subsidy requirement also has implications with regard to the issue of PPPs. They suggest that when financial rates of return are close to the rate required by the public operator, the use of a private operator who would not be capable of significantly improving the profitability of the operation can prove costly: for an 8 per cent rate of return, a concession can be awarded to a public operator without any need for subsidy; but to increase the rate of return from 8 per cent to the 12 per cent likely to satisfy a private operator would

require a public subsidy of 45 per cent of the investment cost. Within these IRR percentages, unless the public operator is vastly more efficient, it would not seem to be in the general interest to use a PPP.

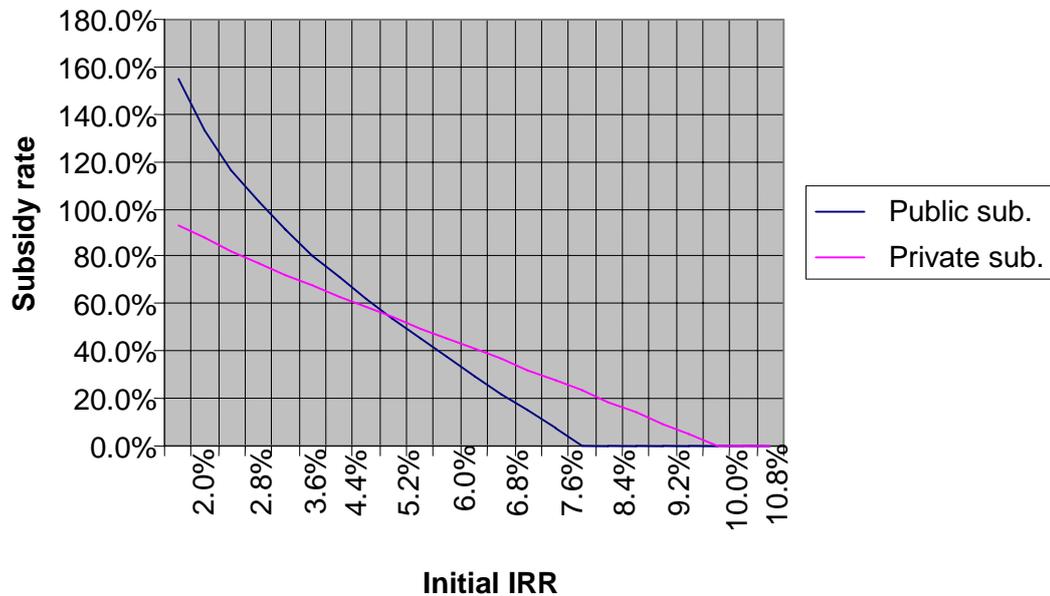
The concavity of the curves does have one major consequence, however, which is that, for projects with a low initial IRR, the switch from a public operator to a private one is of low marginal cost to public finances. In the case of an initial IRR of 4 per cent, represented by the curve highlighted in bold in our graph, the 80 per cent subsidy rate needed to achieve an 8 per cent rate of return only has to be increased to 93 per cent, i.e. a further 13 per cent, to bring the rate of return up to 12 per cent. These results illustrate what I have called the paradox of financial profitability¹⁰, which may be stated as follows: *while the additional cost to government of making use of a private operator rather than a public operator assumed to be more efficient is higher when the profitability of a project is close to that required by the public operator, this additional cost will be lower if the initial IRR is itself low.*

This outcome bears out the equally paradoxical observation that private firms are returning to the development of major infrastructure at a time when the projects that still remain to be completed are significantly less profitable than those already completed and in service. The theoretical paradox is clearly not the sole explanation for the empirical paradox, but reveals that the process of privatisation should pose fewer financing problems for government than might be suggested by an overly cursory analysis.

It obviously remains for us to add to these considerations the dimension to the public-private partnership issue that we have until now avoided, namely, the respective efficiency of public and private enterprises. It would be fair to assume that private operators are capable of improving the internal rate of return of the operation, either through better control of operating costs [improvement of a and b in equation (4) which determines α_0], lower investment costs (lowering of c), short construction lead times (reduction of d) or a combination of these profitability factors. By way of a simple illustration, we shall assume that the initial IRR α_0 is thereby improved by 2 per cent.

Inputting variable values of this IRR α_0 in the target IRR scenario of 8 per cent for the public operator and 12 per cent for the private operator, we shall therefore obtain the subsidy values listed in Figure 4 below.

Figure 4. **Subsidy rate as a function of initial IRR α_0**
on the assumption that the private operator is the more efficient
 (Target IRR of 8% for the public operator and 12% for the private operator,
 Initial IRR with public operator = α_0 , Initial IRR with private operator = $\alpha_0 + 2\%$)



What is interesting about this chart is the way in which the particular configuration it represents suggests that a distinction can be made between three areas of IRR values. These three areas correspond to three relatively contrasting choice universes for the policymaker:

- 1) In the area to the right of the chart, for rates of return of the same order or higher than that targeted by the public operator, public finances can only lose as a result of making use of a private operator. If the loss is relatively limited, however, use of a private operator may be justified by the overall surplus in productivity from which the economy benefits as a whole, due to the difference in efficiency levels.
2. In the area to the left of the chart, for very low rates of return, the efficiency differential has a major role to play, but this then brings us closer to situations in which the social return of the project may be insufficient and may result in the project, or its consistency¹¹, being challenged. However, if the economic rate of return justifies undertaking the project, awarding the concession to a private operator will be less expensive for public finances.
- 3) Between these two areas lies a "switchover" point up to which, at a particular value¹² of α_0 , the use of a private operator reduces public expenditure. In this case, the social return and public finance economics criteria are convergent and both indicate the private operator as the best collective choice.

It needs to be noted that the existence of *this switchover point* is not a necessary outcome of the concavity of the subsidy requirement function; there are clearly parameter values for which this function will at all points remain higher in the case of a private operator. The paradox of financial profitability therefore implies the existence of a switchover point solely for a subset of possible values

for the parameters a, b, c and d, the IRR targeted by both types of operator and, of course, the efficiency differential whose level is clearly decisive.

5. CONCLUSION

We shall draw three conclusions from the above analysis, which, although equally paradoxical, are nonetheless the outcome of the inevitable consequences of the financial constraint.

- 1) When the public financial constraint is very high, the best social return on an investment programme is obtained by giving priority to financial profitability over social and economic profitability.
- 2) If private operators are no more efficient than public operators, it is always more expensive for the State to award a concession for public infrastructure to a private enterprise. However, this additional expense to public finances will be proportionately lower if the financial profitability of the project is itself low.
- 3) If private operators are more efficient, the additional expense entailed by their use may become a gain for public finances, and the lower the financial profitability of the project the higher the probability of such a gain being realised. It is therefore by no means inconsistent that private operators be awarded projects with very low rates of return in that such a course of action can both lower public expenditure and increase the social return of the project.

NOTES

1. World Bank PPI Project Database.
2. As is the case for the countries in the Economic and Monetary Union which, under the Maastricht Treaty, had to meet the criterion of debt convergence (no more than 60 per cent of GDP) and which remain subject to the same constraint under the Stability and Growth Pact. Independently of this particular case, any country with a high level of debt may wish to free itself of the "snowball effect" whereby public debt will increase the weight of the debt as a percentage of GDP if interest rates are higher than the nominal rate of growth..
3. The TGV Atlantique was subsidised but could just about have been able to finance itself without subsidies; the TGV Nord had a lower rate of return due to higher construction costs and links to London and Brussels that were not as efficient or that were put in place later than expected; the percentage of self-financing generated by the TGV Méditerranée was even lower, and in the case of the TGV Est will be no more than around 10 per cent
4. A shadow toll means that users are not charged for using the infrastructure and that the government pays the toll in their place. The operator is thereby encouraged to meet demand as fully as possible, provided that the shadow toll is higher than the marginal cost of usage.

5. In practice, the principles on which the calculation is based may propose demand forecasts cautiously considered to be linear or exponential forecasts to a given date after which they become linear. The net result (benefit minus cost) will then correspond to the same type of function. The following calculations can be readily transposed with an exponential function and the resultant analyses will not be radically affected.
6. Details of the calculations are given in Bonnafous (2002).
7. The following results are from simulations performed by Julien Brunel in the course of a research seminar at the LET.
8. These were competing projects for the French network proposed in the early 1990s. Most have since been completed with a low apparent subsidy from government in that the contracts were awarded to motorway construction companies able to underwrite and amortize their loans by means of net revenue from connecting roads which were generating profits. In accordance with an EU directive, the use of this instrument, known as linked financing, is no longer permitted.
9. While there is no reason why they should be proportional, the IRR and ERR are linked to the projected traffic levels in each project and are therefore correlated.
10. This paradox was first discussed in an earlier paper (Bonnafous, 1999), but was not based on the mathematical analysis subsequently presented (Bonnafous, 2001 and 2002); curves close to those in Figure 3 had been established on the basis of empirical simulations generated by the CALQUECO model (Faivre d'Arcier, Mignot, 1998).
11. In the case of motorways, for example, it might be wiser to abandon plans to build a toll motorway in favour of a dual carriageway link whose specification will be less demanding and less expensive, partly because of the fact that it is possible to use all or part of an existing road.
12. For the mathematically curious, this value for α_0 is 5.2 per cent in the simulation used.

BIBLIOGRAPHY

- Baird, A.J. (2001), "Trend in Port Privatisation in the World's Top 100 Containers Ports", 9th WCTR, Seoul, July, 21 pp.
- Bonnafous, A. (1999), "Infrastructures publiques et financement privé : le paradoxe de la rentabilité financière", *Revue d'Economie Financière*, No. 51.
- Bonnafous, A. (2001), "Transport Infrastructure and Private Financing: a Profitability Rate Paradox", 9th WCTR, Seoul, July, 9 pp.
- Bonnafous, A. (2002), "Les infrastructures de transport et la logique financière du partenariat public-privés : quelques paradoxes", *Revue Française d'Economie*, Vol. 17, No. 1.

- Budin, K.J. and L.S. Thompson (2001), "Directions of Railway Reform", *Rail International – Schienen der Welt*, Sept.–Oct., pp. 30-45.
- Cohen, Y. (1991) "California's Private Infrastructure Initiative", *Journal of Transport Economics and Policy*, No. 25, 1991
- Commissariat Général du Plan (1996), *Transports : pour un meilleur choix des investissements*, Report by the group chaired by Marcel Boiteux, Documentation Française.
- Commissariat Général du Plan (1997), *Transports : le prix d'une stratégie*, Report on the workshop chaired by Alain Bonnafous, 2 vol., Documentation Française.
- Dewenter, K.L. and P.H. Malatesta (2001), "State-Owned and Privately Owned Firms: An Empirical Analysis of Profitability, Leverage, and Labor Intensity" *American Economic Review*, March, 91(1), pp. 320-334.
- Faivre d'Arcier B., D. Mignot (1998), "Using Economic Calculation as a Simulation Tool to Assess Transport Investments", 8th WCTR, Antwerp, July, 14 pp.
- Gomez-Ibanez, J.A. and J.R. Meyer (1993), *Going Private*, Brookings Institution, Washington DC.
- Mills, G. (1996), "Public Infrastructure: Private Ownership or Contracting Out", Working Paper No. 18, Center for Microeconomic Policy Analysis, University of Sydney.
- Molnar, E. (2003), "Trends in Transport Investment Funding", in: *50 Years of Transport Policy: Successes, Failures and New Challenges*, ECMT, OECD, Paris.