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COST BENEFIT ANALYSIS AND THE RATES OF RETURN OF DEVELOPMENT PROJECTS: AN INTERNATIONAL COMPARISON

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Abstract

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Abstract

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Introduction

At any given time, all around the world, thousands investment projects proposals come under scrutiny by decision-makers. If concerned parties will appraise them as technically feasible and financially profitable, they will be implemented. Some projects will be a success, others a failure. While most projects are purely private, a subset of them will be co-financed, directly or indirectly, by public funds. Many investment projects, particularly infrastructures, will be considered for financing exclusively by governments or by international organizations, particularly in developing countries, transition economies, regions lagging behind within developed economies.

In this paper we analyse variations of the rate of return of development projects sponsored by three international institutions: the European Union (EU), the European Bank for Reconstruction and Development (EBRD), the World Bank (WB).

The three institutions widely differ in their objectives, geographical scopes, project selection processes, etc. However they share a broad committment to development a. Each of them has a different geographical coverage, respsctively less developed regions in Western Europe (EU), Centre-Eastern Europe (EBRD), less developed countries worlwide (WB). This offers an interesting opportunity for an international comparison of rates of return of development projects.

The focus of the paper is on the variability of ex-ante economic rate of returns (ERR), of financial rates of return (FRR, available for EU and EBRD) and ex-post or re-estimated economic rates of return (RERR, available for WB only). We propose a framework of analysis of FRR and ERR variations across projects, sectors, financing institutions, of the wedge between ERR and FRR, and of the gap between ERR and RERR[1]. In principle the same framework could be used for comparing rates of return variability of development projects across countries, time of approval or completion, or other relevant sampling criterion.

1 In principle we would like to consider also the difference between ex-ante and ex-post FRRs, but the data are not avalaible.

The basic idea is to consider project rates of return as signals for decision making, determined by unknow variables, including true structural parameters and measurement errors. Thus we consider the data as the results of experiments, and we treat them accordingly. The information we extract allows to distinguish between variations in rate of return determined by project-specific factors (including forecasting or data collection and elaboration errors) and sector-specific or source-specific factors. Further analysis may then distinguish between true structural economic factors and systematic bias at appraisal or evaluation level: this was not attempted here, but some examples are given on how to use rates of return variability as the starting point for this more in depth review of the appraisal process as advocated by Gramlich (1994), Isham, Kaufmann (1999).
Our research points not so much on rates of return values in themselves, but on analytical issues arising when one considers cumulative information on them. What we envisage, in a nutshell, is an heuristic approach.
When data of rates of return are regularly collected and sampled in the format of the matrix of Fig. 1, the study of variations among the average values by source, sector, country, etc. will point directly to the key-issues of development project analysis: why are expected financial rates of return in one sector greater than elsewhere? Why is there a big difference between financial and economic rates of return in some countries? Why in some sectors is there a gap between ex-ante and ex-post rates of return? and so on.
We do not answer all these questions, but we show how to structure project information to explore these issues and we focus on a set of specific propositions based on cost-benefit analysis principles.

Fig. 1. The four project rates of return

PROJECT ANALYSIS ↓ / PROJECT IMPLEMENTATION →		
	FRR ex-ante	FRR ex-post
	ERR ex-ante	ERR ex-post

Sample mean and standard deviation by:

- Sector
- Country
- Institution
- Year of appraisal
- ......

The paper is in the following sections: first we present the framework of analysis, then a set of testable propositions ; third, we present our sources of data, fourth we discuss financial rates of returns, then economic rates of return arising from cost-benefit analysis as applied by international organizations, sixth the wedge between FRRs and ERRs, seventh RERR data, i.e. the result of ex-post evaluation; eight, we bring together our findings at sectoral level, and propose some interpretations on the pattern of variations of rates of return we have detected with our approach; finally, we discuss possible implications for project appraisal by international organizations and for further research.

1. Research issues

Data on the returns of private projects are regularly collected by financial institutions and - particularly for projects concerning companies listed in the stock exchange - part of the information is relatively easily accessible to external observers, albeit imperfectly. In principle, a financial analyst may know how to find data about expected and realized profits by sector, by country and for individual companies.

In contrast to privately financed projects, and in a sense paradoxically, data accessibility is often quite limited for projects funded by public money. Obviously, most projects that candidate for Government funds will be approved only if they pass some kind of test (legal, administrative, financial, socio-economic, political) and the information concerning this process will be recorded somewhere. However, the incentives to standardize data, collect them regularly and to make them available to the public, are apparently weaker in most Government bodies then they are in the private sectors, where data are essential food for investors and financiers. As a consequence, public investment data are dispersed among different offices, not well standardized and recorded, difficult to access from the outside: a wealth of potentially useful knowledge is wasted. Project analysts and decision-makers dealing with capital expenditures in important sectors such as water supply, roads, hospitals, just to mention some obvious examples, are denied easily accessible comparative information on costs and benefits of past decisions.

Some or most of this waste of information is avoidable. Government bodies and international organizations should invest in building project databases. A key-aspect of building a project database is the decision on which information should be standardized and recorded. In this paper we use data on investment projects financed by three international institutions in order to show how, with a minimum amount of information, it is possible to learn from experience.

In principle, we would need financial and economic rates of return, both ex-ante and ex- post (thus four sets of data) for each project; a sectoral and country breakdown; years of approval and completion; possibly scale indicators (total investment cost and employement).

Financial and economic rates of return, the latter being the result of cost-benefit analysis, for infrastructures are relatively easy to calculate. There may be different methods and errors in the process of calculating the rate of return of a railway, but if we have large samples of projects for which project analysts calculated ex-ante and ex-post rates of return, both financial and economic, we may build on this knowledge in order to learn systematically from project analysis across countries and sectors.

It is important to understand that when we observe average values of the rates of return of projects approved by an institution what we see is the result of a long chain of selection processes. Starting from thousands of potential candidates, only some projects will be considered, a part of them will be approved and for just a fraction of them we are going to have a record of rates of return . Thus, when we observe statistics on project rates of return, we must understand the nature of the sampling process that created the observations.

Suppose we have two universities that potentially draw from two populations of candidate students (the two populations may be partially or totally overlapping, or entirely different ones). Some potential candidates will not apply, some will apply, but they will not be admitted, some of those admitted will never graduate, and some of those who will get their degrees, will not find an appropriate job.

We have information on graduation marks (the ex-ante rates of return) and on job-histories after graduation (the ex-post data). When we look at the average graduation marks and we compare this information for different schools, we may discover that there are variations across schools, but this observations may mean different things. Populations of potential candidates may comprise abler types in one case, or a school may admit only the best candidates, or it may give too generously graduation marks, etc. [2]

Whatever the reasons for different sample average values, a preliminary test we need to check whether we can thrust that the averages reflect different populations (of graduate students, of approved projects). This is the starting point for further questions.

The framework of analysis we propose aims to study the variability of rates of return of development projects in such a way as to extract information from large project databases. We also show how useful it is collecting and using regularly these data by international organizations or national development agencies, and by researchers.

Finally, let us discuss more broadly the heuristic approach we advocate. Many practitioners would subscribe the view that it is difficult or impossible to compare rates of return across sectors, (even within one institution), because methods of analysis differ. According to Baum, Tolbert (1985), in their reading of World Bank experience in project analysis:

> "The difficulties of measuring benefits vary a great deal among projects in different sectors, as one would expect; they range from problems in determining what the additional outputs produced by the project are worth to the economy to problems in assessing what the outputs in fact are. Although the general approach is always the same, the exact form that the analysis takes must be tailored to the circumstances of each sector….. Since the measurement of costs and benefits differs from sector to sector, it is usually not meaningful to compare project profitability across sectors, and indices such as the net present value and the internal rate of return are not a sound yardstick for intersectoral resource allocation"

According to the authors projects in agricolture, industry or petroleum projects produce output that are generally internationally traded and ERR is consequently a good index of economic impact. In contrast, projects in public utilities, such as water and sanitation or telecommunications the benefits to consumer may substantially exceed the regulated tariffs they pay. For highways and other transport services there are often no tariffs, and benefits are based on avoided costs. Moreover for projects in health or education or other social infrastructures "no meaningful measures of the monetary benefits exist" and the analysis focus on cost-effectiveness. The cited view was reflected by the World Bank Operational Manual that uses more or less the same wording to underline differences in project analysis across sectors.

However, in this paper we take a more positive attitude and we show that intersectoral and international comparisons of the returns of development projects are feasible and useful.

It is important to stress the conceptual relationship between rates of return and the more general, but more vague, issue of performance. The World Bank since some years has redesigned its evaluation system (OED, various years, 1994-2001) in such a way as to enlarge the range of indicators used to rate projects. The new system establishes three results accounts (outcome, sustainability, institutional development) and two process oriented accounts (Bank performance and borrower performance). We are not going here to discuss in detail this new system of evaluation. Clearly ERR and RERR

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[2] For example the World Bank invests in Africa, while Eu and EBRD do not. Africa may be a difficult region for project implementation for a number of reasons. Thus expectations and risks of the World Bank portfolio will be influenced by its country composition.

calculation is just an aspect of it, however we think it would be a mistake to move further away from it.

According to OED (1997a, Vol. I, p. 52) in the ‘90s ERR analysis was applied in about 36% of the projects, down from an average of 58-56% respectively in the '70s and the '80s. This trend may be attributed to a shift towards social sector investments and technical assistance, but the report advocates a reversal of the trend "with wider application of cost-benefit analysis, including the social sectors".

There may be very good reasons in fact to reverse the trend. It seems that according the same source projects for which the ERR were calculated perform significantly better than the average: "Within the 1995 cohort, of the 95 projects with ERRs at appraisal, 84 percent were rated satisfactory as compared with the overall average of 68 percent". The explanations given by OED points to the role of measurability of physical goals.

Battaile, Candler (1997) explicitly examine and test by econometric analysis the hypothesis that carrying out ex-ante the calculation of ERR significantly improves the probability that an operation is ex-post rated satisfactory, regardless of the estimated ex-ante rate of return itself: they find convincing evidence that it is not the ERR level per se that influences the probability of a project to be rated satisfactory at completion, (while it is linked to the RERR), but just the fact that an ERR was calculated, perhaps thus increasing the knowledge of all involved parties of strenghts and weaknesses of the operation.

We suggest that an even greater effectiveness could be gained by calculating *always* FRR and ERR ex ante ed ex post and sampling together these four sets of data. The variations across sectors and countries or institutions of the wedge beteween FRR and ERR, and between ex-ante and ex-post rates of return may dirive further applied analyisis pointing either on the revision of practical methods of appraisal, or of the portfolio composition (or both). But also will give project appraisers and decision makers the feeling that their work can be effectively evaluated. Thus cumulative information of rates of return may offer an incentive to sound appraisal and to better development projects.

2. Some testable propositions

We start our analysis with some simple definitions and propositions.

Let FRR be the internal rate of return of the project, i.e. the discount rate rate at which a stream of costs and benefits has a net present value equal to zero. We can observe financial costs and benefits either ex-ante, i.e at time 0, or ex-post, at a convenient time t. Thus, for financial profits, i.e. the difference between benefits and costs π_f, discounted at the rate ϕ_0 by definition it is:

$$NPV(\pi_{f0}, \phi_{f0})= 0$$

$$NPV(\pi_{ft}, \phi_{ft})= 0$$

In turn, cost and benefits are project inputs (y quantity vector, vector notation omitted) and outputs (x quantity vector) multiplied by the appropriate price vectors, say p_y and p_x.

Hence ex ante :

$NPV(\pi_{f0}, \phi_{f0})= 0$ implies $NPV(x_0 p_{xf0}, \phi_{f0}) = NPV(y_0 p_{yf0}, \phi_{f0})$.

The ex-post counterpart of this is simply

$NPV(x_t p_{xft}, \phi_{ft}) = NPV(y_t p_{yft}, \phi_{ft})$.

When we move from financial analysis to economic analysis, both ex ante and ex post, there we need to substitute observable prices with shadow prices, i.e. the opportunity cost of inputs and outputs (Dréze, Stern, 1990). For examples, externalities that have zero price in the financial accounts of the project, should be valued with their social opportunity costs.
The economic discount rate (ex-ante or ex post) that zeroes net social benefits, with obvious notation, is the solution of :

$NPV(\pi_e, \phi_e)= 0$.

We thus have four internal rates of return for any project : ϕ_{f0} , ϕ_{ft} , ϕ_{e0} , ϕ_{et} and we would like to understand whether there are conceptual relationships among these four project performance indicators.
A preliminary remark is that the internal rates of return we can observe are project specific. However they depend upon parameters, namely

a) the observable prices (in financial analysis) and shadow prices (only very large projects are not parametric in prices, and we shall ignore this case, that has less practical relevance)
b) the input/output coefficients that are given by the project technology

In turn these parameters are related to the project environment : prices and technologies accessible to the investor change with industries, countries and other factors.
Suppose now you are an investor or a financier that wants to select its optimal portfolio of projects. If you are a private organization, it is reasonable to assume that you want to maximize your discounted financial profits. In contrast, if you are an international organization devoted to development objectives, you should aim to maximizing the discounted economic profits of the projects you select for financing. It is important to note here that at this general level it makes no difference in terms of the objective function if a development agency finances a projects through a grant or a loan or a combination of these sources of funds. However, if you commit funds through loans there is an additional costraint: the project you select for financing should be able to pay interest and refund back the loan.
In this framework the following propositions may offer a way to formalize a set of testable research issues.

Proposition 1.

For the project population or for a large unbiased sample of projects optimally selected by a development agency (optimal project portfolio,OPP), ex-ante and ex-post internal rates of return , either economic or financial, should be positively correlated: $E(\phi_{ft})= f(\phi_{f0}, u)$, $E(\phi_{et}) = f(\phi_{e0}, u)$.

Here *u* is a vector of other variables that influence the project performance and that were unknown to the evaluator ex-ante. On average positive and negative deviations from the ex-ante return will compensate (to a certain extent), and the ex-ante return is a predictor of the ex-post return. Under a systematic optimism bias, however, : $E(\phi_{ft}) < \phi_{f0}$, $E(\phi_{et}) < \phi_{e0}$.

Hence, appropriate data will allow us to measure the extent of optimism bias, and for example whether forecasting errors are evenly dispersed across the project potfolio or whether they occur more frequently in some countries/sectors. This may be the starting point for a detailed analysis of the reasons for project forecasting errors

Proposition 2

An OPP (unconstrained by rationing of finance) will comprise all the projects with an ex ante rate of return higher than a required rate of reurn. Hence, the ex-post rate of return will exceed the required of return.

Thius is a well known criterion in cost-benefit analyisis literature. A rational development agency (using only information such as ϕ_{f0}, ϕ_{e0}) will determine a threshold ϕ^{*f} and $\phi^{*e,}$ (based on its respectively financial and social opportunity cost of capital), and approve only projects when $\phi_{f0} > \phi^{*f}$ or $\phi_{e0} > \phi^{*e}$.
When we observe that there are systematic deviations from this criterion, for example approved projects in one sector or country have often economic returns under the threshold, we can start a review to understand if and why this apparent bias occurs.

Proposition 3.

For any OPP there should be no systematic differences in average returns across sectors and countries.

If the development agency has no preference over countries (e.g because the shadow prices in economic analysis include the distributional characteristics of goods) or industries (e.g. because all externality impacts are included in project returns through the shadow prices vector), and the population of candidate projects is large enough, difference in ex ante returns are suboptimal.

Proposition 4

The required financial rate of return and the average ex ante and ex post rates of return of an OPP for a development agency committed to financing projects through lending will be higher than for an agency disbursing grants.

While one may think to situations where the opportunity cost of capital is equal for the two types of agency, the former will typically add a risk premium to ϕ^{*fT}

Proposition 5

The wedge between the economic and financial rate of return will be positive for the average project in the 0PP: $\phi_{e0} - \phi_{f0} > 0$, $\phi_{e\tau} - \phi_{ft} > 0$

The wedge between the financial and economic rates of return is different from zero when observable and shadow price do not coincide. Typically social cost benefit analysis introduces corrections to observable input and output prices such that

$NPV(x_t p_{xf0}) < NPV(x_t p_{xe0})$ And/or
$NPV(y_t p_{yf0}) > NPV(y_t p_{y0t})$

Proposition 6

Within an OPP the wedge between economic and financial rate of returns may be sector/country specific.

The reason is simple: in some sectors, typically Industry, prices are nearer to oppurtunity costs than in monopolistic and heavily regulated sectors, e.g. the public utilities. Countries may have varying degrees of price distortions. It is important to remark that this does not contradict Proposition 3.

Proposition 7
For an OPP the variability of ex-ante economic rates of return should not be greater than the variability of financial rates of return.

When we consider e.g. the standard deviation of ϕ_{e0} and of ϕ_{f0} and we compare this information, having in mind proposition 5 and 6, we should not expect that economic analysis increases returns variability as compared with financial analysis. In fact, the transition from observable (distorted) prices to economic prices may be neutral or even decrease returns variability, for example because price discrimination, monopoly prices, different duties on imported goods are wiped out by the standard rules for shadow pricing. If we observe an increase of standard deviation this may be the starting point for understanding whether cost benefit analysis at project level has mixed up the results (for instance with inconsistent shadow pricing).

In the remaining of the paper we test (with the limitation imposed by data availability) these propositions (and some of their implications). We are unable to offer a systematic statistical analysis, but we show how a new approach, simple and feasible, can be implemented to go beyond the skeptical view that cost-benefict analysis of development project is too 'ad hoc' for comparisons and testing.

3. Data

As said, there are four sets of basic data we need: financial and economic rates of return, both ex-ante and ex post.[3]

For the EU we consider a data base of 400 major projects built for the European Commission, DG XVI Regional Policies and Cohesion.[4] For the EBRD, we consider data on 253 projects, collected by the Office of the Chief Economist and made available

[3] FRRs are avalaible for EBRD and EU samples only; ERRs ex post for WB samples only.

4 Start up and first results of this analysis were discussed in Florio (1997). More comprehensive data were published in European Commission (1997).

for this research. Finally, the World Bank data were extracted by the large database built by the Operations Evaluation Department, comprising 2147 projects: for this research two smaller samples were extracted by OED in such a way as to match with years of approval or implementation, and with sectoral classifications of the other two sources (105 World Bank projects approved in fiscal years 1988-97; 336 projects completed in years 1990-97).

Our testing procedure is the following:

First, we make simple tests on variances and averages of FRR and ERR (and if available also on their ex-post counterparts). These tests are necessary because even if a project databases may comprise hundreds of cases, in fact when we spread them across sectors (or countries or years of approval or any other key characteristic), we need to treat relatively small samples. We calculate confidence intervals for variance and average values, and test whether in any comparison these statistics are likely or not to reflect structural differences of populations of approved projects (including differences in their appraisal or evaluation methods). For checking the averages, we use a simple t-test ratio, where the upper part of the ratio is just the difference between two sample averages and the lower part is a measure of the variability of the variable. The null hypothesis is the assumption of equal averages for the two populations of projects. The appropriate statistic for testing the hypothesis that the variance are equal is the ratio between the sample estimates of the variances. If the null hypothesis is true, this ratio is distributed as a probability distribution that depends on the F distribution.

Second, we calculate the wedge between ERR and FRR. A large (small) FRR-ERR wedge is an indication of the width of price distortion as appraised by the evaluator. It can reflect either an actually large (small) discrepancy between financial and social profitability, or systematic error at appraisal level because of some methodological bias.

Third, the comparison between ex-post and ex-ante rates of return, both financial and economic, will tell us whether the perhaps unavoidable optimism bias at time of appraisal is eavenly distributed across sectors (or cohorts or any other sampling criteria). If not, there may be specific reasons.

Fourth, we standardize ERR and FRR across sectors, by using industry as a benchmark. This allows us immediately to see systematic differences in financial or economic profitability as (imperfectly) reflected by the rates of return. Because all projects have been approved, these differences point to methodological issues or policy preferences imperfectly included in the appraisal process.

Table 1 presents the samples we use, with a breakdown by sources, sectors and type of data. The projects we consider have been approved in the late 80's and have then been implemented in recent years or still are in their implementation phase. For the World Bank there are also data covering approval years since 1974 and we shall mention some of these longer term evidence.
Geographical coverage is the following: Objective 1 Regions of the European Union (particularly the whole of Greece, Portugal, Ireland, most of Spain, the Italian Mezzogiorno, the new Länder of Germany, overseas territories of France); Centre-Eastern Europe and former Soviet Union Republics for EBRD; a large array of less

developed countries worldwide, particularly in Asia, Latin America and Africa, for the WB.

We consider projects in nine sectors: energy transport and distribution; energy production; roads and highways; railways; ports, airports, other transport infrastructures; water supply (transport and distribution); forests and natural parks; telecommunications; industry and other productive investments.

For each of these sectors we have data for at least two of the three international sources. This sectoral selection criteria implies that we do not analyze data for some sectors that play an important role for one institution, but not so for the others: this is particularly the case of agricolture projects for WB, and for environment protection infrastructures for the EU (sewers and depurators, refuse and waste treatment, etc).
As said, this implies that the data we use cannot be taken as representative of the whole project portfolio of each institution.

Total investment costs for most projects we consider may be in the region of USD 15-50 millions, however there are a number of larger projects, some mega-projects (e.g. more than 100 million USD) and some smaller projects. While we have financial data for individual projects of the EU and the EBRD, and some average data for WB, the inclusion in the research plan data on capital expenditures and of many other potentially interesting variables was not attempted at this stage.

TAB. 1 Sample composition EU, EBRD, WB. Number of projects

SECTORS	*EU* (1)		*EBRD* (2)		*WB*			*TOTAL*	
	FRR	*ERR*	*FRR*	*ERR*	*ERR, RERR* (a)	*ERR, RERR* (b)	*ERR, RERR* (c)	*FRR* (3)	*ERR* (4)
Energy transport and distribution	4	3	10	11	14	46	126	14	140
Energy production	2	3	19	15	19	65	187	21	205
Roads and highways	12	91	5	15	34	78	337	17	443
Railways and underground	34	47	5	7	3	14	77	39	131
Ports, airports	9	14	6	1	6	27	95	15	110
Water supply, transport and distribution	10	23	13	1	4	28	98	23	122
Telecommunication infrastructures	..	..	29	18	8	22	86	29	104
Industries and other productive investments	64	2	83	40	10	25	104	147	146
Overall sample	135	183	170	108	98	305	1,110	305	1,401

Notes: (1) Approval years 1988-1996
(2) Approval years 1992-1996
(3) EU + EBRD
(4) EU + EBRD + WB(c)
(a) Approval years 1988-1997
(b) Exit year 1990-1997

(c) All evaluated projects 1974-1997.

It is important to underline a crucial institutional difference between EU projects on one side and EBRD or WB ones on the other side: while the former are supported by grants disbursed by a non-financial institution, the latter are loans disbursed by international banks. Moreover both EBRD and WB adopt a rate of return threshold of 10% for project proposals, while this is not the case for EU. However, the three institutions are all international bodies backed by governments, and are involved in and commmitted to development policies. They use cost-benefit analysis as an aid for project decision-making in this framework. Thus in spite of important differences a comparison seems interesting (but one has to be very careful in the interpretation of the actual data)[5].

4. Financial rates of return.

A financial rate of return is the rate that determines a zero net present value of project cash flows, evaluated at observed prices. There may be differences in practice on how to calculate it (e.g. concerning the project time horizon and its residual value, taxation, inflation), but the technique is a fairly standard one, and we have found no evidence of systematic differences in financial analysis methods between the sources of our data.
Tab. A.1 in the Statistical Appendix presents FRR data respectively for EU and EBRD: sectoral and total averages, variances, standard deviations, confidence intervals at the 5% level, coefficients of variation. See Fig.2 for a simple comparison of data from the two sources.

A first remark concerns the striking differences in the total sample average FRR: EBRD expected average return is two times EU (around 23% against 12.13%). There may be three factors that account for most of this wide gap:

a) EBRD uses a 10% cut off rate, i.e. does not consider project whose ex-ante rate of return is less than this threshold, while the EU does not have any fixed threshold. As mentioned, EBRD disburses loans, and a relatively high ex-ante cut-off rate (the same used by the World Bank) may be a way to insure from the risk of default. The EU offers grants, and does not face the same kind of risk.

b) EBRD portfolio is influenced by a high number of telecommunications and energy projects, many of them being improvements of existing networks, with a high rate of return.

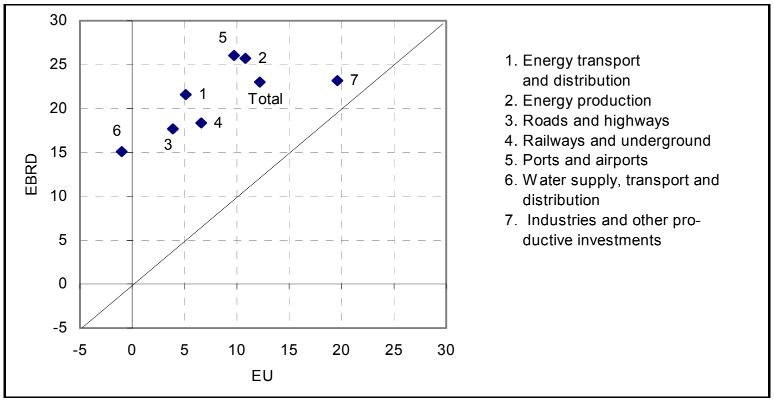
c) there may exist structural differences in the tariff policies in Centre-Eastern Europe and in Western Europe: EBRD may expect a substantial rise in tariffs for services such as transport and water, while this is not the case for EU member states. This may explain the wide difference of ex ante ERR also in these sectors.

[5] The differences across institutions may be particularly relevant for the FRRs. For example, the EBRD must get a commercial rate of return on projects, while obviously this is not the case for the EU. Mandate, terms and conditions of finance, the role of rates of return may widely differ across institutions. For example the EBRD might sacrifice ERR in the traditional sense, for a project with a high "transitional impact". The World Bank, as well, has developed a larger set of indicators and ERR is far from being the sole decision criterion. This point is further discussed in the Conclusions.

Further analysis is needed to disentangle these possible explanations.

However there are also similarities in relative sectoral expected performances, as Fig.2 shows: e.g. water and roads are expected to have relatively low performance as compared with energy production or airports.

Fig.2 EBRD and EU. Financial rates of return.



We shall discuss in greater detail sectoral aspects below. Now we wish simply to check whether we can consider the two samples as revealing a structural difference. This can be done first by testing the sectoral and overall sample variances; table 2 presents the results of this test. We tested the homogeneity of the variances of the EU and EBRD total samples and of the single sectors of the two institutions.
We test two alternative hypotheses:
$H_0 : \sigma^2_1 = \sigma^2_2$
$H_1 : \sigma^2_1 \neq \sigma^2_2$
We use F-statistics at 5% level to check for homoschedasticity (Tab. 2) and to use this information in the comparison of sample averages. We use the following formula:

[1] $$\text{TEST } F_{(n_1-1,\, n_2-2)} = \frac{S_1^2}{S_2^2}$$

where S^2_1 and S^2_2 are the variance estimates, $S^2_1 > S^2_2$, and n_1 is the number of observations of the sample with the greater variance.
Under null hypothesis this statistic has distribution F with n_1-1 and n_2-1 degree of freedom. Thus if calculated F is more than a value F_α we reject the null hypotheses, i.e. there are significant differences between the variances.

TAB.2 Test for variance of FRR - EU and EBRD

Sectors	*F*	*Degrees of freedom*		*F(α)*	*Test results*
		n_1-1	*n_2-1*	*α=0.05*	
Energy transport and distribution	1.8	9	3	8.8	ACC. H_0
Energy production	∞	18	1	247.0	REJ. H_0
Roads and highways	1.3	4	11	3.4	ACC. H_0
Railways and underground	3.6	4	33	2.7	REJ. H_0
Ports, airports	1.6	5	8	3.7	ACC. H_0

Water supply, transport and distribution	2.1	9	12	2.8	ACC. H_0
Industries and other productive investments	2.9	63	82	1.5	REJ. H_0
Overall sample	1.4	134	140	~1	REJ. H_0

Notes: if we choose to set α=0.01, H_0 is accepted also for sector 4 (Railways and underground).

Results of the test for variance may be used to check the existence of significant differences between sample averages. We test the two hypotheses:

$H_0 : \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

with the statistic $\overline{X}_1 - \overline{X}_2$, where $\overline{X}_i$ is the sample average.

For groups that are homoschedastic, we can estimate σ^2 by S^2_p where S^2_p is the weighted average of the estimates S^2_1 and S^2_2:

[2]
$$S_p^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

Thus we can use as statistic test the variable:

[3]
$$t = \frac{\overline{X}_1 - \overline{X}_2}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

that has distribution t of Student with n_1+n_2-2.

If the t-value calculated for the groups is greater than $t_{\alpha/2}$, we reject the null hypothesis.

For comparison between groups that are heteroschedastic we can not use the same statistic because we don't know anything about the sample variances. In this case we can approximate the statistic t with the variable:

[4]
$$f = \frac{\left(\frac{S_1^2}{n_1}\right)t_1 + \left(\frac{S_2^2}{n_2}\right)t_2}{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}$$

where t_i (i=1,2) is the value $t_{\alpha/2}$ of the distribution t (n_i-1). (Cochran e Cox, 1957).

Results of the sample average test are reported in Tab.3.

TAB.3 Test for averages of FRR: EU and EBRD.

Sectors	*t*	*Df:* n_1+n_2-2	$t(\alpha/2)$ $\alpha=0.05$	*Test results*
Energy transport and distribution	3.55	12	2.18	REJ. H_0
Energy production*	*2.10*	*19*	*2.09*	REJ. H_0
Roads and highways	8.51	15	2.13	REJ. H_0
Railways and underground *	*2.75*	*37*	*2.03*	REJ. H_0
Ports, airports	6.60	13	2.16	REJ. H_0
Water supply, transport and distribution	5.65	21	2.08	REJ. H_0
Industries and other productive investments*	*2.00*	*145*	*1.97*	REJ. H_0
Overall sample*	*1.977*	*274*	*1.967*	1)

Notes: if we choose to set α=0.01, H_0 is accepted for sector 6 (Water supply, transport and distribution).
these sectors are heteroschedastic
1) H_0 should be rejected: calculated t is approximatively equal to $t_{\alpha/2}$

There is a clear confirm that the two overall FRR sample averages and all of the sectoral FRR average show a statistically significant difference. For example, the difference between the higher average financial rate of return of the 83 EBRD industry projects (23.16%) as compared with the 63 EU projects (19.59%), while relatively small, is likely to reflect true differences in the two project populations.

Because these are *ex-ante* rates of return, there are two possible (not mutually exclusive) interpretations:

a) different systematic forecasting errors, with an optimistic bias higher at EBRD than at EU;

b) true differences in project profitability, either depending upon the general conditions of the countries that are the targets of investments; or depending upon differences in the average quality of the proposals submitted to and approved by the two institutions.

This question may be ascertained by the collection of ex-post FRRs, not yet available for the two institutions. However data analysis and comparisons offer a first signal for the project monitoring process, because they reveal a significant difference that needs a structural explanation. For example EBRD should ask itself wich are the factors that determine high expectations, while the EU has to ask itself how it can justify relatively low expectations on financial returns in its less developed regions.

5. Economic rates of return

There are no major differences in the definition of the economic rate of returns among most international organizations and national agencies.[6] However, this wide consensus on the ERR concept may conceal differences in practice. A key issue in the definition is: how to compute taxes, duties, shadow prices and externalities. Different organizations and individual appraisers may follow different rules and shortcuts, and obviously different circumstances may imply a different role for the corrections of observed prices[7]. Thus we have additional sources of variability, that should be added to the variability of FRRs.

Tables A.2 in the Statistical Appendix and Tab.4 present ERR data for respectively the EU, EBRD and the World Bank. For the latter, we present as said above three different samples: the first and smallest one refers to projects approved (and completed) by the World Bank since 1988 up to 1997, i.e. in the same time span (appromatively) than the other two sources (see the Appendix). It is important to underline that projects considered in the WB sample are those included in the OED database and for which both ERR and RERR exists. Projects approved, but not completed or not re-evaluated,

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[6] The EC Guide (1997) has the following definition: "Internal rate of return: the discount rate at which a stream of costs and benefits has a net present value of zero" (p. 20) and suggests that "After corrections for price distortion and externalities, one has to calculate the economic rate of return" (p. 30).
The World Bank in a number of publications cited in the bibliography, the European Investment Bank (Sarbeck 1990), the British Overseas Development Agency (1988), the OECD (Pearce et al 1994), and many national and international other institutions give the same definition.
[7] For example, some projects have been evaluated taking the monetary variables at costant dollars, some at current dollars and others in national currency.

are then excluded. This contrasts with the other two sources where just approval date were considered.

Because of their intrinsic interest, we report data also from two larger samples: all projects completed in fiscal years 1990-97 and finally all projects recorded in the OED database for which both ERR and RERR exist. Tab. 4 shows that the average values of the ERRs across the three sources differ streakingly, both as for the overall samples and for most sectors. Again, considering the sample averages, EBRD rates are two times higher than those of EU projects, as with FRR, and the World Bank projects lie often in between.

TAB.4 Comparison between ERRs average values.

SECTORS	*EBDR*	*WB*[1]	*EU*
Energy transport and distribution	35.73	22.94	14.19
Energy production	44.48	14.69	11.70
Roads and highways	23.51	33.34	18.63
Railways and underground	21.43	25.97	16.68
Ports, airports	…	23.15	17.43
Water supply, transport and distribution	25.90	10.68	18.92
Telecommunication infrastructures	38.56	24.11	...
Industries and other productive investments	28.28	26.71	(19.59)[2]
Overall sample	31.82	25.03	17.19

Notes: 1 projects for fiscal year 88
2 For EU industries sample we use FRR instead of ERR because we have the economic rate of return only for two projects.

However, because of the high variance of the samples and because some sample partitions are very small, we wish to test how confident we can be that the average differences reflect population differences.
We think to ex ante ERRs as observations lumped in three samples extracted from the same world projects population[8], while we consider sectors as a 9-level factor.
Then we study variability between the samples and within samples in the following way: the total deviation can be considered as the sum of the deviation between the groups (SS_B) and the deviation within groups (SS_W).

[5] $$SS_T = SS_B + SS_W$$

The ratio of variance between and within groups has distribution F with r-1 and N-r degrees of freedom[9]. We use this statistics to check the null hypothesis (Tab.5):
$H_0 \ \mu_1 = \mu_2 = ... = \mu_r$
against the alternative H_1: $\mu_i \neq \mu_j$ for at least one pair of value. With the null hypothesis we postulate the null effect of the level factor on the variable.

[8] In fact the three institutions do not extract random samples from the world project population. However we use this as a working hypothesis. When we discover significant variations across the samples, we can infer that project populations differ and we can try to understand wich are the causes.
[9] r is the number of factors and N is the total of observations.

The results we get are shown in Table 6 and allow us to reject H_0 for the case where level factors are both the institutions and the sectors.

TAB.5 Analysis of variance and components of variance

Variability sources	*Sum of squares*	*Degrees of freedom*	*Mean squares*	*F*
Between groups	SS_B	r-1	$SS_B/(r-1)$	$\frac{SS_B(r-1)^{-1}}{SS_W(N-r)^{-1}}$
Within groups	SS_W	N-r	$SS_W/(N-r)$	
Total	SS_T	N-1		

TAB 6 Variance analysis.

	Df	*Variance*	*F*	*F(2,22)* $\alpha = 0.05$	*Test result*
Factor is sector[1)]					
Between groups	2	396.26	9.06	3.52	REJ. H_0
Within the groups	19	43.73			
Factor is institution[2)]					
Between groups	7	1425.57	14.44	2.76	REJ. H_0
Within the groups	14	98.73			

Note: 1) the institutions are the samples of a population and the sectors are the levels of a factor
2) sectors are the sample of a population and institution are a factor with three level

Moreover, we decompose this general result in three comparisons of pairs of sample averages: EU-EBRD, EBRD-WB, EU-WB with the same technique used for FRR. Results are shown in Tables A1-7.

The comparison between Tab.3 and Tab.8 for EU and EBRD projects shows that while H_0 is generally rejected for FRR, it is often accepted for ERR[10].
These results can be easily explained when we look at the structure of *t* or *F* test.
For the following sectors that are homoschedastic for both FRRs and ERRs we use the t test [3]. They are:

- Energy transport and distribution
- Roads and highways
- Ports and airports
- Water supply, transport and distribution.

For these sectors while the FRRs sample averages widely differ between EBRD and EU, the weighted sum of sample variances is sufficiently small to allow us to reject H_0.

[10] Detailed informations on the sample data are in the tables A.1 e A.2. However for tables 3 and 8 we have excluded some sectors that does not have a counterpart in the comparison between institutions. The recalculated overall sample averages ($\bar{x}$) and standard deviation (s) are:

	Institution	$\bar{x}$	s
FRR	EBRD	23.14	10.80
	EU	12.18	12.90
ERR	EBRD	32.10	17.81
	EU	17.18	11.72

But for ERRs, while differences in the averages are still big, variances are much bigger than for FRRs, and we cannot reject H_0.[11]

This, we think, is an important result never observed before in project analysis literature. We suggest the following interpretation: additional variability of economic rates of return as compared with financial rates of returns may be explained by cost-benefit analysis. In fact, while for financial analysis the techniques and hypothesis are fairly standard across sectors, institutions, individual evaluators, cost-benefit analysis in practice, is more heterogenous or *ad hoc*. We cannot further test this but our own reading of many published WB reports and of hundreds of unpublished EU and EBRD projects reports, may confirm our interpretation[12].

TAB.7 Test for averages of ERR

Sectors	*t*	*Df: n_1+n_2-2*	*$t(\alpha/2)$ $\alpha=0.05$*	*Test results*
EU and EBRD				
Energy transport and distribution	2.65	12	2.18	REJ. H_0
Energy production	2.08	16	2.12	ACC. H_0
Roads and highways	1.37	104	1.99	ACC. H_0
Railways and underground	1.02	52	2.01	ACC. H_0
Industries and other productive investments	1.16	42	2.02	ACC. H_0
Overall sample*	1.967	290	1.968	1)
EBRD and WB2)				
Energy transport and distribution	2.51	23	2.07	REJ. H_0
Energy production*	2.14	32	1.98	REJ. H_0
Roads and highways	-2.39	47	2.01	REJ. H_0
Railways and underground	-0.68	8	2.31	ACC. H_0
Telecommunication infrastructures*	2.18	24	2.06	REJ. H_0
Industries and other productive investments	0.30	50	2.01	ACC. H_0
Overall sample*	1.978	205	1.97	1)
EU and WB2)				
Energy transport and distribution	-1.14	15	2.13	ACC. H_0
Energy production	-1.03	20	2.09	ACC. H_0
Roads and highways	-5.39	123	1.98	REJ. H_0
Railways and underground	-1.32	48	2.01	ACC. H_0
Ports, airports*	2.27	18	2.10	REJ. H_0
Water supply, transport and distribution*	2.28	25	2.06	REJ. H_0
Industries and other productive investments	-1.45	10	2.23	ACC. H_0
Overall sample	-4.54	279	1.97	REJ. H_0

Notes: see Tab.4

1) H_0 should be rejected, but we do not thrust this result, because calculated t is approximatively equal to $t_{\alpha/2}$

[11] For the overall sample and for heteroschedastic sectors the results are less clear cut, however it is still true that we observe greater variance with the ERRs than with the FRRs

[12] For example we have found that for the same country and sector, different shadow wages or other shadow prices are often used in different projects without a clear structural reason for such differences. Further research is needed on this point. It may include a comparison of the cost-benefit analysis handbooks internally used by each institution, and the study of a sample of projects in order to see how in practice appraisal guidelines were interpreted by project examiners. We feel that the latter process is a main source of inconsistency, rather than fundamental differences in CBA methods.

2) Projects approved in fiscal years 1988-97
* these sectors are heteroschedastic.

5. The wedge between FRR and ERR.

We wish now to compare financial and economic rates of return. This is possible only for EU and EBRD, because the World Bank, while calculates FRR for each and every project, apparently does not record it for further analysis by OED.

As mentioned above, conceptually the difference between FRR and ERR is that the former is an internal rate of return based on observed prices and tariffs, without any attempt to consider the opportunity costs of inputs and outputs and to include positive or negative externalities arising from the project. In contrast, ERR should be calculated using, whenever this is relevant, a shadow price reflecting opportunity costs of resources used by the project or created by it as a result of purchases and sales. Moreover the economic analysis of project should include any increases or decreases of quantities of goods in the economy for third parties if generated by the project and not accounted for by market transactions or any other form of monetary compensation.

Thus, any difference between FRR and ERR must be always seen as the result of using a different set of prices when considering the variations in quantities of projects inputs and outputs. Typical examples of corrections of observed prices are shadow prices for labour under a régime of unemployement, corrections for custom duties and other indirect taxes, correction for public tariffs or monopoly prices, etc. Corrections for externalities can be considered as way to give an accounting price to goods otherwise priced zero in financial analysis.

As a consequence we can say that price distortions (including taxes on goods and factors of production) and externalities create a wedge between observed and economic values (price times quantities) and that this wedge is measured by the difference between FRR and ERR.[13]

We report in Tab. 9 a standardized measure of the wedge (ERR-FRR)/FRR for EU and EBRD. For two sectors (roads and highways, railways and underground) we can compare directly EU and EBRD wedges: the difference is very wide.
Tipically the shadow price of time savings in transport projects is estimated by income of users. This is obviously higher in Western Europe than in the Central and Eastern Europe or in the CIS Region and this may explain a larger wedge in Western Europe, where tariffs are generally low. Moreover EBRD transport projects show rather surprisingly high financial rates of return, perhaps because of high expectations of real tariff increase. In the EBRD sample the least wedge is with industry projects and this seems to be quite reasonable because of EBRD mandate(more on this below).

Tab 8 Comparison between FRR and ERR: EBRD

Sectors	*Project n°*	*FRR*	*ERR*	*(ERR-FRR)/FRR*

[13] Again, the observed ex-ante or ex-post wedge is subject to measurement errors, depending upon the errors of FRR and ERR (particularly in the latter case systematic errors related to the kind of shortcuts or conventions used by the appraisers).

EBRD				
Energy transport and distribution	8	18.50	31.00	0.68
Energy production	15	28.13	44.38	0.58
Roads and highways	5	17.68	27.82	0.57
Railways and underground	5	18.36	22.60	0.23
Water supply, transport and distribution	1	15.00	25.90	0.73
Telecommunication infrastructures	17	23.87	39.65	0.66
Industrial estates and technological parks	2	14.00	20.00	0.43
Industries and other productive investments	39	25.11	29.07	0.16
Overall sample	93	23.61	33.76	0.43
EU				
Roads and highways	11	3.9	18.4	3.69
Railways and underground	31	6.6	14.4	1.19
Ports, airports	9	9.7	18.2	0.87
Overall sample	51	6.5	15.9	1.43

Note: we take only the sector with a significant number of observations.
sector 2 of EU has only one observation and FRR and ERR have the same value

To back our statement we report in the table 10, the results of a statistical test on the average difference between FRR and ERR, where we wish to check for the two hypothesis

$H_0 : \mu_1 = \mu_2$ or $\mu_1 - \mu_2 = 0$

$H_1 : \mu_1 \neq \mu_2$

where μ_1 is the average of FRR and μ_2 the average of ERR.

The two samples have the same numerousness *n*, so under the assumption that the differences between the average of FRR and the average of ERR are normally distributed and are indipendent of each other we can use a paired *t*-test.

We can calculate the value of the following statistics:

[6] $$t_{(n-1)} = \frac{\left[\sum\left(\overline{X}_1 - \overline{X}_2\right)\right]/n}{\sqrt{\dfrac{\sum\left(\overline{X}_1 - \overline{X}_2\right)^2 - \sum\left(\overline{X}_1 - \overline{X}_2\right)/n}{n-1}}}\sqrt{n}$$

Under the null hypothesis *t* is distributed as Student's *t* with n-1 degrees of freedom. H_0 is rejected for both EU and EBRD.

Tab.9 Comparison between ERR and FRR.

	EU			***EBRD***		
Sectors	*Project n°*	*FRR*	*ERR*	*Project n°*	*FRR*	*ERR*
Energy transport and distribution				8	18.5	31.0
Energy production				15	28.1	44.4

Roads and highways	11	3.9	18.4			
Railways and underground	31	6.6	14.4			
Ports, airports	9	9.7	18.2			
Telecommunications infrastructures				17	23.9	39.7
Industries and other productive investments				39	25.1	29.1
Average difference (FRR-ERR) Standard deviation t $t_{(n-1, \alpha = 0.05)}$	-10.26 3.70 -4.805 ± 4.303			-12.12 5.69 -4.26 ± 3.182		
Test result	Rej. H_0			Rej. H_0		

This result reveals that structural differences in projects populations, significant for FRRs, less significant for ERRs, generate a significant difference in the wedge between observed and shadow prices.

6. Comparing ERR and RERR data.

Re-estimated economic rates of return are available for WB only. They are based on a new appraisal of the project at the time of its completion. In this sense they update cost and benefit estimates some years after the approval of the project, but cannot be considered always true ex-post data: these could be collected only some years after the project operations started. The European Commission is now considering to start this exercise for some of major projects, but data are not yet available. EBRD perhaps will start a similar exercise in future.

In spite of these limitations, the comparison of World Bank ERR-RERR data may be of general interest, and it has still been the object of some study (Pohl G., Mihaljek D, 1992). EU and EBRD (or other development agencies) may learn from World Bank experience in this area.

Tab. 9 shows ERR and RERR for our samples. The difference between the two can be considered sector by sector and standardized as we did with the difference between ERR and FRR. Here we take (RERR-ERR)/ERR and we consider its width as a relative measure of the initial forecasting error by the project appraisers (Tab. 10).

TAB. 10 Comparison between ERR and RERR. (WBs sample)

Sectors	*(RERR-ERR)/ERR*		
	Approval fiscal year 1988-97	*Fiscal year 90-97 exit year*	*Evaluated 1974 to present*
Energy transport and distribution	0.11	-0.05	-0.20
Energy production	-0.19	-0.02	-0.13
Roads and highways	0.01	-0.07	-0.06
Railways and underground	-0.24	-0.35	-0.30
Ports, airports	0.32	-0.06	-0.13
Water supply, transport and distribution	-0.39	-0.33	-0.38
Telecommunication infrastructures	-0.18	-0.13	-0.05
Industries and other productive investments	-0.34	-0.35	-0.41

Overall sample	-0.04	-0.10	-0.14

In the following table 11, we report the results of a statistical tests on the average differences.

The test shows that for the sample of projects approved 1988-1997 there are no statistically significant differences between ERRs ex-ante and ex-post, while for the other groups of project we reject the null hypothesis[14].

TAB. 11 WB. ERR ex-ante and ex-post.

	Approval fiscal year 1988-97	*Fiscal year 90-97 exit year*	*Evaluated 1974 to present*
Average difference	2.02	3.88	4.05
Standard deviation of difference	5.28	3.48	2.73
t	1.079	3.154	4.192
$t_{(7, \alpha = 0.05)}$	±2.365	± 2.365	± 2.365
Test result	Acc. H_0	Rej. H_0	Rej. H_0

However this result conceals wide intersectoral differences. Interestingly three sectors show systematically high forecasting errors: railways, water and industry. This result signals the need to study sector specific sources of forecasting errors. Data analysis may drive this to further research work.

7. Intersectoral comparisons

In order to see some implications of the above analysis at sectoral level we need to standardize some of the relevant data for the three sources. We avoid using sample averages to do this, because these are driven by two factors: first, as said above, EU does not use a cut-off rate, while EBRD and WB use both a 10% rate for ERR and FRR; second, the sectoral composition of the two samples is quite different.

Thus we prefer to standardize data using the average returns of "industry projects" as benchmark. The reasons to do this are the following ones: it is likely that projects in this sector are more market oriented and then their forecasts are less depending upon special hyptheses on demand and prices; samples for industry are relatively large for all the three sources (however in relative terms, they are small for WB); in fact the distance between the averages of FRR and ERR for the three source is limited. For EU we use as a benchmark FRR instead of ERR because these were not calculated for most industry projects.

Results are shown in Table 12, 13 and briefly discussed below.

TAB. 12 Comparisons of standardized FRRs and ERRs

	$FRR_{sector\ i}/FRR_{sector\ 9}$		*$ERR_{sector\ i}/ERR_{sector\ 9}$9*		
Sectors	*EBDR*	*EU*	*EBRD*	*EU*[1]	*WB*[2]

[14] This is a rather interesting result that may need some interpretation. The 1988-97 sample is more recent and smaller than the other ones. Is there a trend towards better predictability of project returns, e.g. because of greater macroeconomic stability? A larger sample may be necessary to discuss the conjecture.

Energy transport and distribution	0.93	0.26	1.25	0.72	0.86
Energy production	1.11	0.55	1.55	0.60	0.55
Roads and highways	0.76	0.20	0.82	0.95	1.25
Railways and underground	0.79	0.33	0.75	0.85	0.97
Ports, airports	1.12	0.50	3.49	0.89	0.87
Water supply, transport and distribution	0.65	-0.05	0.90	0.97	0.40
Telecommunication infrastructures	1.18	..	1.34	..	0.90
Industries and other productive investments	1.00	1.00	1.00	1.00	1.00

Notes: 1 For EU we used as a benchmark FRR instead ERR of industry (see in the text).
2 projects for fiscal year 88

TAB. 13 WB. $RERR_{sector\ i}$ / $RERR_{sector\ 9}$

Sectors	*Approval fiscal year 1988-97*	*Fiscal year 90-97 exit year*	*Evaluated 1974 to present*
Energy transport and distribution	1.44	1.22	1.23
Energy production	0.68	0.87	0.94
Roads and highways	1.92	1.96	1.93
Railways and underground	1.12	0.96	1.07
Ports, airports	1.74	1.37	1.53
Water supply, transport and distribution	0.37	0.49	0.54
Telecommunication infrastructures	1.12	1.25	1.43
Industries and other productive investments	1.00	1.00	1.00

Notes: Industries and other productive investments captures less than 10% of the WB sample

First, as for the financial rates of return, available for EBRD and EU, they respectively broadly cover projects in Eastern Europe and regions lagging behind in Western Europe. When we use Industry as a benchmark, there is a striking confirm that the expected returns of infrastructure projects in Eastern Europe are much higher than in Objective 1 regions in the EU.

The sector for both institutions showing the least standardized returns is Water (2/3 of the benchmark for EBRD and no return at all, or slightly negative for EU). The difference between projects sponsored by the two institutions, may pick up totally different trends in expected tariffs (an expectation that may be interesting to study per se), but the similar position in the ranking of the FRRs may show the persistent difficulty of Water industry projects to have returns similar to those of other sectors. The wedge between financial and economic rates of return almost disappears for both the EU and EBRD in Water projects, thus confirming that the key issue underlying the results are low tariffs: when shadow tariffs of a sort are used in economic analysis, water projects have returns close to those of Industry. But surprisingly, the World Bank Water projects still show very low standardized economic returns, by far the minimum across sectors. Only the detailed study of a sample of World Bank Water projects may explain why.[15]

Sectors closest to the financial benchmark for EU and EBRD are Energy production, Energy distribution, and Ports and Airports. In fact the returns for EBRD projects even exceed those of Industry (perhaps because some of the projects are of incremental

[15] An example of calculation from one study is as follow: the water project expects to earn an ERR slightly beyond the 10% threshold after estimating the willingness to pay as a shadow tariff: but willingness to pay may fail to capture large externalities of Water projects in less developing countries. Perhaps water project analysis needs a methodological re-consideration.

nature and capture large benefits with limited costs). When available, Telecommunication data also show high returns. However, when considering ERRs, again the World Bank sample shows lower returns. A cursory reading of some project reports reinforces the view that it would be useful for the WB to publish separate data on FRRs and ERRs, and to achieve greater standardization in the calculation of shadow prices for Energy.

Quite interesting are also comparisons of returns for Roads and for Railways. Financial returns are relatively low, both for EBRD and EU projects, as compared with Industry projects. However the wedge between ERR and FRR is very wide for EU, and very modest for EBRD. Again this may reflect different expectations of tariff increase. ERRs for World Bank projects are high, both as compared with the benchmark and with the other two institutions[16].
Tab. 14 shows sector rankings: it confirms that FRRs for EU and EBRD, while so different in absolute levels are consistent; however when we look at ERRs, ordering consistency between the two European institutions is destroyed. When we consider also the World Bank, EU data are closer to the WB data than EBRD. We interpret this as a further indication of higher inconsistency in cost-benefit analysis than in financial analysis.

TAB. 14 Sector rankings

Sector	*FRR*		*ERR*		
	EBRD	*EU*	*EBRD*	*EU*	*WB*
Energy transport and distribution	4	5	2	6	5
Energy production	2	2	1	7	6
Roads and highways	6	6	5	3	1
Railways and underground	5	4	6	5	3
Ports, airports	1	3	n.a.	4	4
Water supply, transport and distribution	7	7	4	2	7
Industries and other productive investments	3	1	3	1	2

n.a.: not available

Many of the above mentioned comparisons may be more interesting when discussed using ex post returns as well. As said unfortunately these are available for the WB only, and just for the ERRs. We discussed these data already in section 5 where we observed that apparently the forecasting error diminished for more recent years. When we look at sectors, the highest error is with Industry, the least with Roads. We suspect that the latter is influenced by the fact that ex-post actual demand is not recorded, while actual revenues for other sectors, particularly of Industry or Railways are easier to observe. However the distribution of forecasting error across sector shows in general large differences that may need specific inquiry.

Finally, when we look at ex-post returns against the Industry ERR benchmark, a clear and consistent ranking across sectors appears over time: the most socially profitable projects in the WB portfolio are Roads and Highways (two times the return of Industry), Ports and Airports, Energy distribution and Telecommunication infrastructures: all these sectors show higher returns than Industy projects. Railways

[16] The methodology is a rather standard one, and very similar to that in use in the two European institutions. However it seems that WB results are strongly influenced by shadow wages, quite low in countries with high unemployement.

show returns close to those of Industry, Energy Production shows returns decreasing over time, while Water confirms to be, it seems, a low return sector. Again, we suspect that these results, that as far as we know are new, signal that either the portfolio is sub-optimal in terms of the maximum rate of return, or - and more probably - that ERR calculation fails in some cases to capture important externalities, or is based on ad hoc sectoral assumptions. This point is further discussed below.

8. Summary of results, concluding remarks and implications for project analysis

This paper has explored a simple approach to using rates of return as the starting point for the formulation of important questions concerning the appraisal and planning of development projects. We have suggested some testable propositions in the standard cost-benefit analysis framework arising when one consider a large project portfolio, in contrast to the consideration of individual project returns as uncomparable performance measures.

We have suggested the following step-by-step procedure.

a) We have proposed to start from project returns in financial analysis and then to move to economic returns.

b)We need to know whether there are sectors for which ERRs are systematically (across periods of time, countries, sources) higher or lower than a benchmark level. We propose to use Industry as this benchmark.

c) When we discover that for example, Water and sanitation projects ERRs show sistematically relative low returns as compared with Industry there are just two possible explanations (not mutually exclusive): either social benefits of these projects are truly low relative to those of, e.g., Industry, or the method of analysis of their benefits fails to capture external benefits that accrue to society.

d) Should we find that the latter is true, we should - if possible - revise the method of analysis (for example, with a shadow price for the health impact of clean water: something that is no more difficult to guess than the money value of accidents avoided in highways projects). The most effective way to explore this issue would be to extract samples of project reports by sectors and compare how crucial variables were included in the calculation of FRR and particularly of ERR. Examples of these variables are the shadow price of labour, the value of time, willingness to pay for outputs, the treatment of taxation, etc. In our opinion, procedural consistency is here more important than a perhaps impossible exactitude.

We think the heuristic approach we have outlined could be of some importance for institutions committed to development that need to appraise and implement a wide range of projects, from telecommunications to sewers, or from oil extraction to hospitals.

For the particular set of the data we studied, our main findings are the following ones:

a) EBRD sponsored projects have an expected financial rate of return two times the EU projects co-financed by Structural Funds: this is not surprising because EBRD accepts projects that have a FRR in excess of 10% and disburses loans, while the EU has no threshold and delivers capital grants.

b) the difference between the two samples was tested, and found statistically significant both for the overall portofolio and for each of 7 comparable sectoral partitions

c) less obviously, ex-ante economic rates rates of return of EBRD projects are much higher than for EU projects, while those of World Bank projects lie often (i.e. for most sectors and for the overall sample) in between those of the other institutions

d) while the absolute difference between the ERRs of EU and EBRD is as large as the difference between the FRRs, it is impossible to reject the hypothesis that the true difference is zero for 4 out of 5 comparable sectors: basically cost-benefit analysis introduces additional variability in the data, as compared with financial analysis. The comparison of EU and EBRD data on economic rates of return respectively with the World Bank sample shows that the *null* hypothesis (no average difference) is rejected for 7 sectors and accepted for 6 sectors.

e) after standardization by using Industry sector as a benchmark, we observe that for EBRD and EU the wedge between financial and economic return is wide: 43% for the EBRD and 167% for the EU. For both institutions the difference is statistically significant. We suspect that a wider difference in the EU projects is explained by two factors: a wide gap between actual and shadow tariffs; and a high opportunity cost of time savings in transport projects.

f) the difference between ex-ante ex-post rate of return can be tested for the World Bank only. We tested three samples: for the larger one starting from year 1974 the forecasting error is 14%. For more recent project vintages the error is smaller and statistically not significant. However forecasts are consistently less accurate for some sectors: railways, water, industry.

g) in order to study variations of project returns across sectors we used, as said, Industry as a benchmark. We find that ranking across is sector is preserved in the comparison between financial returns of EU and EBRD projects: rail, water and roads show low returns relative to industry.

h) however when we turn to economic rate of return the pattern is not preserved: rankings of EU and EBRD sectors are quite different. When compared with World Bank data we find greater similarity between EU and World Bank sectoral returns, than between the latter and EBRD. This confirms the overall impression that EBRD projects expected economic returns are not just very high, but also they tell a rather peculiar story.

Obviously these results depend upon the particular data sets we have considered and do not imply any general proposition on the overall projects-portfolio or the international institutions. Some of these results are interesting and new, but our main objective was to show that with limited cumulative information on just four rates of return on project samples it is possible to focus on important policy issues. Let us turn to these more general implications.

First, financial rates of returns should always be the starting point for project analysis: these were available for EU and EBRD samples, but not for WB. Using industry FRRs as a benchmark, it was easy to discover that EBRD has in all other sectors much higher expectations than EU. Is this justified by the nature of the projects or by differences in appraisal optimism? The second question would be answered by the regular collection of ex-post FRRs, something that we would strongly suggest. The first question may imply a more detailed analysis of individual projects. In any case, differences between expectations in Western Europe and Eastern Europe seem to be very large indeed. It would be extremely useful for the World Bank to build a FRR database as well, in order to see how their data compare with European development projects.

Second, we have seen some similarities and differences between ex-ante economic rates of return between EBRD, WB, and EU. While it is difficult to compare directly ERRs across sectors (and across different institutions), it is again possible to standardize data using as a benchmark those sectors were price distortions are least and were there is more factor mobility: this may be the case of industry. Ranking average ERRs ratios relatively to ERR of industry projects gives an indication of which infrastructure or other sectors appear to signal statistically significant relative high or low returns. This information cannot be used at its face-value. Either these variations reflect true differences in social returns, or they reflect methodological bias (or both). This should then be the starting point for a review process and for further analysis.
We have found that while we can reject the hypothesis that average financial rate of returns differences across institution are zero, this hypothesis is accepted for economic rates of return, despite widely different average values. This suggests that inconsistent cost-benefit analysis may introduce additional variability in the ERRs samples and calls for a review of CBA use within each institution.

Third, the intersectoral wedge between financial and economic rates of return may be an useful indicator of the width of the correction that cost-benefit analysis introduces on observed prices: FRR data should be calculated and compared with ERR for samples comprising the same projects. This will give project appraisers and evaluators a clearer picture of both price distortions and of methods to deal with them in project analysis. These data are available for EBRD and for a limited number of EU projects and reveal interesting differences across sectors and across the two sources. For example, the average correction for EU roads and railways is a multiple of EBRD corresponding data, and this is surprising because the ERRs of the two samples are not so distant.

Fourth, the average gap between ex ante and ex post rates of return (possibly both for FRRs and ERRs) points to forecasting errors: above average errors across sectors (or countries or institutions) may suggest a revision of appraisal methods. While we do not have any information on ex-post financial rates of return, the OED at the World Bank collects regularly information on RERRs, and analyse them in different ways. We have reported their results and tested them. The average difference between ERR and RERR in more recent years is diminishing, so much that in the most recent (and smallest) sample there is virtually no statistical difference between the two values. However, the sectoral pattern shows striking variations. In some sectors there is a constant forecasting optimism around 30% or more of the ex-ante ERR (Industry, water, railways), in others forecasting error is apparently more limited (roads). Again, this should be the starting point for further analysis.

Obviously only sector and country specific studies can ascertain the reasons of the problems revealed by the above mentioned sequence of tests, and this is beyond the scope of the present paper. However, the framework we propose shows how to use cumulative information arising from cost-benefit analysis to achieve greater appraisal consistency and improve the composition of the development projects portfolio.

Statistical Appendix

TAB.A1 Test for variance ERR

SECTORS	*F*	*Degree of freedom*		*F(α)*	*Test results*
		n_1-1	*n_2-1*	*α=0.05*	
EBRD and EU					
Energy transport and distribution	1.93	10	2	19.40	ACC. H_0
Energy production	16.72	14	2	19.42	ACC. H_0
Roads and highways	1.86	90	14	2.20	ACC. H_0
Railways and underground	1.90	46	6	3.74	ACC. H_0
Industries and other productive investments	4.64	39	1	251.10	ACC. H_0
Overall sample	2.27	108	182	1.32	REJ. H_0
EBRD and WB[1)]					
Energy transport and distribution	1.10	10	13	2.67	ACC. H_0
Energy production	36.27	14	18	2.29	REJ. H_0
Roads and highways	2.24	33	14	2.29	ACC. H_0
Railways and underground	2.02	2	6	5.14	ACC. H_0
Telecommunication infrastructures	6.57	17	7	3.48	REJ. H_0
Industries and other productive investments	2.18	41	9	2.82	ACC. H_0
Overall sample	2.75	108	97	1.39	REJ. H_0
WB[1)] and EU					
Energy transport and distribution	1.75	13	2	19.42	ACC. H_0
Energy production	2.17	2	18	3.55	ACC. H_0
Roads and highways	1.20	33	90	1.57	ACC. H_0
Railways and underground	1.06	2	46	3.20	ACC. H_0
Ports. Airports	6.46	13	5	4.65	REJ. H_0
Water supply. transport and distribution	25.23	22	3	8.65	REJ. H_0
Industries and other productive investments	2.13	9	1	240.50	ACC. H_0
Overall sample	1.21	182	97	1.35	ACC. H_0

Notes: [1)] projects approved in fiscal year 1988-97.

TAB.A.2 Financial rates of return.

SECTORS	*Project n*	*FRR Average*	*Confidence intervals (a=0.05)*	*FRR Std. Dev.*	*FRR variance*	*Coefficient of variation*	*Sector average / total average*
EU							
Energy transport and distribution	4	5.1	(-4.7, 14.9)	6.2	38.4	0.13	0.4
Energy production	2	10.8	n.c.	0.0	0.0	n.c.	0.9
Roads and highways	12	3.9	(2.0, 5.7)	2.9	8.5	0.46	0.3
Railways and underground	34	6.6	(5.1, 8.0)	4.2	17.5	0.37	0.5
Ports, airports	9	9.7	(6.4, 12.9)	4.2	17.9	0.54	0.8
Water supply, transport and distribution	10	-1.0	(-6.7, 4.7)	8.1	64.9	-0.02	-0.1
Industries and other productive investments	64	19.6	(15.9, 23.2)	14.6	212.1	0.09	1.6
Overall sample	135	12.2	(9.9, 14.4)	12.9	166.2	0.07	1.0
EBRD							
Energy transport and distribution	10	21.61	(15.6, 27.6)	8.34	69.52	0.31	0.94
Energy production	19	25.71	(18.8, 32.6)	14.23	202.49	0.13	1.12
Roads and highways	5	17.68	(13.5, 21.8)	3.35	11.21	1.58	0.77
Railways and underground	5	18.36	(8.5, 28.2)	7.93	62.85	0.29	0.80
Ports, airports	6	26.05	(20.4, 31.6)	5.35	28.58	0.91	1.13
Water supply, transport and distribution	13	15.07	(11.7, 18.4)	5.61	31.49	0.48	0.65
Telecommunication infrastructures	29	27.41	(21.5, 33.3)	15.53	241.04	0.11	1.19
Industries and other productive investments	83	23.16	(21.3, 25.0)	8.52	72.52	0.32	1.01
Overall sample	170	23.04	(21.4, 24.7)	10.79	116.47	0.20	1.00

Notes: Coefficient of variation = $\bar{X}/S^2$; Standard deviation = $\sqrt{\dfrac{n\Sigma X^2 - (\Sigma X)^2}{n(n-1)}}$

TAB.A.3 Economic rates of return.

SECTORS	*Proj. n°*	*ERR Average*	*Confidence intervals (α=0.05)*	*ERR Std. Dev.*	*ERR variance*	*Coefficient of variation*	*Sector average / total average*
EU							
Energy transport and distribution	3	14.19	(1.4, 26.9)	9.36	87.69	0.16	0.85
Energy production	3	11.70	(2.9, 20.5)	6.48	42.00	0.28	0.70
Roads and highways	91	18.63	(16.3, 20.9)	13.23	174.97	0.11	1.11
Railways and underground	47	16.68	(13.7, 19.6)	11.83	139.88	0.12	0.99
Ports, airports	14	17.43	(11.6, 23.3)	12.43	154.56	0.11	1.04
Water supply, transport and distribution	23	18.92	(14.5, 23.3)	12.31	151.43	0.12	1.13
Industries and other productive investments	2	15.17	(0.10, 30.2)	7.30	53.35	0.28	0.90
Overall sample	183	17.19	(15.5, 19.8)	11.73	137.55	0.12	1.00
EBRD							
Energy transport and distribution	11	35.7	(28.7, 42.7)	13.01	169.22	0.21	1.26
Energy production	15	44.4	(32.4, 56.4)	26.50	702.19	0.06	1.57
Roads and highways	15	23.5	(19.1, 27.9)	9.69	93.84	0.25	0.83
Railways and underground	7	21.4	(15.3, 27.6)	8.58	73.62	0.29	0.76
Water supply, transport and distribution	1	25.9	n.c.	n.c.	n.c.	n.c.	0.91
Telecommunication infrastructures	18	38.6	(31.9, 45.3)	16.48	271.46	0.14	1.36
Industries and other productive investments	42	28.3	(23.4, 33.2)	15.74	247.7	0.11	0.89
Overall sample	109	31.8	(28.5, 35.2)	17.68	312.5	0.10	1.00
WB (Approved fiscal year 1988-1997)							
Energy transport and distribution	14	22.94	(17.2, 28.6)	12.39	153.51	0.15	0.92
Energy production	19	14.69	(12.9, 16.4)	4.40	19.36	0.76	0.59
Roads and highways	34	33.34	(29.1, 37.5)	14.51	210.54	0.16	1.33
Railways and underground	3	25.97	(9.4, 42.5)	12.20	148.84	0.17	1.04
Ports, airports	6	23.15	(19.3, 27.1)	4.89	23.91	0.97	0.92
Water supply, transport and distribution	4	10.68	(8, 13.3)	2.45	6.00	1.78	0.43
Telecommunication infrastructures	8	24.11	(19.9, 28.3)	6.43	41.34	0.58	0.96
Industries and other productive investments	10	26.71	(20.6, 32.7)	10.58	111.94	0.24	1.07
Overall sample	98	25.03	(22.9, 27.2)	10.66	113.65	0.22	1.00

TAB.A.4 Economic rates of return - WB

SECTORS	*Proj n°*	*ERR Average*	*Confidence intervals (α=0.05)*	*ERR Std. Dev.*	*ERR variance*	*Coefficient of variation*	*Sector average / total average*
Approved fiscal year 1988-1997							
Energy transport and distribution	14	22.94	(17.2, 28.6)	12.39	153.51	0.15	0.92
Energy production	19	14.69	(12.9, 16.4)	4.40	19.36	0.76	0.59
Roads and highways	34	33.34	(29.1, 37.5)	14.51	210.54	0.16	1.33
Railways and underground	3	25.97	(9.4, 42.5)	12.20	148.84	0.17	1.04
Ports, airports	6	23.15	(19.3, 27.1)	4.89	23.91	0.97	0.92
Water supply, transport and distribution	4	10.68	(8, 13.3)	2.45	6.00	1.78	0.43
Telecommunication infrastructures	8	24.11	(19.9, 28.3)	6.43	41.34	0.58	0.96
Industries and other productive investments	10	26.71	(20.6, 32.7)	10.58	111.94	0.24	1.07
Overall sample	98	25.03	(22.9, 27.2)	10.66	113.65	0.22	1.00
Exit fiscal year 1990-1997							
Energy transport and distribution	46	22.39	(17.7, 27.1)	19.05	362.73	0.06	0.98
Energy production	65	15.29	(13.7, 16.7)	7.75	60.10	0.25	0.67
Roads and highways	78	36.61	(32.9, 40.2)	19.23	369.88	0.10	1.61
Railways and underground	14	25.73	(20.9, 30.5)	10.12	102.33	0.25	1.13
Ports, airports	27	25.22	(23.5, 26.9)	5.31	28.20	0.89	1.11
Water supply, transport and distribution	28	12.78	(10.6, 14.9)	6.89	47.50	0.27	0.56
Telecommunication infrastructures	22	24.78	(22.2, 27.3)	6.96	48.48	0.51	1.09
Industries and other productive investments	25	26.57	(20.3, 32.8)	18.18	330.39	0.08	1.17
Overall sample	305	22.77	(21.4, 24.1)	14.16	200.47	0.11	1.00
All evaluated projects 1974-1997							
Energy transport and distribution	126	21.03	(18.6, 23.4)	16.45	270.60	0.08	0.97
Energy production	187	14.80	(14.1, 15.5)	5.97	35.64	0.42	0.68
Roads and highways	337	28.17	(26.6, 29.7)	17.88	319.69	0.09	1.30
Railways and underground	77	20.74	(19.4, 22)	6.86	47.06	0.44	0.95
Ports, airports	95	24.09	(22.6, 25.6)	8.81	77.62	0.31	1.11
Water supply, transport and distribution	98	11.84	(10.8, 12.9)	6.29	39.56	0.30	0.54
Telecommunication infrastructures	86	20.55	(19.2, 21.8)	7.30	53.29	0.39	0.95
Industries and other productive investments	104	23.02	(20.1, 25.9)	17.99	323.64	0.07	1.06
Overall sample	1110	21.73	(22.4, 21.1)	13.44	180.75	0.12	1.00

Notes: see Tab.2

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