An International Comparison of the Financial and Economic Rate of Return of Development Projects

Massimo Florio

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Dipartimento di Economia Politica e Aziendale
Università degli Studi di Milano

via Conservatorio, 7
20122 Milano
tel. ++39/02/76074501
fax ++39/02/76009695

E Mail: dipeco@unimi.it

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Massimo Florio

Department of Economics
University of Milan
Via Conservatorio 7
20122 Milano - Italy
tel. 0039 +2-76074523
fax 0039 +2-76009695
e-mail: Massimo.Florio@unimi.it

Summary

In this paper we analyse data on the rates of return of investment projects sponsored by three international institutions: the European Union, the European Bank for Reconstruction and Development, the World Bank.

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. 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 any other relevant sampling criterion.

Introduction

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

For the EU we consider a data base of 400 major projects built for the European Commission, DG XVI Regional Policies and Cohesion.[1] For the EBRD, we consider data on 253 projects, collected by the Office of the Chief Economist and made available 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).

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[2]. 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 any other relevant sampling criterion.

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 because more information is

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

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

needed, 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.
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 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.

Fig. 1. The four project rates of return

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

Sample mean and standard deviation by:

- sectors
- country
- institution
- year of appraisal
- ......

The paper is in the following sections: first we present data and the framework of analysis, second we discuss financial rates of return data, third economic rates of return, fourth the wedge between FRRs and ERRs, fifth RERR data, sixth we bring together our findings at sectoral level, and propose some interpretations and conjectures on systematic variations of rates of return; finally we discuss possible implications for project appraisal and for further research.

1. Data and framework of analysis

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.
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 may 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 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 appropriated 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.

Whatever the reasons for different average values, the first thing we need to know is whether we can thrust that these score 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.

As said, there are four sets of basic data we need: financial and economic rates of return, both ex-ante and ex post.[3]
We extract samples by sectors and originating sources of the data and treat these samples as experiments.

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).

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 FRR and ERR, respectively ex-post and ex-ante, will tell us whether the perhaps unavoidable optimism bias at time of appraisal is eavenly distributed across sectors. 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 infrastuctures; water supply (transport and distribution); forests and natural parks; telecommunications; industry and other productive investments.

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

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 trasport 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, trasport 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
Total	135	183	170	108	98	305	1110	305	1401

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.

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).

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 on many other potentially interesting variables was not attempted at this stage.

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)[4].

2. 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. 2 and 3 presents FRR data respectively for EU and EBRD: sectoral and total averages, variances, standard deviations, confidence intervals at the 5% level, coefficients of variation.

TAB.2 Financial rates of return - EU.

SECTORS	*Project number*	*FRR Average*	*FRR Std. Dev.*	*Sector average / total average*
Energy trasport and distribution	4	5.1	6.2	0.4
Energy production	2	10.8	0.0	0.9
Roads and highways	12	3.9	2.9	0.3
Railways and underground	34	6.6	4.2	0.5
Ports, airports	9	9.7	4.2	0.8
Water supply, trasport and distribution	10	-1.0	8.1	-0.1
Industries and other productive investments	64	19.6	14.6	1.6
Total	135	12.2	12.9	1.0

Notes:
See Tab. A.1 in the Statistical Appendix for more detailed informations.

[4] 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.

TAB.3 Financial rates of return - EBRD

SECTORS	*Project number*	*FRR Average*	*FRR Std. Dev.*	*Sector average / total average*
Energy trasport and distribution	10	21.61	8.34	0.94
Energy production	19	25.71	14.23	1.12
Roads and highways	5	17.68	3.35	0.77
Railways and underground	5	18.36	7.93	0.80
Ports, airports	6	26.05	5.35	1.13
Water supply, trasport and distribution	13	15.07	5.61	0.65
Telecommunication infrastructures	29	27.41	15.53	1.19
Industries and other productive investments	83	23.16	8.52	1.01
Total sample	170	23.04	10.79	1.00

Notes: see Tab.A.2 in the Statistical Appendix.

A first remark concerns the striking difference in the total sample average FRR: EBRD 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 striking difference of ex ante ERR also in these sectors.

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 4 presents the results of this test. The methodology is explained in the Statistical Appendix, Section A.

TAB.4 Test for variance of FRR - EU and EBRD

Sectors	*F*	*F(a)* *a=0.05*	*Test results*
Energy trasport and distribution	1.8	8.8	ACC. H_0
Energy production	∞	247.0	REJ. H_0
Roads and highways	1.30	3.4	ACC. H_0
Railways and underground	3.60	2.7	REJ. H_0
Ports, airports	1.60	3.7	ACC. H_0
Water supply, trasport and distribution	2.10	2.8	ACC. H_0
Industries and other productive investments	2.90	1.5	REJ. H_0
Total sample	1.43	~1	REJ. H_0

Notes: if we choose to set α=0.01, H_0 is accepted also for sector 4 (Railways and underground). For more detailed informations on the test see statistical appendix, Tab.A.3

Results of the test for variance may be used for check the existence of significant differences between sample averages. Results of the sample average test are reported in Tab.5.
Details are in the appendix tables A.3, A.4

TAB.5 Test for averages of FRR: EU and EBRD.

Sectors	*t*	*t(a/2)* *a=0.05*	*Test results*
Energy trasport and distribution	3.55	2.18	REJ. H_0
Energy production	*2.10*	*2.09*	REJ. H_0
Roads and highways	8.51	2.13	REJ. H_0
Railways and underground	*2.75*	*2.03*	REJ. H_0
Ports, airports	6.60	2.16	REJ. H_0
Water supply, trasport and distribution	5.65	2.08	REJ. H_0
Industries and other productive investments	*2.00*	*1.97*	REJ. H_0
Total sample	*1.977*	*1.967*	REJ. H_0

Notes: if we choose to set α=0.01, H_0 is accepted also for sector 6 (Water supply, transport and distribution). For more detailed informations on the test see statistical appendix, Tab.A.4

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%), is likely to reflect true differences in the two project populations.

Because these are ex-ante rates of return, there are two possible interpretations:

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

b) true differences in project rentability, 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 may be ascertained by the collection of ex-post FRRs, not yet available for the two institutions.

3. 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.[5]
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[6]. Thus we have additional sources of variability, that should be added to the variability of FRRs.

Tables 6-7-8 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.

TAB.6 Economic rates of return - EU.

SECTORS	*Proj. n°*	*ERR Average*	*ERR Std. Dev.*	*Sector average / total average*
Energy trasport and distribution	3	14.19	9.36	0.85
Energy production	3	11.70	6.48	0.70
Roads and highways	91	18.63	13.23	1.11
Railways and underground	47	16.68	11.83	0.99
Ports, airports	14	17.43	12.43	1.04
Water supply, trasport and distribution	23	18.92	12.31	1.13
Industries and other productive investments	2	15.17	7.30	0.90
Total sample	183	17.19	11.73	1.00

Notes: For more detailed informations see statistical appendix, Tab.B.1

TAB.7 Economic rates of return - EBRD.

SECTORS	*Proj. n*	*ERR Average*	*ERR Std. Dev.*	*Sector average / total average*
Energy trasport and distribution	11	35.7	13.01	1.26
Energy production	15	44.4	26.50	1.57
Roads and highways	15	23.5	9.69	0.83
Railways and underground	7	21.4	8.58	0.76
Water supply, trasport and distribution	1	25.9	n.c.	0.91
Telecommunication infrastructures	18	38.6	16.48	1.36
Industries and other productive investments	42	28.3	15.74	0.89
Total sample	109	31.8	17.68	1.00

[5] 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.
[6] Some projects have been evaluated taking the monetary variables at costant dollars, some at current dollars and others in national currency.

Notes: For more detailed informations see statistical appendix, Tab.B.2.

TAB.8 Economic rates of return - WB (Approved fiscal year 1988-1997)

SECTORS	*Proj n°*	*ERR Average*	*ERR Std. Dev.*	*Sector average / total average*
Energy trasport and distribution	14	22.94	12.39	0.92
Energy production	19	14.69	4.40	0.59
Roads and highways	34	33.34	14.51	1.33
Railways and underground	3	25.97	12.20	1.04
Ports, airports	6	23.15	4.89	0.92
Water supply, trasport and distribution	4	10.68	2.45	0.43
Telecommunication infrastructures	8	24.11	6.43	0.96
Industries and other productive investments	10	26.71	10.58	1.07
Total sample	98	25.03	10.66	1.00

Notes: For more detailed informations see statistical appendix, Tab.B.3.

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, 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. 9 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.9 Comparison between ERRs average values.

SECTORS	*EBDR*	*WB*[1]	*EU*
Energy trasport 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, trasport 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]
Total 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, 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 population, while we consider sectors as a 9-level factor.

Then we study variability between the samples and within samples. Methodology is explained in Statistical Appendix, Section B.
The results we get are shown in Table 10 (a,b) and allow us to reject H_0 for case where level factor are both the institutions and the sectors.

TAB 10.a Variance analysis: factor is sector.

	Df	*Variance*	*F*	*F(2,22)* a *= 0.05*	*Test result*
Between groups	2	396.26	9.06	3.52	REJ. H_0
Within the groups	19	43.73			

Note: the institutions are the samples of a population and the sectors are the levels of a factor
For more detailed informations see Statistical Appendix, Tab.B.5.

TAB 10.b Variance analysis: factor is institution.

	Df	*Variance*	*F*	*F(7,14)* a *= 0.05*	*Test result*
Between groups	7	1425.57	14.44	2.76	REJ. H_0
Within the groups	14	98.73			

Note: sectors are the sample of a population and institution are a factor with three level
For more detailed informations see Statistical Appendix, Tab.B.6.

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 11-12.

TAB.11 Test for variance ERR

SECTORS	*F*	*F(a)* *a=0.05*	*Test results*
EBRD and EU			
Energy trasport and distribution	1.93	19.40	ACC. H_0
Energy production	16.72	19.42	ACC.H_0
Roads and highways	1.86	2.20	ACC. H_0
Railways and underground	1.90	3.74	ACC. H_0
Industries and other productive investments	4.64	251.10	ACC. H_0
Total sample	2.27	1.32	REJ. H_0
EBRD and WB [1]			
Energy trasport and distribution	1.10	2.67	ACC. H_0
Energy production	36.27	2.29	REJ. H_0
Roads and highways	2.24	2.29	ACC. H_0
Railways and underground	2.02	5.14	ACC. H_0
Telecommunication infrastructures	6.57	3.48	REJ. H_0
Industries and other productive investments	2.18	2.82	ACC. H_0
Total sample	2.75	1.39	REJ. H_0
WB[1] *and EU*			
Energy trasport and distribution	1.75	19.42	ACC. H_0
Energy production	2.17	3.55	ACC. H_0
Roads and highways	1.20	1.57	ACC. H_0
Railways and underground	1.06	3.20	ACC. H_0
Ports. airports	6.46	4.65	REJ. H_0
Water supply. trasport and distribution	25.23	8.65	REJ. H_0
Industries and other productive investments	2.13	240.50	ACC. H_0
Total sample	1.21	1.35	ACC. H_0

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

For more detailed informations see statistical appendix, Tab.L.

TAB.12 Test for averages of ERR

Sectors	*t*	$t_{(a/2)}$ $a=0.05$	*Test results*
EU and EBRD			
Energy trasport and distribution	2.65	2.18	REJ. H_0
Energy production	2.08	2.12	ACC. H_0
Roads and highways	1.37	1.99	ACC. H_0
Railways and underground	1.02	2.01	ACC. H_0
Industries and other productive investments	1.16	2.02	ACC. H_0
Total sample*	1.967	1.968	(a)
EBRD and WB [b]			
Energy trasport and distribution	2.51	2.07	REJ. H_0
Energy production*	2.14	1.98	REJ. H_0
Roads and highways	-2.39	2.01	REJ. H_0
Railways and underground	-0.68	2.31	ACC. H_0
Telecommunication infrastructures*	2.18	2.06	REJ. H_0
Industries and other productive investments	0.30	2.01	ACC. H_0
Total sample*	1.978	1.97	(a)
EU and WB [b]			
Energy trasport and distribution	-1.14	2.13	ACC. H_0
Energy production	-1.03	2.09	ACC. H_0
Roads and highways	-5.39	1.98	REJ. H_0
Railways and underground	-1.32	2.01	ACC. H_0
Ports, airports*	2.27	2.10	REJ. H_0
Water supply, trasport and distribution*	2.28	2.06	REJ. H_0
Industries and other productive investments	-1.45	2.23	ACC. H_0
Total sample	-4.54	1.97	REJ. H_0

Notes: see Tab.5

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

b) Projects approved in fiscal years 1988-97

For more detailed informations see statistical appendix, Tab.B.7.

The comparison between Tab.5 and Tab.12 for EU and EBRD projects shows that while H_0 is generally rejected for FRR, it is commonly accepted for ERR.

This, we think, is an important result. We suggest the following interpretation: additional variability of economic rates of return as compared with financial rates of returns may be explained by inconsistent 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. We cannot prove this but a sample of published WB reports and our reading or unpublished EU and EBRD projects reports, confirm our suggestion (See Appendix)[7].

[7] 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.

4. 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 differente 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.
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).

Tab 13 Comparison between FRR and ERR: EBRD

Sectors	*Project n°*	*FRR*	*ERR*	*(ERR-FRR)/FRR*
Energy trasport 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, trasport 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
Total	93	23.61	33.76	0.43

Note: sector 2 of EU has only one observation and FRR and ERR have the same value

Tab 14 Comparison between FRR and ERR: EU

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

Note: we take only the sector with a significant number of observation.

We report in Tab. 13 and 14 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 so wide that we may suspect a methodological bias. Tipically the shadow price or 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. Moreover EBRD transport projects show rather surprisingly high financial rates of return. This may explain the large value of the correction in the Eu projects, but only project by project analysis could reject other explainations. 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).

For methodology see section C, on the Statistical Appendix.

Tab.15 Comparison between ERR and FRR.

	EU			*EBRD*		
Sectors	*Project n°*	*FRR*	*ERR*	*Project n°*	*FRR*	*ERR*
Energy trasport 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)	-10.26			-12.12		
Standard deviation	3.70			5.69		
t	-4.805			-4.26		
$t_{(n-1, \alpha = 0.05)}$	± 4.303			± 3,182		
Test result	Rej. H_0			Rej. H_0		

Notes: For more detailed informations see statistical appendix, Tab.C.1, C.2.

5. 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.

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).

Tab. 16 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. 17).

Tab.16 WB- ERR ex-ante and ex-post

Approval fiscal year 1988-97			
Sectors	*Projects n°*	*ex-ante*	*ex-post*
Energy trasport and distribution	14	22.94	25.42
Energy production	19	14.69	11.97
Roads and highways	34	33.34	33.84
Railways and underground	3	25.97	19.67
Ports, airports	6	23.15	30.62
Water supply, trasport and distribution	4	10.68	6.53
Telecommunication infrastructures	8	24.11	19.79
Industries and other productive investments	10	26.71	17.63
Total	84	29.21	28.02
Exit fiscal year 1990-1997			
Sectors	*Projects n°*	*ex-ante*	*ex-post*
Energy trasport and distribution	46	22.39	21.23
Energy production	65	15.29	15.06
Roads and highways	78	36.61	34.07
Railways and underground	14	25.73	16.63
Ports, airports	27	25.22	23.81
Water supply, trasport and distribution	28	12.78	8.50
Telecommunication infrastructures	22	24.78	21.65
Industries and other productive investments	25	26.57	17.39
Total	259	28.91	26.09
All evaluated projects 1974-1997			
Sectors	*Projects n°*	*ex-ante*	*ex-post*
Energy trasport and distribution	126	21.03	16.76
Energy production	187	14.80	12.86
Roads and highways	337	28.17	26.35
Railways and underground	77	20.74	14.55
Ports, airports	95	24.09	20.87
Water supply, trasport and distribution	98	11.84	7.36
Telecommunication infrastructures	86	20.55	19.49
Industries and other productive investments	104	23.02	13.65
Total	984	24.51	21.09

TAB. 17 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 trasport 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, trasport 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
Total	-0.04	-0.10	-0.14

In the following table 18, we report the results of a statistical tests on the average differences. Details in the Statistical Appendix, Tab. D.1, D.2, D.3.

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[8].

TAB. 18 WB. ERR ex-ante and ex-post,.

	Approval fiscal year 1988-97	*Fiscal year 1990-97 exit year*	*Evaluated 1974-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

Notes: For more detailed informations see Statistical Appendix, Tab. D.1, D.2, D.3

6. Intersectoral comparisons

In order to see some implications of the above analyisis 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.

[8] 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.

Thus we prefer to standardize data using the averages 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 19, 20 and briefly discussed below.

TAB. 19 Comparisons

	$FRR_{sector\ i}/FRR_{sector\ 9}$		$ERR_{sector\ i}/ERR_{sector\ 9}$		
Sectors	*EBDR*	*EU*	*EBRD*	*WB*[1]	*EU*[2]
Energy trasport and distribution	0.93	0.26	1.25	0.86	0.72
Energy production	1.11	0.55	1.55	0.55	0.60
Roads and highways	0.76	0.20	0.82	1.25	0.95
Railways and underground	0.79	0.33	0.75	0.97	0.85
Ports, airports	1.12	0.50	3.49	0.87	0.89
Water supply, trasport and distribution	0.65	-0.05	0.90	0.40	0.97
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 projects for fiscal year 88
2 For EU we used as a benchmark FRR instead ERR of industry (see in the text).

TAB. 20 WB. $RERR_{sector\ i}/RERR_{sector\ 9}$

Sectors	*FY 88*	*FY 90-97*	*Eval. 74-*
Energy trasport 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, trasport 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 thus 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 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 shows 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. Surprisingly, the World Bank Water projects 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 (an example of calculation from one study is in the Appendix, the projects 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).

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 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. We report in the Appendix some examples of how the shadow prices of Energy are calculated in typical recent WB projects. A cursory reading of these 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. In Appendix we report some examples of cost-benefit analysis of Transport projects at the WB. 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 (see also an example of a Forestry project in the Appendix).

Many of the above mentioned comparisons may be more interesting when discussed using ex post returns. As said unfortunately these are available for the WB only, and just for the ERRs. Table 20 shows these data for three different samples. 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: 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 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.

7. Concluding remarks and implications for project analysis

This paper showed how to use rates of return as the starting point for the formulation of important questions concerning the appraisal and planning of development projects.
In this final section we discuss some of our findings and directions for future research.

a) 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 easy to discover that EBRD has in all other sectors much higher expectations than EU (Tab. 19). 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 re-estimated FRRs, something that we would strongly suggest. The first question may imply a more detailed analyis of individual projects. In any case, differences between expectations in Western Europe and Eastern Europe are very large indeed and it would be extremely useful to build a FRR database for the World Bank as well, in order to see how their data compare.

b) We have seen (Tab. 19) 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.

c) 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 (Tables 13-14). 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 (Tab.9): this shows that the two samples differ for the absolute level of the expected financial rates of return, and this is rather interesting to explain.

d) 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 just reported their results (tab15) and tested them. Tables 16 and following show that 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 is the starting point for further analysis.

Obviously only 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 of analysis we propose may suggest which are the sectors more in need of review.

Let us now 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 method 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 determning 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 take 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, we suggest that the recognition of the existence of differences in methods of analysis should just be the starting point for further analysis and elaboration. We suggest the following step by step procedure.

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

Second, when we discover that for example, Water and sanitation projects ERRs show sistematically relative low returns as compared with Industry (see for examble the World Bank sample in Tables 9 and 19) 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.

Third, 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, 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.

A final remark concerns the 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, 1994, 1996,1997a, 1997b, 1998) 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 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) 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.

A more detailed analysis is provided by Battaile, Candler (1997). They 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 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 suggest further analyisis pointing either on the revision of 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.

Appendix

In this Appendix we give examples of the calculation of social benefits and consequently of economic rates of return in a small sample of recent World Bank projects. Sources are the Staff Appraisal Reports, now publicly available. We have considered two countries only, Albania and Indonesia, and four sectors: energy, water, transport, forestry. Staff Appraisal Reports were selected at random.

Energy

The 'Renewable energy small power projects" for Indonesia (May 1997, Re 16266 IND) forecasts ERR 74% adding-up tariff revenues and consumer surplus (from a simple estimation of a demand curve) on the benefit side.
In the same country, the "2nd Power Transmission and Distribution Project (January 1996, Re 15048-IND) forecasts an ERR 37% using the following conventions: "For industrial consumers, willingness-to-pay is estimated by the cost of self generation from a captive diesel plant. For resident consumers WTP is estimated aggregating two components: a) consumer surplus in the diverted market, i.e. costs of kerosene by electricity for lighting and b) consumer surplus in the new market, i.e. the benefit of increased consumption because of the availability of lower cost electricity. WTP for commercial and public and other users is assumed equal to tariff levels".
An earlier project, "The Sumatra and Kalimantan power project" (Re12662-IND) forecasts ERR15% based on incremental consumer surplus. Thus, while the average tariff revenue per KWH was USD cents 7.0, the consumer surplus for industry was 4.42 and for residential users 11.95. The weighted average of the two consumer surplus was calculated 6.5 USD cents per KWH. As a result tariff revenues per year of 22 USD millions were increased of additional 16.71 millions USD of consumer surplus. The following year the "Second Rural Electrification project" (February 1995, Re 12920-IND) forecasts ERR 21%, based on a residential tariff of 5.99 cents per KWH and a consumer surplus of 12.77.
Two examples from Albania. “The Power Loss Reduction Project” (December 1994-Re 12779) forecasts an ERR 21% from investing in the reduction of non technical losses (e.g. theft) on the basis of cost savings minus consumer wilingness to pay, the latter one derived by the estimation of a price elasticity of -0.02. The "Power Transmission and Distribution Project" (January 1996, Re 14532) forecasts an ERR 24% based on loss reduction in trasmission, valued at long-run marginal costs, on loss reduction in distribution, again based on long run marginal costs, and on reduced outages on the basis of cost of unserved energy of 0.25 USD per KWH.

Forestry
The "Forestry Projects" for Albania (March 1996- Re 15104) estimates ERR 49.4% with road rehabilitation and 16.3 without this component. The gap between FRR and ERR in some activities is the following one

	FRR	ERR
thinning beech	6.1	17.4
thinning pine	11.6	29.6
improved pasttures	19.2	53.8

While FRR is based on market prices for the incremental value of timber, the adjustment for ERR include a value for reduced soil erosion and a shadow wage of unskilled labor at 0.3 of actual wages "in view of the current high rate of unemployment”.

Water

The "Durres Water supply rehabilitation project" (April 1994- Re 12316 ALB) forecasts an ERR 10,6% on the following assumptions: "The incremental rate of return has been calculated using the value of a cubic meter as a proxy for benefits.….based on a household 'willingnes to pay' survey undertaken by the feasibility study consultants in january 1993 which determined that consumers would pay ...0.22 USD/mc"[9]. After correcting for inflation, this figure was re-evalueted to 0.26 USD, or 25 Lek, against 5 Lek for actual tariffs (40-50 Lek for industry and hotels).

Transport

In Indonesia, the "Strategic Urban Roads Infrastructure Project" (June 1996 - Re 15295) estimates on the basis of
- vehicle operating cost savings
- time savings
- reduced accidents benefits.

ERR is 30%, but reduces to 17% without time savings (for some components the difference is as high as from 27% to 6%).
In the same country the " Northern Sumatra Region Road Project" (January 1988, Re 17331-IND) expects an ERR 30% assuming the value of time for users 430 Rp per hour/passenger. The "Railway efficiency project" (October 1996, Re 15646-IND) expected ERR 20.9% and FRR 11,7%. The difference is based on estimates in transit time costs, with value of time of 1400 Rp, plus reduction in air pollution and accidents. The "Second Highway sector investment project" (February 1994, Re 12161 IND) expects an ERR 38% based on VOC savings.
VOC savings plus reduction of maintenance costs led to an expected ERR 30% for the Albanian "National Roads Project", including the rehabilitation of around 50 Km (May 1966, Re 15464-ALB). In the same country the "Rural Road Project" (May 1995), including the rehabilitation of around 975 Km expects ERR 33%, based on VOC approach on the benefit side (using the World Bank HDM III Model) and on the cost side the following assumptions: "Since unemployment is estimated to be around 30 percent, the cost of unskilled labour was valued at 50% of the wage rate". Diesel fuel price was adjusted ("retail price less border price plus the cost of distribution") as other prices. Just per comparison: the "Irrigation Rehabilitation project" (July 1994, Re 12609-ALB) says that unskilled labor opportunity cost is near to zero and fixes a shadow wage rate of 0.50 USD per day (Lek 50)
Again in Albania, for the "Durres Port Project" (April 1998, Re 17652), "The analysis was based on market prices except that labour was valued at 60% of the market rate", because unemployment was estimated at 25%, or 40% of unskilled workers. The expected ERR was 18.9% including in the benefits after tax cash flows for the port authority, harbor taxes, taxes paid by the port authority, custom revenues, savings from reduced ship waiting time, reduction of pilferage[10].

[9] The "Fourth Dhaka Water supply project" in Bangladesh (November 1996 - Re 16144 BD) estimates ERR 22% after having observed that while water tariff is as low as USD 0.09 per mc, retail price for consumers who do not have access to the network is 0.675 USD per cubic meter. Willingness to pay is estimated 8 times the tariff, but in some cases up to 50 times it.

[10] The World Bank should be praised for its decision to make avalaible these information to the public. We hope other institution will follow. Our feeling is that inconsistencies in cost-benefit analysis is widespread among other international bodies and government departments (Florio, 1997). This can be easily corrected if the whole project appraisal process becomes more transparent.

Statistical appendix

A. Financial rates of return

TAB.A.1 Financial rates of return - EU.

SECTORS	*Project number*	*FRR Average*	*Confidence intervals (a=0.05)*	*FRR Std. Dev.*	*FRR variance*	*Coefficient of variation*	*Sector average / total average*
Energy trasport 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, trasport 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
Total	135	12.2	(14.4, 9.9)	12.9	166.2	0.07	1.0

Notes:

Coefficient of variation $= \frac{\bar{X}}{S^2}$; Standard deviation $= \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$

TAB. A.2 Financial rates of return - EBRD

SECTORS	*Project number*	*FRR Average*	*Confidence intervals (a= 0.05)*	*FRR Std. Dev.*	*FRR variance*	*Coefficient of variation*	*Sector average / total average*
Energy trasport 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, trasport 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
Total sample	170	23.04	(21.4, 24.7)	10.79	116.47	0.20	1.00

In the section 2 we tested the homogeneity of the variances of the EU and EBRD total samples and of the single sectors of the two institutions.
The two alternative hypotheses we have utilised, are:

$H_0 : \sigma^2_1 = \sigma^2_2$

$H_1 : \sigma^2_1 \neq \sigma^2_2$

We use F-statistics at 5% level to check for homoschedasticity (Tab. A.3) and to use this information in the comparison of sample averages. We use the following formula:

$$\text{TEST F}_{(n_1-1,\ n_2-2)} = S_1^2 / S_2^2$$

where S^2_1 and S^2_2 are the variance estimates, $S^2_1 > S^2_2$ and n_1 is the numerousness 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 hypothesis, i.e. there are significant differences between the variances.

TAB. A.3 Test for variance of FRR - EU and EBRD

Sectors	*Instit. n_1*	*F*	*Degrees of freedom*		*F(a) a=0.05*	*Test results*
			n_1-1	*n_2-1*		
Energy trasport and distribution	EBRD	1.8	9	3	8.8	ACC. H_0
Energy production	EBRD	∞	18	1	247.0	REJ. H_0
Roads and highways	EBRD	1.30	4	11	3.4	ACC. H_0
Railways and underground	EU	3.60	4	33	2.7	REJ. H_0
Ports, airports	EBRD	1.60	5	8	3.7	ACC. H_0
Water supply, trasport and distribution	EU	2.10	9	12	2.8	ACC. H_0
Industries and other productive investments	EU	2.90	63	82	1.5	REJ. H_0
Total sample	EU	1.43	134	140	~1	REJ. H_0

Results of the test for variance may be used for check the existence of significant differences between sample averages.
Exactly we can test the two hypothesis:

$H_0 : \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

with the statistic $\bar{X}_1 - \bar{X}_2$, where $\bar{X}_i$ is the sample average.
For groups that are homoschedastic, we can estimate σ^2 with S^2_p where S^2_p is the weighted average of the estimates S^2_1 and S^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 like statistic test the variable:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

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 (Behrens-Fisher' problem). In this case we can approximate the statistic t with the variable:

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

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

TAB.A.4 Test for averages of FRR: EU and EBRD.

Sectors	*t*	*Df: n_1+n_2-2*	*t(a/2) a=0.05*	*Test results*
Energy trasport 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, trasport and distribution	5.65	21	2.08	REJ. H_0
Industries and other productive investments*	*2.00*	*145*	*1.97*	REJ. H_0
Total sample*	*1.977*	*274*	*1.967*	REJ. H_0

Notes: if we choose to set α=0.01, H_0 is accepted also for sector 6 (Water supply, transport and distribution).
*Sectors 2, 4, 9, and the total sample are heteroschedastic, so for this groups we used the statistic: $f = \frac{\left(s_1^2/n_1\right)t_1 + \left(s_2^2/n_2\right)t_2}{s_1^2/n_1 + s_2^2/n_2}$ where t_i is the value $t_{\alpha/2}$ of the distribution $t_{(n_i-1)}$.

B. Economic rates of return

TAB.B.1 Economic rates of return - EU.

SECTORS	*Proj. n°*	*ERR Average*	*Confidence intervals (a=0.05)*	*ERR Std. Dev.*	*ERR variance*	*Coefficient of variation*	*Sector average / total average*
Energy trasport 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, trasport 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	(30.2, 0.1)	7.30	53.35	0.28	0.90
Total sample	183	17.19	(15.5, 19.8)	11.73	137.55	0.12	1.00

Notes: see Tab.A.1.

TAB.B.2 Economic rates of return - EBRD.

SECTORS	*Proj. n*	*ERR Average*	*Confidence intervals (a=0.05)*	*ERR Std. Dev.*	*ERR variance*	*Coefficient of variation*	*Sector average / total average*
Energy trasport 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, trasport 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
Total sample	109	31.8	(28.5, 35.2)	17.68	312.5	0.10	1.00

Notes: see Tab.A.1.

TAB.B.3 Economic rates of return - WB

SECTORS	*Proj n°*	*ERR Average*	*Confidence intervals (a=0.05)*	*ERR Std. Dev.*	*ERR variance*	*Coefficient of variation*	*Sector average / total average*
Approved fiscal year 1988-1997							
Energy trasport 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, trasport 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
Total sample	98	25.03	(22.9, 27.2)	10.66	113.65	0.22	1.00
Exit fiscal year 1990-1997							
Energy trasport 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, trasport 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
Total sample	305	22.77	(21.4, 24.1)	14.16	200.47	0.11	1.00
All evaluated projects 1974-1997							
Energy trasport 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, trasport 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
Total sample	1110	21.73	(22.4, 21.1)	13.44	180.75	0.12	1.00

Notes: see Tab.A.1

Because of the high variance of the samples, 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 population, 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).

$$SS_T = SS_B + SS_W$$

It is possible to show that the ratio of variance between and within groups has distribution F with r-1 and N-r degrees of freedom[11] and to use this statistics for check the null hypothesis:
$H_0 \ \mu_1 = \mu_2 = ... = \mu_r$
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.
The results we get are shown in the tables B.4 and B.5 and allow us to reject H_0 for case where level factor are both the institutions and the sectors.

TAB.B.4 Analysis of variance and components of variance

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

TAB. B.5 Variance analysis: factor is sector.

	Deviation	*Df*	*Variance*	*F*	*F(2,22)*	a = 0.05
Between groups	792.53	2	396.26	9.06	3.52	
Within the groups	830.86	19	43.73			

Note: the institutions are the samples of a population and the sectors are the levels of a factor

TAB. B.6Variance analysis: factor is institution.

	Deviation	*Df*	*Variance*	*F*	*F(7,14)*	a = 0.05
Between groups	9979.00	7	1425.57	14.44	2.76	
Within the groups	1382.22	14	98.73			

Note: sectors are the sample of a population and institution are a factor with three level

[11] r is the number of factor and N is the total of observations.

TAB.B.7 Test for variance ERR

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

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

TAB.B.8 Test for averages of ERR

Sectors	*t*	*Df:* n_1+n_2-2	$t_{(a/2)}$ $a=0.05$	*Test results*
EU and EBRD				
Energy trasport 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
Total sample*	1.967	290	1.968	(a)
EBRD and WB [b]				
Energy trasport 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
Total sample*	1.978	205	1.97	(a)
EU and WB [b]				
Energy trasport 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, trasport and distribution*	2.28	25	2.06	REJ. H_0
Industries and other productive investments	-1.45	10	2.23	ACC. H_0
Total sample	-4.54	279	1.97	REJ. H_0

Notes: *see Tab.A.4

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

b) Projects approved in fiscal years 1988-97

C. The wedge between FRR and ERR

In the following tables C.1, C.2, C.3, D.1, D.2, D.3, we report the results of a statistical tests on the average differences, where we wish to check for the two hypothesis

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1 \neq \mu_2$

This can be done by the following formula:

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

This statistic has distribution t with n-1 degrees of freedom.

TAB.C.1 EU. Comparison between ERR and FRR.

Sectors	*Project n*	*FRR*	*ERR*	*difference between average*	*square of diff. between average*
Roads and highways	11	3.9	18.4	-14.51	210.67
Railways and underground	31	6.6	14.4	-7.80	60.87
Ports, airports	9	9.7	18.2	-8.47	71.67
Total				-30.78	343,20
Average difference	-10.26				
Standard deviation	3.70				
t	-4.805				
$t_{(2,\ \alpha = 0.05)}$	± 4.303				

TAB.C.2 EBRD. Comparison between ERR and FRR.

Sectors	*Project n*	*FRR*	*ERR*	*difference between average*	*square of diff. between average*
Energy trasport and distribution	8	18.5	31.0	-12.50	156.25
Energy production	15	28.1	44.4	-16.25	263.95
Telecommunications infrastructures	17	23.9	39.7	-15.78	249.08
Industries and other productive investments	39	25.1	29.1	-3.96	15.69
Total				-48.49	684.97
Average difference	-12.12				
Standard deviation	+5.69				
t	-4.26				
$t_{(3,\ \alpha = 0.05)}$	± 3,182				

D. Comparing ERR and RERR data

TAB. D.1 WB. ERR ex-ante and ex-post, Approval fiscal year 1988-97.

Sectors	*Approval fiscal year 1988-97*			*difference between average*	*square of diff. between average*
	Project n	*ex-ante*	*ex-post*		
Energy trasport and distribution	14	22.94	25.42	-2.48	6.15
Energy production	19	14.69	11.97	2.72	7.40
Roads and highways	34	33.34	33.84	-0.5	0.25
Railways and underground	3	25.97	19.67	6.3	39.69
Ports, airports	6	23.15	30.62	-7.47	55.80
Water supply, trasport and distribution	4	10.68	6.53	4.15	17.22
Telecommunication infrastructures	8	24.11	19.79	4.32	18.66
Industries and other productive investments	10	26.71	17.63	9.08	82.45
Total	84	29.21	28.02	16.12	227.62

Average difference	2.02
Standard deviation of difference	5.28
t	1.079
$t_{(7, \alpha = 0.05)}$	±2.365

TAB. D.2 WB. ERR ex-ante and ex-post, Fiscal year 1990-97 exit year.

Sectors	*FY 90-97 exit year*			*difference between average*	*square of diff. between average*
	Project n	*ex-ante*	*ex-post*		
Energy trasport and distribution	46	22.39	21.23	1.16	1.36
Energy production	65	15.29	15.06	0.23	0.05
Roads and highways	78	36.61	34.07	2.54	6.46
Railways and underground	14	25.73	16.63	9.10	82.87
Ports, airports	27	25.22	23.81	1.41	1.98
Water supply, trasport and distribution	28	12.78	8.50	4.28	18.36
Telecommunication infrastructures	22	24.78	21.65	3.13	9.78
Industries and other productive investments	25	26.57	17.39	9.18	84.35
Total	259	28.91	26.09	31.04	205.21

Average difference	3.88
Standard deviation	3.48
t	3.154
$t_{(7, \alpha = 0.05)}$	± 2.365

TAB. D.3 WB. ERR ex-ante and ex-post, evaluated 1974-present.

Sectors	Eval. 1974-present			difference between average	square of diff. between average
	Project n	ex-ante	ex-post		
Energy trasport and distribution	126	21.03	16.76	4.27	18.27
Energy production	187	14.80	12.86	1.95	3.79
Roads and highways	337	28.17	26.35	1.82	3.31
Railways and underground	77	20.74	14.55	6.19	38.32
Ports, airports	95	24.09	20.87	3.22	10.37
Water supply, trasport and distribution	98	11.84	7.36	4.48	20.07
Telecommunication infrastructures	86	20.55	19.49	1.06	1.13
Industries and other productive investments	104	23.02	13.65	9.37	87.82
Total	984	24.51	21.09	32.36	183.07

Average difference	4.05
Standard deviation	2.73
t	4.192
$t_{(7, \alpha = 0.05)}$	± 2.365

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